The Heart Surgery Forum

Heart Surg. Forum **2025**; 28(10): 47296
https://doi.org/10.31083/HSF47296

Article

Long-Term Results of Transseptal Atriotomy in Small Left Atrium

Deniz Gunay[1,*], Mehmet Erdem Toker[2]

[1]Department of Cardiothoracic Surgery, Istanbul Medipol University, 34718 Istanbul, Türkiye

[2]Department of Cardiovascular Surgery, Kartal Kosuyolu High Specialization Training and Research Hospital University of Health Sciences, 34846 Istanbul, Türkiye

*Correspondence: surgeondnz@gmail.com (Deniz Gunay)

Academic Editor: Jeffrey H. Shuhaiber

Submitted: 23 April 2025 Revised: 27 May 2025 Accepted: 11 August 2025 Published: 13 October 2025

Abstract

Background: Transseptal atriotomy provides better exposure to the mitral valve in challenging cases but has conflicting results with postoperative rhythm disturbances. We aimed to investigate long term results of limited transseptal atriotomy in cases with a small left atrium. **Methods**: From January 2010 through February 2014, 1214 patients underwent mitral valve surgery at the SBÜ Kartal Kosuyolu High Specialization Training and Research Hospital. Left atrium diameter on 2-dimensional (2-D) echocardiography defined in 119 patients who had small left atrium and met the inclusion criteria were enrolled in the study, of which 57 patients (47.9%) underwent transseptal atriotomy (Group TS), while 62 patients (52.1%) underwent a left atriotomy (Group LA). Data was retrospectively collected. Long-term analyses were performed based on survival. The mean follow-up duration was 10.7 $\pm$ 4.2 years. **Results**: Isolated mitral procedures were performed in 49 patients (41.2%). Concomitant tricuspid valve surgery was performed in 42 patients (35.3%), concomitant aortic valve surgery in 24 patients (20.2%), and concomitant coronary artery bypass grafting in 15 patients (12.6%). The procedure rates were comparable in both Groups ($p > 0.05$). There was no significant difference in pre-operative variables. Ischemic time and total perfusion time were found to be similar in the Group TS vs. Group LA (87.6 $\pm$ 33.5 vs. 77.4 $\pm$ 27.8 minutes and 117.2 $\pm$ 38.4 vs. 112.3 $\pm$ 33.8 minutes respectively; $p > 0.05$). New-onset arrhythmia was higher in the Group TS but did not reach statistical significance (26.3% vs. 19.4%; p = 0.5). The rate of permanent pacemaker insertion was similar (5.3% vs. 4.8%; p = 0.9). Follow-up was completed in all cases and survival rate was 64.7% (64 $\pm$ 7% in Group TS vs. 58 $\pm$ 7% in Group LA; $p > 0.05$). Log rank analyses shows similar survivals (Group TS: 11.7 $\pm$ 0.6 years, 95% CI: 10.5–12.9; Group LA: 11.8 $\pm$ 0.6 years, 95% CI: 10.6–12.9; $p > 0.05$). In the multivariate Cox regression analysis, age, obesity, procedure type, and left ventricular dysfunction were found to be independent risk factors for late mortality. Regardless of tricuspid valve surgery, concomitant coronary artery bypass grafting (CABG) had worse survival compared to isolated mitral procedures and concomitant aortic valve replacement (AVR) (12.5 $\pm$ 0.5 years for mitral, 11.4 $\pm$ 1 years for concomitant AVR, and 8.2 $\pm$ 1.2 years for concomitant CABG; $p < 0.01$). **Conclusion**: Limited transseptal atriotomy was not found to be inferior when compared to left atriotomy in cases with a small left atrium undergoing while mitral valve (MV) should be performed when the exposure is challenging.

Keywords: mitral valve surgery; transseptal approach; atriotomy; small left atrium

1. Introduction

Mitral valve disease is the most common valve pathology in the general population and the second most common in the elderly population, with an anticipated increase in prevalence over the next decade [1]. Due to its deep and inferior location, exposure and accessibility of the mitral valve is more challenging than other valves. In the society of thoracic surgery (STS) 2019 database, the mortality rate associated with mitral valve replacement is 5%, which is higher than aortic valve replacement [2]. Although the most commonly preferred incision in mitral valve surgery is a left atriotomy anterior to the left pulmonary veins, a Sondergaard's Groove incision with an interatrial sulcus dissection is also preferred. However, in patients with a deep chest and a long anteroposterior axis, a history of previous aortic valve surgery and a small left atrium, the exposure is challenging [3,4]. Reports from the early 2000s concluded that transseptal atriotomies, which provide better exposure for the mitral valve, were associated with complete loss of sinus rhythm with a need for transient pacemaker insertion up to 66% and permanent pacemaker insertion of 10% in the postoperative period [5–7]. As a result, transseptal atriotomy was infrequently performed in most surgical practices.

Minimally invasive techniques are gaining popularity in cardiac surgery but the conventional left atriotomy poses significant limitations in patients who require concomitant procedures. In the last decade, there have been successful reports of concomitant cardiac operations including multiple valve procedures and minimally invasive direct coronary artery bypass (MIDCAB) plus mitral valve procedures using minimally invasive approaches, which have contributed to a resurgence in the popularity of transseptal atriotomies [8,9]. In previous studies that reporting unfavourable results, the incision was extended to the dome of the left atrium and concomitant valve procedures were performed more frequently in the Group TS. Meta-analyses have demonstrated that these factors are significant risk factors for postoperative arrhythmias. In addition, studies comparing transseptal atriotomy with conventional left atriotomy have not excluded surgical selection bias and have not conducted analyses on diverse patient Groups [7,10–12].

We aimed to investigate the long-term outcomes of limited transseptal atriotomy during mitral valve surgery in patients with isolated small left atria.

2. Methods

The study was designed as a retrospective cohort. Patient data undergoing mitral valve surgery at the SBÜ Kartal Kosuyolu High Specialization Training and Research Hospital between January 2010 and February 2014 were analyzed. 1214 patients were extracted from the hospital database. Informed consents was obtained from all patients. The ethical approval number is E-10840098-202.3.02-596. Pre-operative echocardiographic evaluations were performed routinely in all patients. Left atrial (LA) diameter was derived from the parasternal long-axis B-mode view on 2-D echocardiography. The operations were performed by 4 different surgical teams, and two of them performed a left atriotomy in all cases. One surgical team decided the incision intra-operatively and performed transseptal incisions in patients with challenging mitral valve exposure. A 4th surgical team routinely performed transseptal incisions in cases with an LA diameter below 4.5 cm. A left atrial diameter measured at 4.5 cm or below on two-dimensional echocardiography was classified as small left atrium. Emergency indications, infective endocarditis, critical preoperative conditions, preoperatively implanted permanent pacemaker, and concomitant rhythm ablation procedures were excluded. Additionally, patients with a history of cancer, cirrhosis, or those receiving immunosuppressive medication, which could influence long-term survival, were excluded from the study to ensure accurate survival analysis. 119 patients with a small left atrium and meeting the inclusion criteria were enrolled in the study. Of these, 57 patients (47.9%) underwent a transseptal atriotomy (Group TS), while 62 patients (52.1%) underwent a left atriotomy (Group LA).

In all patients a post-operative electrocardiography (ECG) was performed shortly after transfer to the intensive care unit (ICU). An ECG was recorded in all patients and was repeated daily until discharge. A-V block other than Type 1, junctional rhythm, atrial fibrillation-flutter, amiodarone or electro-cardioversion therapies were defined as arrhythmias. In case of new-onset atrial fibrillation/flutter an electro-cardioversion was performed as the first stage therapy and treatment was continued with iv-amiodarone. An anticoagulation regimen was started on postoperative day 1 with low molecule weight heparins (LMWHs) and warfarin after the removal of all drainage catheters. The international normalized ratio (INR) goal was 2–3 in the repair group and 2.5–3.5 in the mitral mechanical prosthesis group. The anticoagulation therapy was decided based on the patients CHA_2DS_2-VASc score after 3 months; and warfarin was preferred over non-vitamine K oral anti-coagulants (NOACs). Post-operative evaluations were performed routinely at 1st week, 1st month, 1st year and 2nd year after discharge. 3 points major adverse cardiac events (MACE) rates at 2 years were obtained from the hospital database. However, further evaluation of MACE could not be performed due to inadequate contact addresses and telephones. Survival datas for all patients were obtained from the National population administration system (MERNIS).

The distribution of continuous variables were evaluated both visually (using histograms) and statistically (using the Kolmogorov-Smirnov or Shapiro-Wilk tests). For numerical variables, statistical comparisons were performed using the independent samples *t*-test if the data were normally distributed, and the Mann-Whitney U test if the data were not normally distributed. For categorical variables, the Chi-square and Fisher's exact tests were used. Survival analyses were conducted using the Kaplan-Meier method and Cox regression tests.

The significance level was set at $p < 0.05$. In comparison analysis when the difference can not reach to 0.05, it was noted as non-significant (NS).

Surgical Technique

Operations were performed via a full median sternotomy. In redo cases, femoral cannulation was performed prior to sternotomy, followed by median sternotomy using an oscillating redo saw. The operations were conducted under moderate hypothermia at 32 °C, with myocardial protection achieved via antegrade and retrograde isothermic blood cardioplegia. In the left atriotomy group (Group LA), the incision was made using the standard method without an interatrial groove dissection. In the transseptal group (Group TS), the right atriotomy was performed parallel to the atrioventricular groove then the fossa ovalis was in-

Table 1. Operative data.

	Group TS	Group LA	*p*
Isolated MV procedure	22 (38.6%)	27 (43.5%)	0.7
MV repair	12 (21.1%)	24 (38.7%)	0.052
Concomitant procedure			
TV annuloplasty	23 (40.4%)	19 (30.6%)	0.3
AV replacement	16 (28.1%)	8 (12.9%)	0.07
CABG	8 (14.1%)	7 (11.3%)	0.7
Total perfusion time (min.)	117.2 ± 38.4	112.3 ± 33.8	0.4
Ischemic time (min.)	87.6 ± 33.5	77.4 ± 27.8	0.07

MV, mitral valve; AV, aortic valve; TV, tricuspid valve; CABG, coronary artery bypass grafting; TS, transseptal; LA, left atriotomy.

Table 2. Demographic and echocardiographic data.

	Group TS	Group LA	p
Age	50.8 ± 14.8	57.8 ± 12.9	0.07
Obesity	8 (14.1%)	14 (22.6%)	0.3
Gender (male)	22 (38.6%)	23 (37.1%)	0.8
EuroSCORE II*	2.38 ± 2.45	2.33 ± 2.33	0.3
Previous cardiac surgery	7 (12.3%)	6 (9.7%)	0.6
NYHA class**			0.2
II	23 (40.4%)	30 (48.4%)	
III	28 (49.1%)	30 (48.4%)	
IV	6 (10.5%)	2 (3.2%)	
LVEF	53.6 ± 9	53.5 ± 9	0.5
LV systolic dysfunction	14 (24.6%)	14 (22.6%)	0.8
Mitral stenosis	22 (38.6%)	16 (25.8%)	0.1
Secondary MR	11 (19.3%)	9 (14.5%)	0.1
Left atrial diameter (cm)	4.2 ± 0.3	4.3 ± 0.3	0.7
Normal sinus rhythm	42 (73.7%)	46 (74.2%)	0.9

*Median ± IQR, NYHA, New York Heart Association; LVEF, left ventricular ejection fraction; LV, left ventricle; MR, mitral regurgitation.

**Statistical analyse was performed with Mann-Whitney U Test.

cised vertically. The septostomy was not extended to the left atrial dome. An extrended transseptal incision was performed by only one surgical team in 4 patients who met the inclusion criteria. These 4 patients were not included in the study. For left atrial venting, a suction cannula was placed through the right superior pulmonary vein (RSPV) in Group LA and through the transseptal incision in Group TS. Mitral valve repairs were performed with a valvuloplasty and ring annuloplasty, while mechanical valves were preferred for both mitral and aortic valve replacements. Tricuspid annuloplasty was performed using the De Vega suture annuloplasty technique. Isolated mitral procedures were performed in 49 patients (41.2%). Concomitant tricuspid valve surgery was performed in 42 patients (35.3%), concomitant aortic valve surgery in 24 patients (20.2%), and concomitant coronary artery bypass grafting in 15 patients (12.6%). Although concomitant procedures were more frequently performed in Group TS, the difference was not statistically significant. The mean perfusion time and the ischemic time were found to be similar in both Groups (Table 1).

3. Results

The mean age was 52.8 ± 14 years, and 37.8% of the patients were male. A history of previous cardiac surgery was present in 13 cases (10.9%). 28 patients (23.5%) have left ventricular systolic dysfunction and the left ventricular ejection fraction (LVEF) was below 35% in 7 patients (5.8%). The mean left atrial diameter was 4.2 ± 0.3 cm. The prevalence of secondary mitral regurgitation was significantly higher in the mitral valve repair (MVr) group compared to the replacement (MVR) group (44.4% in MVr vs. 4.8% in MVR, $p < 0.001$). Normal sinus rhythm was present in 88 patients (73.9%) during the preoperative period. No significant differences were observed between the Groups in terms of demographic characteristics (Table 2).

Table 3. Post-operative variables.

	Group TS	Group LA	p
LCOS	12 (21.1%)	22 (35.5%)	0.08
IABP	0	4 (6.5%)	0.052
ECMO	1 (1.8%)	0	0.3
Respiratory insufficiency	3 (5.3%)	4 (6.5%)	0.7
Bleeding-revision	5 (8.8%)	3 (4.8%)	0.3
AKI	5 (8.8%)	4 (6.5%)	0.6
Haemodialysis	1 (1.8%)	1 (1.6%)	0.9
New onset arrhythmia	15 (26.3%)	12 (19.4%)	0.5
Atrial fibrillation flutter	4 (7.1%)	5 (8.1%)	0.7
Type 2–3 A-V Block	1 (1.7%)	1 (1.6%)	0.9
Junctional Rhythm	10 (17.5%)	6 (9.7%)	0.09
Persistent arrhythmia	7 (12.3%)	7 (11.3%)	0.9
Transient pacemaker	12 (21.1%)	7 (11.3%)	0.06
Pacemaker implantation	3.0 (5.3%)	3.0 (4.8%)	0.9
NSR at discharge	35 (65.5%)	42 (70%)	0.7
CVE	2 (3.6%)	0	0.1
Wound infection	2 (3.5%)	3 (4.8%)	0.7
ICU stay (days)	2 ± 3	2 ± 3	0.8
Discharge (days)	8 ± 5	7 ± 5	0.2
In-hospital mortality	2 (3.5%)	2 (3.2%)	0.9

LCOS, low cardiac output syndrome; AKI, acute kidney injury; NSR, normal sinus rhythm; CVE, cerebrovascular event; ICU, intensive care unit; IABP, intra-aortic balloon pump; ECMO, extracorporeal membrane oxygenation.

Table 4. Overall survival rates.

	Group TS	Group LA	p
1st year survival	95 ± 3%	92 ± 3%	0.8
5th year survival	86 ± 5%	89 ± 4%	0.6
10th year survival	70 ± 6%	69 ± 6%	0.6
14th year survival	64 ± 7%	58 ± 7%	0.5
1st year MACE free survival	52 (91.2%)	56 (90.3%)	0.8
2nd year MACE free survival	49 (85.9%)	55 (88.7%)	0.6

MACE, major adverse cardiac events.

Postoperative variables are summarized in Table 3, and both Groups have similar outcomes. Surgical mortality occurred in 4 patients (3.4%). One patient who underwent isolated MVR died due to an atrioventricular groove rupture, two patients who underwent aortic valve replacement (AVR) plus MVR died in the early postoperative period due to low cardiac output syndrome (LCOS), and one patient who underwent CABG plus MVr died due to mediastinitis and sepsis. Permanent pacemaker implantation was required in 6 patients (5.2%) and no statistically significant differences were observed between the Groups (p

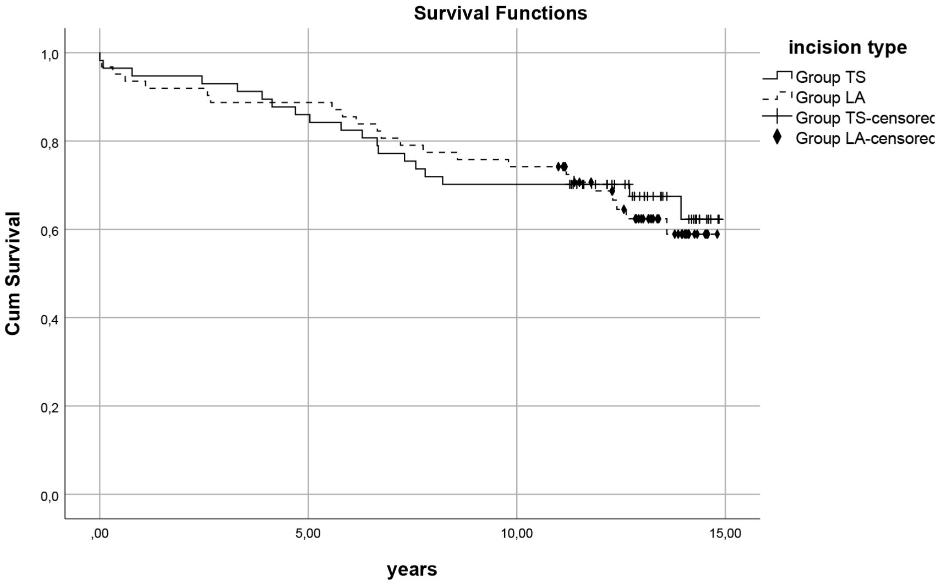

Fig. 1. Survival curves for atirotomies. Comparison of late survival 11.7 ± 0.6 (95% CI: 10.5–12.9) years in Group TS vs. 11.8 ± 0.6 (95% CI: 10.6–12.9) years in Group LA ($p > 0.05$).

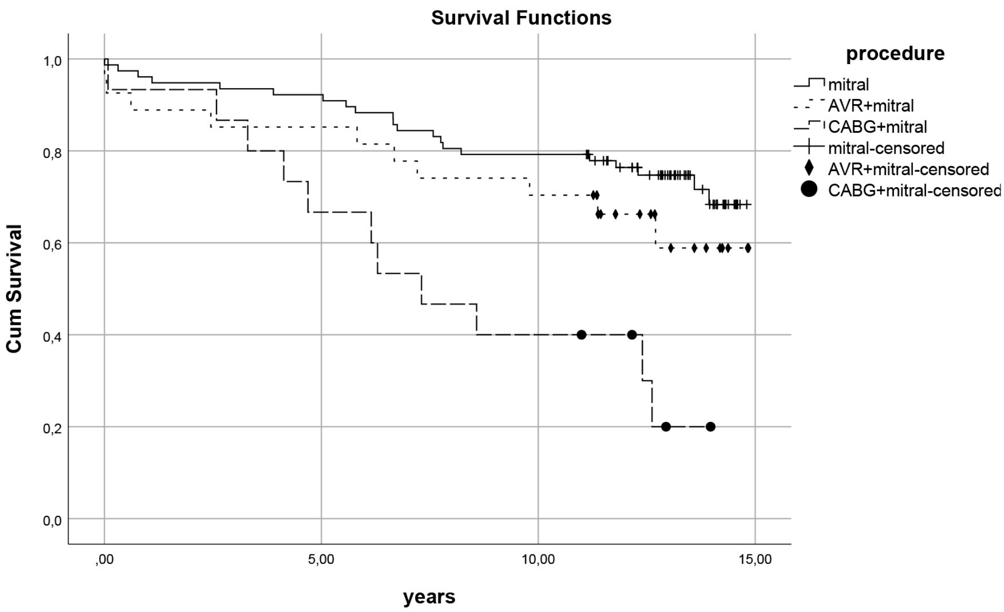

Fig. 2. Survival curves for procedures. Late survival curves for procedure types regardless of TV repair 12.5 ± 0.5 (95% CI: 11.6–13.5) years for mitral procedure vs. 11.4 ± 1 (95% CI: 9.4–13.3) years for concomitant AVR vs. 8.2 ± 1.2 (95% CI: 5.9–10.5) years for concomitant CABG ($p < 0.01$).

> 0.05). Post-operatively permanent pacemaker implantation rates for isolated mitral surgery, concomitant tricuspid valve (TV) repair, and concomitant AVR were 2.1%, 9.5% and 8% respectively. Respiratory insufficiency was defined as reintubation and found to be similar in both Groups ($p > 0.05$).

The mean follow-up duration was 10.7 ± 4.2 years (0–14.9 years). At the end of the follow-up period, the overall survival rate in the cohort was 64.7%. 1, 5, 10, and 14-year survival rates were similar in both Groups (Table 4). MACE free survival rates at 1st year and 2nd year after surgery are comparable (91.2% and 86% in Group TS vs. 90.3% and 88.7% in Group LA respectively, $p > 0.05$).

Survival analyses revealed no significant differences between the Groups (Group TS: 11.7 ± 0.6 years, 95% CI: 10.5–12.9; Group LA: 11.8 ± 0.6 years, 95% CI: 10.6–12.9; $p > 0.05$) (Fig. 1). In the survival analysis based on surgical procedures, the survival rate in the concomitant CABG

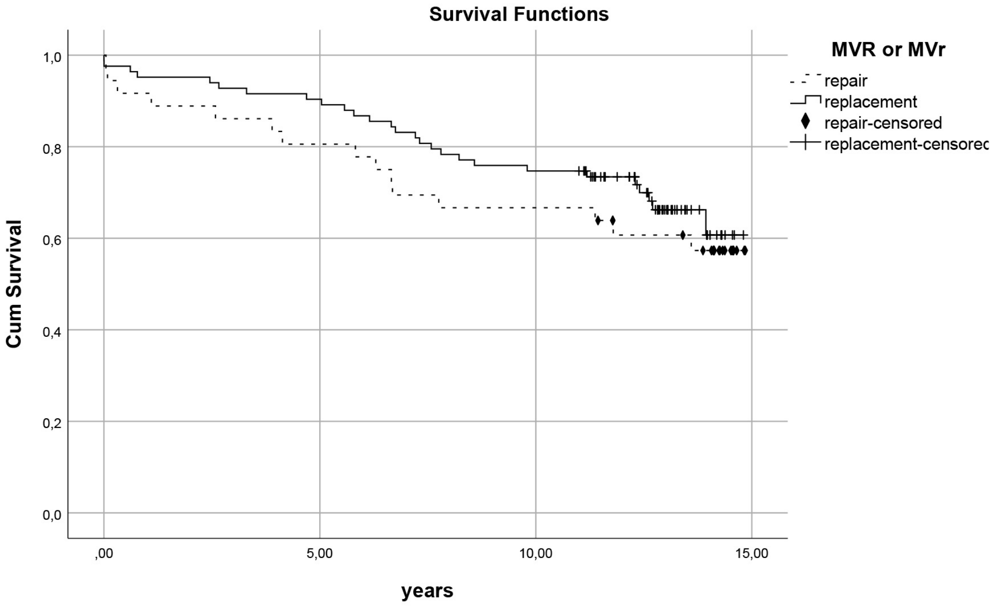

Fig. 3. Survival curves for mitral repair vs. replacement. Comparison of late survival of patients who had mitral valve repair (MVr) versus replacement (MVR) ($p > 0.05$) 10.9 ± 0.9 (95% CI: 9.2–12.7) years for MVr vs. 12.1 ± 0.4 (95% CI: 10.9–12.6) years for MVR ($p > 0.05$).

Table 5. Risk factors for late mortality (Cox-regression).

	HR	95% CI	Sig
Age (per years)	1.05	1.02–1.08	<0.001
Obesity	3.9	1.7–8.6	<0.001
Pre-operative cardiac failure	2.6	1.2–5.1	<0.01
Procedure type			<0.05
Concomitant AVR	1.8	0.8–4.3	
Concomitant CABG	3	1.3–6.9	

AVR, aortic valve replacement; CABG, coronary artery bypass graft; Sig, significance.

group was significantly lower compared to the concomitant AVR and isolated mitral groups (12.5 ± 0.5 years for mitral, 11.4 ± 1 years for concomitant AVR, and 8.2 ± 1.2 years for concomitant CABG; $p < 0.01$) (Fig. 2). Mitral valve repair did not provide superior long-term survival compared to mitral valve replacement (10.9 ± 0.9 years for MVr vs. 12.1 ± 0.4 years for MVR; $p > 0.05$) (Fig. 3).

In univariate analyses, several variables were identified as risk factors for long-term survival: age, obesity, chronic obstructive pulmonary disease (COPD), left ventricular systolic dysfunction, procedure type, and EuroSCORE II ($p < 0.05$). However, in the multivariate Cox regression analysis, only age, obesity, procedure type, and left ventricular dysfunction were found to be independent risk factors for late mortality (Table 5).

4. Discussion

Transseptal atriotomies preferred for its better exposure in challenging mitral valve cases. However, it has been associated with a high incidence of postoperative sinus node dysfunction in studies conducted between 1990 and 2000 and an incidence of permanent pacemaker insertion [5,6,13]. This pathology was primarily attributed to the transection of the sinus node artery during the extension of the transatrial incision to the left atrial dome. In a previous report, the superior vena cava was also transected to enhance exposure, resulting in a ten-fold increase rate of permanent pacemaker implantation in the Group TS [14]. Large-scale meta-analyses have shown that concomitant valve procedures increase the need for pacemaker implantation by up to 2.7-fold independent of the incision type [11,12]. Studies reporting higher rates of postoperative transient and permanent pacemaker requirements in the Group TS also noted a significantly higher prevalence of redo cases and concomitant tricuspid and aortic valve interventions in this Group [7,8]. In our study, concomitant procedures were similar in both Groups (61.4% in Group TS vs. 53.5% in Group LA; $p > 0.05$). New-onset arrhythmias, transient pacemaker requirements and permanent pacemaker implantation were comparable in Group TS vs. Group LA (26.3% vs. 19.4%, 21.1% vs. 11.3%, 5.3% vs. 4.8% respectively; $p > 0.05$). In studies where the incision was extended to the left atrial dome and the superior vena cava was transected, ischemic time and total perfusion time were found to be longer compared to the left atriotomy approach [5,7,14]. This may be caused by difficulties in the closure of the atriotomy. In our surgical technique, since the incision was not extended to the left atrial dome, the risk of injury to the sinus node artery was lower compared to other studies. Additionally, closure was easier than for extended transseptal atriotomies. Thus ischemic time and total perfusion time were similar in both Groups in our study (87.6 $\pm$ 33.5 vs. 77.4 $\pm$ 27.8 and 117.2 $\pm$ 38.4 vs. 112.3 $\pm$ 33.8 in Group TS vs. Group LA, respectively; $p > 0.05$).

The mitral valve is more difficult to access and expose compared to the other valves. Studies reported that isolated mitral valve procedures have an operative mortality rate between 1.1% and 1.4%. However, real-world population data show that this rate can rise to 5%, and the mortality rate for mitral valve replacement (MVR) is twice as high as that for aortic valve replacement (AVR) [2,15,16]. In our study, the overall operative mortality rate was 3.4%, and comparable in both Groups (3.5% in Group TS vs. 3.2% in Group LA; $p > 0.05$). Meta-analyses have shown that concomitant tricuspid valve (TV) repair does not increase mortality in mitral valve surgery [17]. Due to the limited number of patients in our study, mortality analyses were conducted independently of TV repair to avoid statistical distortion in cross-tabulation analyses. Operative mortality rates were found as 1.3% for isolated mitral valve procedures, 7.4% for concomitant AVR, and 6.7% for concomitant CABG. The median EuroSCORE II value for our patients was 2.35 $\pm$ 2.35 (range: 0.8–23.5) and our observed operative mortality rate was higher. Recent publications report operative mortality rates for concomitant AVR plus MVR ranging between 4.2% and 13.5% [8,18], while real-world population data for concomitant CABG plus MVR indicate a rate of 9% [2]. Our mortality rates are consistent with the literature.

In mitral valve surgery, mitral valve repair has demonstrated a significant improvement in both early postoperative outcomes and long-term survival, reducing mortality by 50% [2,18]. However, the use of biological valves in the mitral position negatively impacts survival in patients under 70 years of age [19]. In our study, mechanical valves were chosen as the prosthetic valve, and mitral repair did not show a long-term survival advantage over replacement. This may be attributed to the significantly higher prevalence of secondary mitral regurgitation (MR) in the repair group (44.4% in MVr vs. 4.8% in MVR; $p < 0.001$). Sannino *et al*. [20] reported that the risk of cardiac mortality is 2.62 times higher in secondary MR, and the higher rate of secondary MR in the repair group in our study may have adversely affected the long-term survival of these patients. Concomitant CABG had worse survival rates in our study. Tsao *et al*. [21] reported that 1, 5, 10-year survival rates are 92%, 74% and 39% in CABG plus MVr in patients with severe secondary MY. We found similar results as the 10-year survival rate was 40% in this group. In our study, the survival rates for isolated mitral valve surgery were 95.9% at 1 year, 93.9% at 5 years, and 87.8% at 10 years. These findings are consistent with large-scale analyses, which reported similar survival rates of 95% at 5 years and 87.3% at 8 years [14,15].

Limitations

This is a single centre, retrospective study, which introduces an element of selection bias. The lack of a multicentre study reduces its generalizability to the other centers. The extended transseptal incision is a valuable technique for patients with challenging mitral exposure; however our study only included patients undergoing limited transseptal incision. We report long-term survival data but quality of life is also an important outcome after cardiac interventions.

5. Conclusion

Transseptal atriotomy, when performed without extending the incision to the left atrial dome, yields similar early and long-term outcomes compared to conventional left atriotomy. In our study, no adverse effects on postoperative arrhythmias were observed with this approach.

Availability of Data and Materials

The datasets analyzed during the current study are not publicly available because they were extracted from the hospital database. But they are available from the corresponding author on reasonable request.

Author Contributions

DG designed and drafted the research study. MET and DG made reviewing the study critically for important intellectual content. The interpretation of the data for the work was conducted by DG and MET. Both authors made the final approval of the version to be published. Both authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

The Institutional Ethical Committee of Istanbul Medipol University approved the study protocol (date: 17 January 2025/reference number: E-10840098-202.3.02-596. Preoperative informed consent was obtained from all patients who underwent surgery. The study was conducted in accordance with the Declaration of Helsinki.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, *et al*. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association.

Circulation. 2019; 139: e56–e528. https://doi.org/10.1161/CIR.0000000000000659.
[2] Writing Committee Members, Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP, 3rd, *et al*. 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Journal of the American College of Cardiology. 2021; 77: 450–500. https://doi.org/10.1016/j.jacc.2020.11.035.
[3] Mohebali J, Chen FY. Mitral valve repair for ischemic mitral regurgitation. Annals of Cardiothoracic Surgery. 2015; 4: 284–290. https://doi.org/10.3978/j.issn.2225-319X.2015.05.05.
[4] Adams DH, Filsoufi F, Byrne JG, Karavas AN, Aklog L. Mitral valve repair in redo cardiac surgery. Journal of Cardiac Surgery. 2002; 17: 40–45. https://doi.org/10.1111/j.1540-8191.2001.tb01218.x.
[5] García-Villarreal OA, González-Oviedo R, Rodríguez-González H, Martínez-Chapa HD. Superior septal approach for mitral valve surgery: a word of caution. European Journal of Cardio-thoracic Surgery: Official Journal of the European Association for Cardio-thoracic Surgery. 2003; 24: 862–867. https://doi.org/10.1016/s1010-7940(03)00613-4.
[6] Kovács GS, Szabados S. Superior-septal approach to the mitral valve. The Annals of Thoracic Surgery. 1994; 57: 521–522. https://doi.org/10.1016/0003-4975(94)91049-9.
[7] Nienaber JJ, Glower DD. Minitransseptal versus left atrial approach to the mitral valve: a comparison of outcomes. The Annals of Thoracic Surgery. 2006; 82: 834–9; discussion 839. https://doi.org/10.1016/j.athoracsur.2006.04.014.
[8] Risteski P, Monsefi N, Miskovic A, Josic T, Bala S, Salem R, *et al*. Triple valve surgery through a less invasive approach: early and mid-term results. Interactive Cardiovascular and Thoracic Surgery. 2017; 24: 677–682. https://doi.org/10.1093/icvts/ivw430.
[9] Yamazaki M, Yoshitake A, Takahashi T, Ito T, Kimura N, Shimizu H. Superior trans-septal approach for minimally invasive mitral valve surgery via right small thoracotomy. Journal of Cardiac Surgery. 2019; 34: 728–731. https://doi.org/10.1111/jocs.14101.
[10] Cetinkaya A, Ganchewa N, Hein S, Bramlage K, Bramlage P, Schönburg M, *et al*. Long-term outcomes of concomitant tricuspid valve repair in patients undergoing mitral valve surgery. Journal of Cardiothoracic Surgery. 2020; 15: 210. https://doi.org/10.1186/s13019-020-01244-6.
[11] Badhwar V, Rankin JS, He M, Jacobs JP, Furnary AP, Fazzalari FL, *et al*. Performing Concomitant Tricuspid Valve Repair at the Time of Mitral Valve Operations Is Not Associated With Increased Operative Mortality. The Annals of Thoracic Surgery. 2017; 103: 587–593. https://doi.org/10.1016/j.athoracsur.2016.06.004.
[12] Tam DY, Tran A, Mazine A, Tang GHL, Gaudino MFL, Calafiore AM, *et al*. Tricuspid valve intervention at the time of mitral valve surgery: a meta-analysis. Interactive Cardiovascular and Thoracic Surgery. 2019; 29: 193–200. https://doi.org/10.1093/icvts/ivz036.
[13] Little S, Flynn M, Pettersson GB, Gillinov AM, Blackstone EH. Revisiting the dome approach for partial sternotomy/minimally invasive mitral valve surgery. The Annals of Thoracic Surgery. 2009; 87: 694–697. https://doi.org/10.1016/j.athoracsur.2008.03.043.
[14] Radwan M, Bon D, Dressen L, Walther T, Miscovic A, Moritz A, *et al*. Propensity-Matched Comparison of Two Different Access Modes for Minimally Invasive Mitral Valve Surgery. Seminars in Thoracic and Cardiovascular Surgery. 2020; 32: 36–44. https://doi.org/10.1053/j.semtcvs.2019.08.008.
[15] Olsthoorn JR, Heuts S, Houterman S, Maessen JG, Sardari Nia P, Cardiothoracic Surgery Registration Committee of the Netherlands Heart Registration. Effect of minimally invasive mitral valve surgery compared to sternotomy on short- and long-term outcomes: a retrospective multicentre interventional cohort study based on Netherlands Heart Registration. European Journal of Cardio-thoracic Surgery: Official Journal of the European Association for Cardio-thoracic Surgery. 2022; 61: 1099–1106. https://doi.org/10.1093/ejcts/ezab507.
[16] Al Shamry A, Jegaden M, Ashafy S, Eker A, Jegaden O. Minithoracotomy versus sternotomy in mitral valve surgery: meta-analysis from recent matched and randomized studies. Journal of Cardiothoracic Surgery. 2023; 18: 101. https://doi.org/10.1186/s13019-023-02229-x.
[17] Kara I, Koksal C, Erkin A, Sacli H, Demirtas M, Percin B, *et al*. Outcomes of Mild to Moderate Functional Tricuspid Regurgitation in Patients Undergoing Mitral Valve Operations: A Meta-Analysis of 2,488 Patients. The Annals of Thoracic Surgery. 2015; 100: 2398–2407. https://doi.org/10.1016/j.athoracsur.2015.07.024.
[18] Coutinho GF, Martínez Cereijo JM, Correia PM, Lopes CS, López LR, Muñoz DD, *et al*. Long-term results after concomitant mitral and aortic valve surgery: repair or replacement? European Journal of Cardio-thoracic Surgery: Official Journal of the European Association for Cardio-thoracic Surgery. 2018; 54: 1085–1092. https://doi.org/10.1093/ejcts/ezy205.
[19] Goldstone AB, Chiu P, Baiocchi M, Lingala B, Patrick WL, Fischbein MP, *et al*. Mechanical or Biologic Prostheses for Aortic-Valve and Mitral-Valve Replacement. The New England Journal of Medicine. 2017; 377: 1847–1857. https://doi.org/10.1056/NEJMoa1613792.
[20] Sannino A, Smith RL, 2nd, Schiattarella GG, Trimarco B, Esposito G, Grayburn PA. Survival and Cardiovascular Outcomes of Patients With Secondary Mitral Regurgitation: A Systematic Review and Meta-analysis. JAMA Cardiology. 2017; 2: 1130–1139. https://doi.org/10.1001/jamacardio.2017.2976.
[21] Tsao CW, Aday AW, Almarzooq ZI, Alonso A, Beaton AZ, Bittencourt MS, *et al*. Heart Disease and Stroke Statistics-2022 Update: A Report From the American Heart Association. Circulation. 2022; 145: e153–e639. https://doi.org/10.1161/CIR.0000000000001052.