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Original Article

Conventional left atriotomy versus the superior septal approach for mitral valve replacement: a clinical controlled randomized trial

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Abstract

Background: The most effective techniques to enhance mitral valve visualization while reducing risks associated with the procedure are still debatable. Therefore, this study compared the results of conventional left atriotomy (LA) with those of the superior septa (SS) approach for mitral valve replacement (MVR).

Methods: This randomized controlled clinical trial included patients who underwent MVR between 2024 and 2025. The participants were randomly assigned to: Group A (n=27) included patients who underwent MVR through conventional LA, and Group B (n=33) included patients who had a SS incision for MVR.

Results: The mean age in Group A was 43.04±9.02 years, whereas that in Group B was 47.33±9.92 years (P=0.09). There were no differences in sex or smoking status between the groups (P=0.73 and 0.84, respectively). No statistically significant differences were observed in the preoperative clinical, echocardiography or laboratory data. Cardiopulmonary bypass and ischemic times were shorter in patients with the SS approach (87±12 vs. 81±8 min, P=0.048 and 70±10 vs. 65±6 min, P=0.01, respectively). The vasoactive inotropic score was significantly lower in patients in Group A (P=0.04). Mechanical ventilation [9 (7–12) vs. 12 (9–12) h, P=0.02], ICU stay [3 (3–5) vs. 4 (3–5) days, P=0.09] and hospital stay [9 (8–11) vs. 11 (9–12) days, P=0.01] were shorter in patients in Group A. There were no differences in postoperative atrial fibrillation, heart block, superficial wound infection, or re-exploration for bleeding between the groups. No significant difference in changes in the ejection fraction (β: -0.002 (95%CI: -0.03-0.028), P=0.86) left atrial diameter (β: -0.11 (95%CI: -0.29-0.07), P=0.23) end-systolic diameter (β: -0.06 (95%CI: -0.27-0.14), P=0.55) between the groups.

Conclusions: Both LA and the SS approach are viable options for MVR. A SS approach was associated with shorter operative times; however, LA was associated with faster postoperative recovery, with no difference in the complication rate. Further studies with large sample sizes and longer follow-up periods are warranted.

KEYWORDS

Mitral valve replacement; Left atriotomy; Superior septal approach; Atrial fibrillation

Article History

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Introduction

Mitral valve replacement (MVR) is among the most commonly performed cardiac procedures in developing countries because of the high prevalence of rheumatic heart disease [1-3]. However, the incidence of rheumatic heart

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disease has declined, and the prevalence of degenerative valve disease has increased owing to the aging of the population [4]. Mitral valve disease is the most prevalent valvular affection in rheumatic heart disease and MVR is the intervention of choice in symptomatic patients with severe valvular affection, with durable long-term outcomes compared to mitral valve repair [5, 6].

Good exposure is strictly required for MVR, especially in patients with calcification or previous repairs or replacements [7]. Several challenges exist during MVR, including visualization, which could be inadequate in patients with a small left atrium and right ventricular hypertrophy. Furthermore, previous mitral surgery complicates exposure because of adhesion and limited mobility of the surrounding tissues [8, 9]. Several approaches are available for mitral valve exposure, and left atriotomy (LA) and the trans septal approach are the most commonly used approaches [10]. The superior septal (SS) approach provides good mitral valve exposure; however, it can lead to injury of the sinus node artery and loss of sinus rhythm [11]. Lukac and associates reported a greater prevalence of pacemaker implantation after the SS approach than after the LA approach [12]. Optimizing mitral valve exposure with a lower complication rate is still the subject of investigations. The controversy surrounding optimizing mitral valve exposure focuses on the delicate balance between improving surgical accessibility and minimizing complication rates. The most effective techniques to enhance outcomes while reducing risks associated with the procedure are still debatable. Therefore, the study compared the results of conventional LA with those of the SS approach for MVR.

Patients and Methods

Study Design

This randomized controlled clinical trial included 60 patients who underwent mechanical mitral valve replacement through either conventional left atriotomy or the superior septal approach at two tertiary referral centers from January 2024 to March 2025. The study was approved by the local ethical committees of the participating centers, and patients signed an informed consent form before participating.

Groups and patients

The participants were randomly assigned to two groups via stratified blocked randomization. The randomization was stratified by the participating centers. A random sequence was generated via computer software, and the block size ranged between 3 and 5. Group A included patients who underwent MVR through conventional LA, and Group B included patients who had a SS incision for MVR.

We included patients of both sexes who underwent elective primary MVR, with an ejection fraction of more than 50%. Patients with severe renal or liver dysfunction, emergency surgery, concomitant procedures, coronary artery disease, redo surgery, heart failure or previous cerebrovascular accidents were excluded. Patients lost to follow-up were also excluded.

Data and outcomes

Preoperative data included age, sex, smoking status, and associated comorbidities (diabetes mellitus, chronic obstructive pulmonary disease, atrial fibrillation, and viral hepatitis). Patient symptoms in the New York Heart Association class were reported. Preoperative laboratory data included the international normalization ratio (INR) and hemoglobin and platelet levels. The baseline ejection fraction (EF), left ventricular end-systolic (LVESD) and end-diastolic (LVEDD) diameters, left atrial diameter and pulmonary artery systolic pressure (PASP) were collected. Operative data included cardiopulmonary bypass (CPB) and ischemic times. The postoperative hospital outcomes were complete heart block, a vasoactive inotropic score (VIS), the duration of mechanical ventilation, intensive care unit (ICU) admission and the length of hospital stay. Furthermore, new-onset atrial fibrillation, superficial wound infections and re-exploration for bleeding were reported.

The patients were followed in the outpatient clinic, and echocardiography was performed before discharge and after 3 and 6 months.

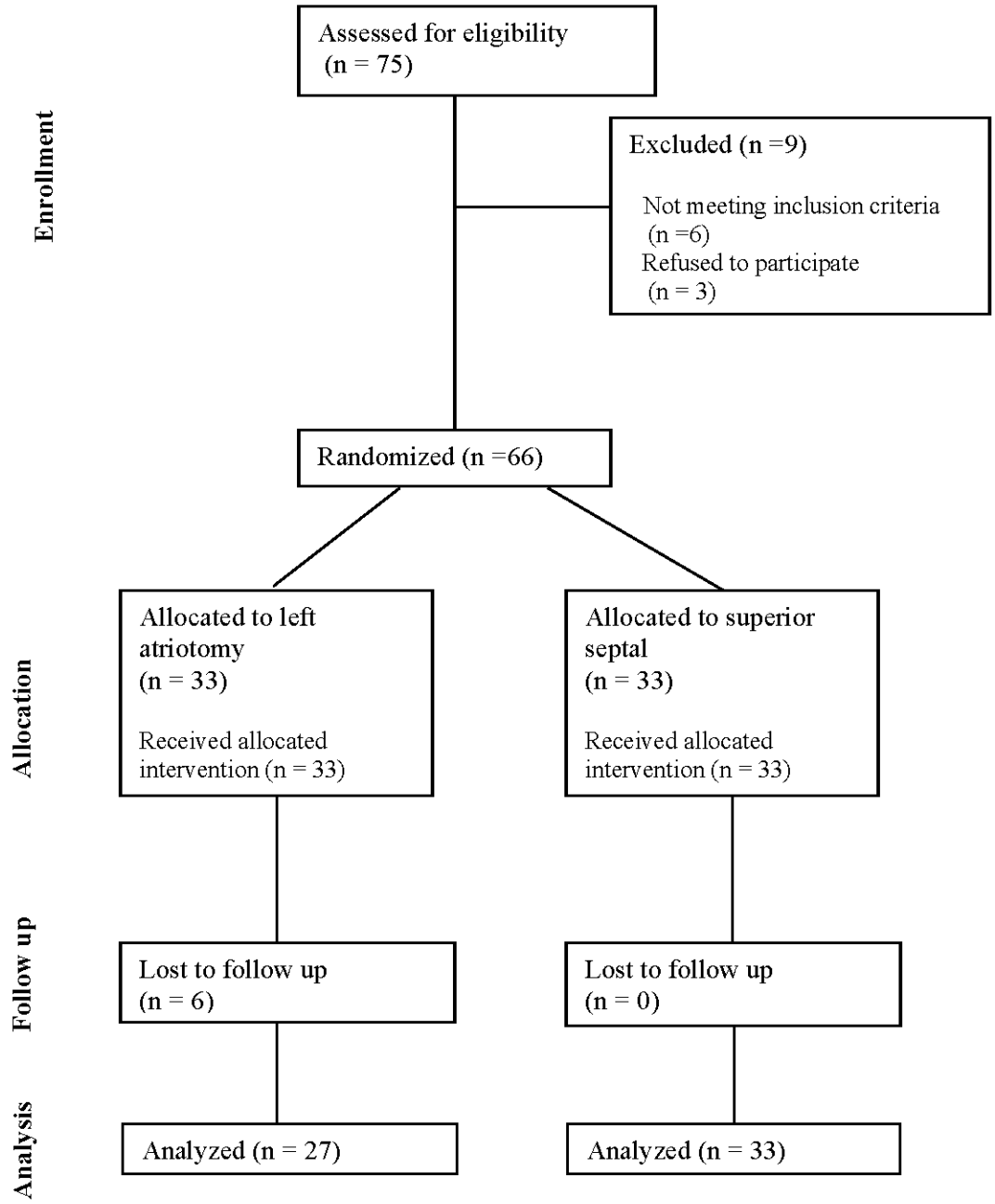

Figure 1: Study flowchart

Follow-up EF, LVESD and left atrial diameters are reported.

The primary outcome was the duration of hospital stay. While secondary outcomes were hospital complications and follow-up echocardiographic measures.

Techniques:

Both techniques were conducted via median sternotomy and aorto-caval cannulation. Cardioplegia was achieved through an antegrade method through an aortic root cannula via cold blood cardioplegia or custodiol cardioplegia. In patients with a SS incision, access to the mitral valve was gained through the right atrium via an incision that ran parallel to the atrioventricular groove. This incision was extended to the superior pole of the atrial septum, where a septal incision was created, continuing into the left atrium. For the LA approach, the mitral valve was accessed through a left atriotomy along Sondergard's groove. Once the procedure was finished, the incisions were closed using 3-0 proline sutures.

Sample size

In a previous study, the duration of hospital stay was 6 days for the standard group and 7 days

Table 1: Comparison of baseline and preoperative data between patients who underwent left atriotomy (Group A) and those who underwent superior septal approach (Group B). The data are presented as the means (SDs), medians (Q1--Q3) or numbers (%).

	Group A (n= 27)	Group B (n= 33)	P value
Age (Years)	43.04± 9.02	47.33± 9.92	0.09
Female	16 (59.26%)	21 (63/64%)	0.73
Smoking	8 (29.63%)	9 (27.27%)	0.84
Diabetes mellitus	7 (25.93%)	8 (24.24%)	0.88
COPD	3 (11.11%)	5 (15.15%)	0.72
NYHA III/IV	12 (44.44%)	13 (39.39%)	0.69
Atrial fibrillation	8 (29.63%)	11 (33.33%)	0.76
Viral hepatitis	4 (14.81%)	6 (18.18%)	0.73
Ejection fraction (%)	62 (56- 69)	62 (56- 69)	0.98
LVESD (cm)	3 (2.9- 3.5)	3 (2.9- 3.5)	0.78
LVEDD (cm)	5.1 (4.9- 5.2)	5 (4.3- 5.1)	0.14
Left atrial diameter (cm)	5 (4.5- 5.3)	4.4 (4.3- 4.6)	<0.01
PASP (mmHg)	60 (43- 70)	60 (46- 70)	0.90
Hemoglobin (mg/dl)	12.78± 0.64	12.75± 0.60	0.87
Platelets	284± 70	283± 66	0.91
INR	1.06± 0.12	1.09± 0.11	0.25

COPD: chronic obstructive pulmonary artery disease; LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter; NYHA: New York Heart Association; PASP: pulmonary artery systolic pressure

for the treatment group. The two groups had a standard deviation of 1.4. The allocation of patients was 1:1, and the type I error probability was 0.05, with a power of 0.8. Thirty-one patients in each group were required to fulfill these criteria [9].

Statistical analysis

Analysis was conducted via Stata 18 Now (Stata Corp, College Station, TX). Continuous data were evaluated for normality, and normal data are expressed as the means and standard deviations and were compared with t tests. Nonnormal data are presented as medians (Q1-Q3) and were compared with the Wilcoxon test. Categorical data are presented as absolute numbers and percentages. The chi-square test and Fisher's exact test were used for comparisons. Random effects models were used to compare the changes in ejection fraction, left ventricular systolic diameter, and left atrial diameter between and within groups, and β-coefficients and their 95% confidence intervals were reported. A P value of less than 0.05 was considered significant.

Results

Study sample

Group A included 27 participants, and Group B included 33 participants. Six patients in Group A were excluded because of loss to follow-up after randomization. The study flowchart is presented in Figure 1.

Baseline data

The average age in Group A was 43.04 ± 9.02 years, while in Group B it was 47.33 ± 9.92 years. There were no significant differences in sex distribution or smoking status between the two groups (P = 0.73 and P = 0.84, respectively). Additionally, no statistically significant differences were found in the prevalence of diabetes mellitus, chronic obstructive pulmonary disease, NYHA class III or IV, atrial fibrillation, or viral hepatitis between the groups.

Echocardiographic comparisons revealed no differences in ejection fraction, LVEDD, LVESD, or PASP. Notably, the left atrial diameter was significantly smaller in patients who underwent surgery via the SS approach compared to those

who had a LA (P < 0.01). Laboratory analyses also showed no differences in hemoglobin levels, platelet counts, or international normalized ratios (INRs) (Table 1).

Operative and postoperative data

Cardiopulmonary bypass and ischemic times were shorter in patients treated with the SS approach (P= 0.048 and 0.01, respectively). The VIS was significantly lower in patients in Group A (P= 0.04). Mechanical ventilation [9 (7–12) vs. 12 (9–12) h, P= 0.02], ICU stay [3 (3–5) vs. 4 (3–5) days, P= 0.09] and hospital stay [9 (8–11) vs. 11 (9–12) days, P= 0.01] were shorter in patients in Group A. There were no differences in postoperative atrial fibrillation, heart block, superficial wound infection, or re-exploration for bleeding between the groups (Table 2).

Follow-up

A total of 240 echocardiograms were available for analysis at the 6-month follow-up. The changes in ejection fraction did not differ significantly between the groups (β: -0.002, 95% CI: -0.03 to 0.028, P = 0.86) (Figure 2). Similarly, there was no significant change in left atrial diameter between the groups (β: -0.11, 95% CI: -0.29 to 0.07, P = 0.23) (Figure 3). Additionally, no significant difference was found in LVESD between the groups (β: -0.06, 95% CI: -0.27 to 0.14, P = 0.55) (Figure 4).

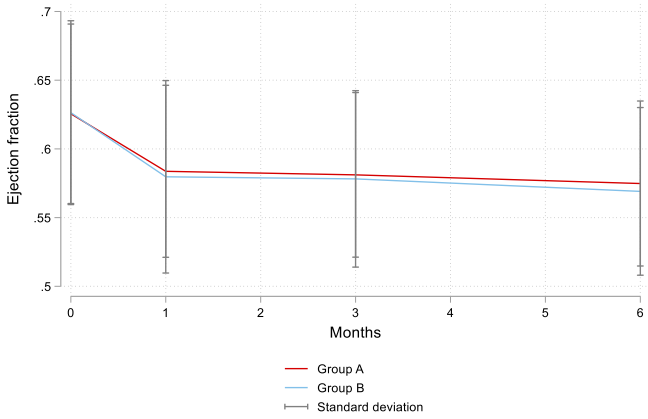

Figure 2: Changes in the ejection fraction at the 6-month follow-up in patients who underwent left atriotomy (Group A) vs. those who underwent the superior septal approach (Group B)

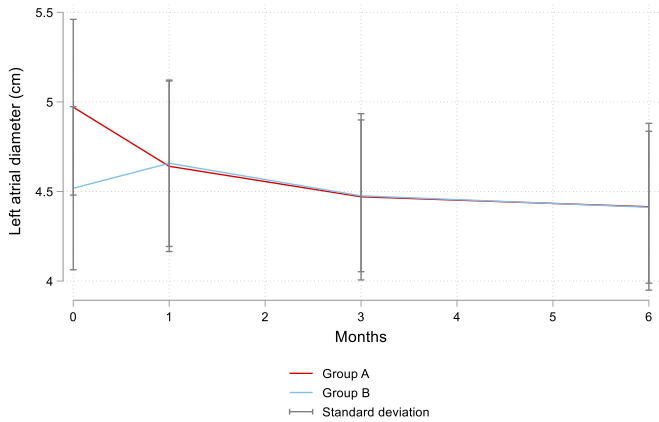

Figure 3: Changes in left atrial diameter at the 6-month follow-up in patients who underwent left atriotomy (Group A) vs. those who underwent the superior septal approach (Group B)

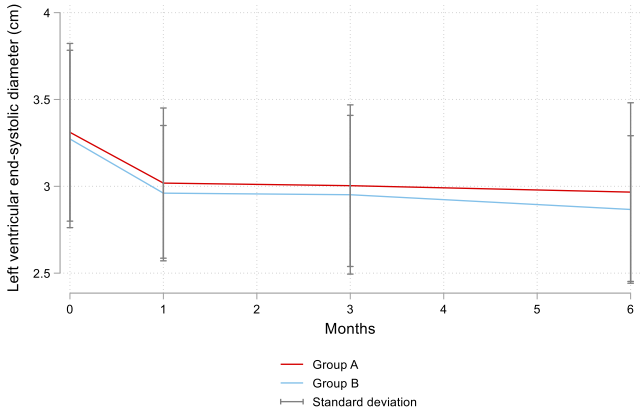

Figure 4: Changes in left ventricular end-systolic diameter at the 6-month follow-up in patients who underwent left atriotomy (Group A) vs. those who underwent the superior septal approach (Group B)

Discussion

This study presents a comparative analysis of conventional left atriotomy versus the superior septal approach for MVR, highlighting the ongoing debate in optimizing surgical exposure while minimizing complications. A total of 60 patients were included and randomly assigned to either the LA or SS approach. The primary outcome measured was the length of hospital stay, whereas secondary outcomes included various postoperative complications and echocardiographic measures over a six-month follow-up. The results indicated that patients who underwent LA had shorter durations of mechanical ventilation, ICU stays, and overall hospital stays than did those who underwent the SS approach. Cardiopulmonary bypass and ischemic times were shorter for the SS approach, but LA patients had lower VIS. Importantly, no significant differences were observed between

Table 2: Comparison of operative and postoperative data between patients who underwent left atriotomy (Group A) and those who underwent superior septal approach (Group B). The data are presented as the means (SDs), medians (Q1-Q3) or numbers (%).

	Group A (n= 27)	Group B (n= 33)	P value
CPB (min)	87± 12	81± 8	0.048
Ischemic time (min)	70± 10	65± 6	0.01
Vasoactive inotropic score	13 (10- 18)	18 (13- 20)	0.04
Mechanical ventilation (h)	9 (7- 12)	12 (9- 12)	0.02
ICU stay (days)	3 (3- 5)	4 (3- 5)	0.09
Hospital stay (days)	9 (8- 11)	11 (9- 12)	0.01
New atrial fibrillation	1 (3.70%)	2 (6.06%)	>0.99
New complete heart block	0	1 (3.03%)	>0.99
Superficial wound infection	2 (7.41%)	3 (9.09%)	>0.99
Re-exploration for bleeding	1 (3.70%)	4 (12.12%)	0.37

CPB: cardiopulmonary bypass; ICU: intensive care unit

the two groups concerning major postoperative complications.

Left atriotomy and the superior septal approach are two commonly used techniques for MVR. Gaudino and colleagues reported that both techniques were safe for MVR. They randomly assigned 146 patients into two groups and reported no differences in atrial fibrillation or arrythmia between LA and the SS approach; however, in contrast to our study, the SS approach had a longer bypass time [13]. This difference between these studies could be related to surgical training and experience. Kumar and associates compared conventional LA (n= 24) with the SS approach (n= 65) and reported a high incidence of junctional arrhythmia (38%) with the SS approach [14]. On the other hand, Masuda and associates compared the SS approach (n= 83) to LA (n= 69) and reported greater early arrhythmia in SS approach patients; however, there was no difference in late arrythmia between the groups [15]. Postoperative arrhythmia has the highest incidence after the SS approach for mitral valve surgery [16]. Aydin and colleagues compared the SS approach (n= 47) and LA (n= 44) for mitral valve surgery and reported greater pacemaker insertion in patients with the SS approach, with no difference in complications or mortality between the two approaches [17]. The low incidence of arrhythmia in our series could be attributed to the cumulative surgical experience, low sample size and lack of longitudinal follow-up of arrhythmia patients. Turkyilmaz and colleagues reported shorter bypass and ischemic times, and shorter lengths of hospital and intensive care unit (ICU) stays in patients with LA [18]. Furthermore, the study reported less bleeding with the LA approach, which partially agrees with our study, where we reported non-significantly greater bleeding with the SS approach. However, the SS approach provides better visualization of the mitral valve [19, 20], which could explain the shorter bypass and ischemic times in our series. Consistent with our findings, Ansar and associates compared 78 patients with the SS approach to 26 patients with LA. They reported shorter operative times in patients who had a SS approach, with no difference in postoperative arrhythmia [21].

The findings of the study suggest that conventional LA may be associated with quicker recovery metrics, making it a preferable choice for certain patients undergoing MVR. This could influence surgical practice and decision-making in cardiac procedures. This study highlights the need for further investigations to explore long-term outcomes and the efficacy of different surgical approaches in various patient populations, particularly given the increase in degenerative valve disease with increasing age. Understanding the comparative advantages of each technique can help tailor surgical interventions to individual patient needs, potentially leading to better patient experiences and outcomes.

Limitations

Although this was a randomized clinical trial, it has several limitations. With only 60 participants, the study may lack the statistical power to detect smaller differences between the two surgical techniques, which could affect the generalizability of the findings. The six-month follow-up may not be sufficient to assess long-term complications or functional outcomes associated with each surgical approach fully. Although randomization was employed, the exclusion of patients with certain comorbidities could limit the applicability of the results to a broader patient population, particularly those with complex medical histories. The study was conducted at two sites, and variations in surgical technique, postoperative care, and patient populations may impact the results, necessitating multicenter studies for broader validation.

Conclusion

Although LA and the SS approach for MVR demonstrated comparable postoperative outcomes in terms of complications such as atrial fibrillation, heart block, and infection rates, significant differences in surgical metrics were noted. The SS approach resulted in shorter cardiopulmonary bypass and ischemic times, suggesting enhanced surgical efficiency. Conversely, patients who underwent conventional LA experienced reduced VIS, a shorter duration of mechanical ventilation, and shorter hospital stays, indicating potentially quicker postoperative recovery.

Overall, while both approaches are viable for MVR, the choice may depend on the specific clinical context and the surgeon's expertise. Further research is warranted to explore long-term outcomes and refine techniques that balance surgical accessibility with patient safety and recovery. This study contributes valuable insights into optimizing mitral valve surgical approaches, emphasizing the need for individualized treatment planning.

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