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Postoperative atrial fibrillation after mitral valve replacement using left atrial versus trans-septal approach in rheumatic mitral lesion

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Abstract--Background: Mitral valve replacement (MVR) is a common surgical intervention for rheumatic mitral valve disease, with two widely used surgical approaches: left atrial (LA) and trans-septal (TS) approaches. Despite improved exposure of mitral valve in TS approach, it has been associated with an increased risk of postoperative atrial fibrillation (AF) and other complications. This study aims to compare postoperative outcomes, including AF, between LA and TS approaches in patients undergoing MVR for rheumatic mitral lesions. **Methods:** A retrospective study was conducted on 180 patients who underwent MVR for rheumatic mitral lesions at Tanta University Hospitals between 2017 and 2021. Patients were grouped into two matched cohorts (n=75 each) based on propensity score: Group A (TS approach) and Group B (LA approach). Data on demographic characteristics, intraoperative details, and postoperative outcomes, including incidence of AF, were collected. **Results:** Patients in TS group had significantly longer intubation durations (20.4 ± 2 vs. 13.1 ± 1.46 hours, $p < 0.001$), ICU stays (4 ± 0.83 vs. 1.9 ± 0.81 days, $p < 0.001$), and hospital stays (12.1 ± 2.07 vs. 9.3 ± 1.78 days, $p < 0.001$). Postoperative AF occurred more frequently in TS group (42.67% vs. 13.33%, $p < 0.001$). TS group also had higher rates of renal replacement therapy (6.6% vs. 1.3%, $p = 0.032$) and AV block requiring permanent pacemaker implantation (8% vs. 2.66%, $p = 0.002$). Mortality rates were comparable between two groups (5.3% vs. 4%, $p = 0.721$). **Conclusion:** TS approach for MVR is associated with longer intubation durations, ICU and hospital stays, and a higher incidence of postoperative AF, renal replacement therapy, and AV

block requiring pacemaker implantation, compared to LA approach. However, mortality rates were similar between two approaches.

Keywords---Mitral valve replacement, Atrial fibrillation, Trans-septal approach, Left atrial approach, Rheumatic heart disease.

Introduction

Mitral valve diseases represent some of most common valvular conditions necessitating surgical repair or replacement [1]. According to guidelines from American College of Cardiology (ACC) and American Heart Association (AHA), mitral valve surgery is strongly recommended for asymptomatic patients with rheumatic mitral valve disease or mild to moderate left ventricular (LV) dysfunction, classified as a Class I indication [2]. Access to mitral valve is typically achieved either through left atrium (LA), posterior to Sondergaard's fissure, or via interatrial septum by making an incision in right atrium. Although LA approach remains standard choice for most surgeons, it can be challenging to visualize and reach mitral valve due to positioning of anterior leaflet and annulus [3].

In cases where LA is restricted, adhesions are present from previous surgeries, or additional procedures necessitate a right atriotomy, as well as during beating heart surgeries, transseptal (TS) approach may offer improved exposure to mitral valve [4]. Despite potential benefits of TS approach, debate remains regarding its overall outcomes. Some studies have suggested that TS technique increases risk of postoperative atrial fibrillation, while others report similar outcomes between LA and TS methods [5]. This raises ongoing question: which of these surgical approaches offers superior results? Hence, the aim of this study is to evaluate the data of cases after MVR to compare TS and LA approach regarding postoperative outcomes.

Patients and methods

This is a retrospective study that was conducted on 180 patients who had MVR due to rheumatic lesion via either superior TS approach or LA approach, in Tanta University Hospitals, between January 1st, 2017 to march 1st, 2021. Propensity score matching gave rise to two equal risk groups each include 75 patients. Patients included in study are those above 18 years old and subjected to MVR due to rheumatic mitral valve lesion.

The exclusion criteria include patients undergoing redo surgery, active endocarditis, third-degree atrioventricular (AV) block, multiple valve surgeries or non-elective surgery, sinus node dysfunction or another indication for permanent pacemaker implantation preoperatively. data used in this analysis were extracted from database of Tanta University.

Grouping: Group A included 75 cases who underwent an operation through TS, and Group B included 75 cases who underwent traditional approach operations through LA.

Surgical technique

An extended superior TS approach was employed via a median sternotomy. Cardiopulmonary bypass (CPB) was initiated using direct arterial cannulation of ascending aorta and bicaval venous cannulation. Myocardial protection was ensured with antegrade administration of Del-Nido cardioplegia into ascending aorta. extended superior TS incision commenced with a cut in anterior right atrium, followed by a second incision in interatrial septum, starting at fossa ovalis. These two incisions were then connected superiorly and extended into roof of LA for optimal exposure.

For LA approach, same median sternotomy was utilized. same CPB and myocardial protection techniques as TS method were applied. An incision was made at junction of right pulmonary veins and interatrial fissure to access LA.

Data Collection

Demographic data for study population were extracted from database, including age, gender, BMI, New York Heart Association (NYHA) functional classification, heart rhythm, type of surgery, comorbidities, preoperative ejection fraction, aortic cross-clamp time, total bypass duration, and LA size.

Postoperative Outcomes

In-hospital complications were recorded, such as postoperative renal dysfunction, need for re-exploration due to bleeding or tamponade, incidence of atrial fibrillation, complete heart block requiring permanent pacemaker implantation, and mortality. Additional metrics included mechanical ventilation duration, length of intensive care unit stay, overall hospital stay, blood transfusion requirements, and mortality rate.

All patients were continuously monitored with electrocardiographic telemetry during postoperative period. Permanent pacemakers were implanted in patients requiring one during their hospital stay, regardless of underlying indication.

Statistical analysis

The statistical analysis was conducted using SPSS v26 (IBM Inc., Armonk, NY, USA). mean and standard deviation (SD) of quantitative variables were reported and compared between two groups using an unpaired Student's t-test. Chi-square test or Fisher's exact test was used to assess qualitative variables, which were expressed as frequency and percentage (%) where applicable. Statistical significance was established as a two-tailed P value of less than or equal to 0.05.

Results

Demographic data (age, sex, weight, height, BMI), risk factors (smoking, diabetes mellitus, hypertension, dyslipidaemia, COPD, AF and NYHA). **Table 1**

Table 1: Demographic data, risk factors, and previous operations in studied groups

		Group A (n=75)	Group B (n=75)	P value
Age (years)	Mean ± SD	40.5 ± 8.34	42.4 ± 7.82	0.321
	Range	25 - 65	25 - 65	
Sex	Male	40 (53.33%)	33 (44%)	0.252
	Female	35 (46.67%)	42 (56%)	
Weight (kg)	Mean ± SD	76.9 ± 10.66	77.8 ± 11.22	0.373
	Range	59 - 95	59 - 95	
Height (m)	Mean ± SD	1.7 ± 0.04	1.7 ± 0.04	0.439
	Range	1.59 - 1.73	1.59 - 1.73	
BMI (kg/m²)	Mean ± SD	27.9 ± 4.23	28.1 ± 4.15	0.645
	Range	20.28 - 37.18	19.94 - 36.33	
Smoking		33 (44%)	38 (50.67%)	0.413
Diabetes mellitus		28 (37.33%)	23 (30.67%)	0.389
Hypertension		30 (40%)	27(36%)	0.610
Dyslipidaemia		34 (36%)	39(52%)	0.513
COPD		12 (16%)	10 (13.33%)	0.214
Preoperative AF		22 (29.33%)	26 (34.67%)	0.483
NYHA classification				0.621
II		15(20%)	17(22.6%)	
III		39(52%)	38(50.6%)	
IV		21(28%)	20(26.6%)	

Data is presented as mean ± SD, frequency (%), * statistically significant as P-value ≤ 0.05. BMI: Body mass index, AF: Atrial fibrillation, NYHA: New York Heart Association.

Laboratory investigations (Hb, WBCs, platelets, creatinine), were insignificantly different between both groups. **Table 2**

Table 2: Laboratory investigations, in studied groups

		Group A (n=75)	Group B (n=75)	P value
Hb (g/dL)	Mean ± SD	12.2 ± 1.36	12.3 ± 1.38	0.657
	Range	10 - 14.5	10 - 14.5	
WBCs (x 10⁹)	Mean ± SD	7.3 ± 1.65	7.3 ± 1.61	0.987
	Range	4.5 - 10.1	4.5 - 10.2	
PLT (x 10⁹)	Mean ± SD	288 ± 38.84	281.3 ± 38.69	0.055
	Range	220 - 350	220 - 349	
Creatinine (mg/dL)	Mean ± SD	1.1 ± 0.2	1.1 ± 0.21	0.301
	Range	0.8 - 1.4	0.8 - 1.4	

Baseline echocardiographic characteristics (EF, MS, MR, LA enlargement) were insignificantly different between both groups. **Table 3**

Table 3: Baseline echocardiographic characteristics in studied groups

		Group A (n=75)	Group B (n=75)	P value
EF (%)	Mean ± SD	52.4 ± 4.5	51.8 ± 4.5	0.393
	Range	45 - 60	45 - 60	
Mitral valve pathology	Mainly stenosis	51 (68%)	53(70.6%)	0.121
	Mainly regurgitation	9(12%)	8(10.6%)	0.781
	Mixed lesion	15(20%)	14(18.6%)	0.683
LA enlargement	Mild	29 (38.6%)	27 (36%)	0.751
	Moderate	35 (46.6%)	38 (50.6%)	0.529
	Severe	11 (14.6%)	10 (13.3%)	0.614

Data is presented as mean ± SD, frequency (%), * statistically significant as P-value ≤ 0.05. EF: Ejection fraction, MS: Mitral valve stenosis, MR: Mitral valve regurgitation, LA: Left atrium.

Group A had significantly longer intubation duration, ICU stay and hospital stay compared to group B (P<0.001). **Table 4**

Table 4: Intubation duration, ICU stay and hospital stay in studied groups

		Group A (n=75)	Group B (n=75)	P value
Intubation duration (Hours)	Mean ± SD	20.4 ± 2	13.1 ± 1.46	<0.001*
	Range	12 - 29	8 - 18	
ICU stay (Days)	Mean ± SD	4 ± 0.83	1.9 ± 0.81	<0.001*
	Range	3 - 5	1 - 3	
hospital stay (Days)	Mean ± SD	12.1 ± 2.07	9.3 ± 1.78	<0.001*
	Range	9 - 15	7 - 12	

Data is presented as mean ± SD, * statistically significant as P-value ≤ 0.05.

Group A had significantly higher prevalence of post-operative AF, renal replacement therapy, and AV block compared to group B. Group A had significantly longer CPB time, cross-clamp time, compared to group B (P<0.001). Prevalence of sinus node dysfunction, temporary pacemaker, re-exploration for bleeding or tamponade, and mortality were insignificantly different between both groups. **Table 5**

Table 5: Post-operative outcomes in studied groups

		Group A (n=75)	Group B (n=75)	P value
Post-operative AF		32 (42.67%)	10 (13.33%)	<0.001*
Renal replacement therapy		5 (6.6%)	1 (1.3%)	0.032*
Sinus node dysfunction		3 (4%)	1 (1.33%)	0.310
Temporary pacemaker		9 (12%)	7 (9.33%)	0.214
Re-exploration for bleeding or tamponade		7(9.33%)	4 (5.33%)	0.210
AV block requiring permanent pacemaker		6(8%)	2 (2.66%)	0.002*
CPB time (min)	Mean ± SD	130.7 ± 15.49	99.8 ± 12.43	<0.001*
	Range	102 - 156	80 - 120	
Aortic cross-clamping time (min)	Mean ± SD	93.1 ± 12.53	70.9 ± 11.97	<0.001*
	Range	72 - 114	51 - 90	
Mortality		4 (5.3%)	3 (4%)	0.721

Data is presented as mean ± SD, frequency (%), * statistically significant as P-value ≤ 0.05. AF: Atrial fibrillation, AV: atrioventricular, CPB: cardiopulmonary bypass.

Discussion

We found that risk factors (smoking, diabetes mellitus, hypertension, dyslipidemia, COPD, preoperative AF), laboratory investigations (Hb, WBCs, platelets, creatinine), NHYA classification, and baseline echocardiographic characteristics (EF, MS, MR, mixed valvular lesion, LA enlargement) were insignificantly different between both groups.

Group A has a significantly extended intubation length, ICU stay, and hospital stay compared to group B, along with a greater prevalence of postoperative atrial fibrillation. Group A had significantly extended aortic cross-clamping and CPB durations compared to group B. occurrence of sinus node dysfunction, temporary pacemaker placement, re-exploration for bleeding or tamponade, and death rates did not significantly vary between two groups. The TS approach had a mortality rate of 9.6% and a re-exploration rate of 8.6%, according to a review of data comparing two surgical techniques [6].

In concordance with our results, Reza Hosseini et al. [7] established that durations of pump and cross-clamp were extended in TS group, corroborating our results. Additional investigations have shown extended pump and cross-clamp durations in TS method, attributing this to heightened incidence of postoperative atrial fibrillation [8, 9]. Reza Hosseini et al. [7] found that rates of re-exploration and death were not significantly different between their two research groups, aligning with our results. results aligned with those of a research by Berreklouw et al. [10].

Our results showed that group A had significantly higher incidence of post-operative AF, renal replacement therapy and AV block requiring permanent pacemaker implantation compared to group B. In line with our results, Reza Hosseini et al. [7] reported that postoperative atrial fibrillation (AF) was more

frequent in TS group, despite both groups showing similar preoperative AF rates and LA size measurements. This finding is consistent with our results. A potential explanation for this could be vulnerability of sinus nodal artery during TS procedure, which may lead to sinus node dysfunction ^[11].

In contrast, Nienaber et al. ^[9] compared a micro TS approach with LA method and found no increased incidence of postoperative AF in TS group, which differs from our findings. This discrepancy may be attributed to micro-TS approach, which involves a smaller atrial incision, quicker closure of atrium, and a reduced risk of sinus nodal artery injury.

We also compared extended superior TS approach with LA method. Patients who underwent extended superior TS procedure had a higher incidence of transient junctional rhythm in early postoperative period, although this typically resolved, and normal sinus rhythm was restored by third postoperative month ^[12]. Another study that evaluated these two surgical approaches, after stratifying patients by preoperative sinus rhythm or atrial fibrillation/junctional rhythm, found that atrial dysrhythmias were more common in early postoperative period with extended superior TS approach, but late postoperative cardiac rhythms were comparable between two groups ^[13].

Contrary to Reza Hosseini et al.'s findings ^[7], we observed that TS approach increased need for permanent pacemaker implantation. However, other studies have indicated that most arrhythmias following TS approach are transient, and technique does not elevate risk of permanent pacemaker placement ^[8, 14, 15].

Similar to our results, Lukac et al. ^[16] identified TS approach as an independent risk factor for pacemaker implantation in their multivariate analysis, which is consistent with our findings (hazard ratio [HR]: 2.2, 95% CI: 1.2-4.1; $p = 0.014$). A recent meta-analysis comparing TS and LA methods in mitral valve surgery revealed a significantly higher rate of pacemaker placement in TS group (5% vs. 3%, $P = 0.007$) ^[17].

Previous studies have yielded mixed results, with some reporting an increased incidence of pacemaker implantation with TS approach, while others have not observed this trend. reported incidence of pacemaker implantation ranges from 0% to 18% for TS approach and 0% to 9% for LA method ^[3, 6, 7, 12-16, 18-19]

In most cases, sinus node artery arises from right coronary artery and traverses superior posterior margin of interatrial septum ^[20]. This anatomical proximity increases risk of intraoperative injury during extended superior TS approach, which, as noted by several authors, is most likely explanation for higher incidence of pacemaker implantation in studies involving superior TS approach ^[12, 16, 18, 19]. Other contributing factors may include length of TS incision, electrical isolation of sinus node, and damage to internodal conduction pathways ^[3, 16]. This study has certain limitations, including its retrospective design, which introduces potential selection bias, as well as relatively small sample size.

Conclusions

TS approach doesn't affect mortality compared with LA approach. Although it was associated with higher pump and cross-clamp times, risk of postoperative atrial fibrillation and AV block requiring permanent pacemaker placement, longer duration of mechanical ventilation, ICU and hospital stay. Further randomized clinical trials on larger cohort are required to validate our results.

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Conflict of Interest: Nil.

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