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Comparison of Left Atriotomy and Superior Transseptal Approaches in Mitral Valve Surgery

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ABSTRACT

Purpose: To compare the operative and post-operative outcomes of mitral valve surgery (MVS) with a superior transseptal (STS) approach and a left atriotomy (LA) approach.

Methods: In a tertiary academic center, the charts of patients who underwent MVS between 2012 and 2016 were analyzed retrospectively. A total of 135 patients underwent MVS. Forty patients who underwent MVS with the STS approach were enrolled in the study as the STS group. In the same period, we selected 40 patients who underwent MVS with the LA approach to serve as the control group (LA group). Two groups were operated by the same surgeon. To minimize the bias related to the lack of randomization in this observational study, LA group patients were selected using propensity score matching.

Results: According to the study design, the preoperative characteristics of gender, age, mitral valve stenosis, and mitral valve insufficiency were matched ($P = .368$, $P = .920$, $P = .250$ and $P = .057$, respectively). The cardiopulmonary bypass time was 91.2 ± 12.1 minutes in the superior transseptal group and 72.8 ± 6.4 minutes in the left atriotomy group ($P < .001$). Additionally, duration of clamp time was significantly shorter in the left atriotomy group ($P < .001$). Estimated blood loss was significantly less in patients with a left atriotomy (535.8 ml versus 658.0 mL, $P < .001$). Duration of intensive care unit stay and hospitalization time were significantly longer in patients who underwent the superior transseptal approach compared with patients who underwent left atriotomy ($P < .001$ versus $P < .001$, respectively). Post-operative dysrhythmia rate and mortality rate were similar between the groups.

Conclusion: Our study demonstrated that MVS with LA decreased cardiopulmonary bypass time, duration of clamp time, amount of hemorrhage, duration of intensive care unit stay, and hospitalization time compared with MVS with STS.

INTRODUCTION

As a result of the small size of the left atrium and limited surgical area around the mitral valve, good exposure of the mitral valve is necessary for mitral valve surgeries (MVS). Moreover, cardiac pathologies may deteriorate the anatomy of the left atrium and mitral valve. Calcifications around the mitral valve ring and hypertrophic right ventricle may contribute to the narrowness of the left atrium. Additionally, scars and adhesions lead to mobility loss in the mitral valve and surrounding tissues and make surgery more challenging [Orhan 2000; Nguyen 2009]. Because of the factors mentioned above, obtaining an adequate view of the mitral valve is mandatory.

The procedure in which the left atrium is directly incised to achieve a mitral valve view is called the left atrial approach (LA) [Kumar 1995]. The superior transseptal (STS) approach was developed to achieve a wider view of the left atrium and mitral valve. Although there is a larger operative field with the STS approach, it is associated with increased cardiopulmonary bypass (CPB) time, ischemia time, and cross-clamp time [Lukac 2006]. Additionally, Masiello et al stated that the STS approach led to significantly more hemorrhaging compared with LA [Masiello 1999]. Moreover, Utley et al showed that the STS approach led to more sinus node dysfunction [Utley 1995].

Although previous reports have investigated the most appropriate approach for mitral valve surgery, the question is still under investigation. In the present study, we aim to compare the operative and post-operative outcomes of mitral valve surgery with the STS and LA approaches.

MATERIALS AND METHODS

After obtaining approval from the local ethics committee, the charts of patients who underwent MVS between 2012 and 2016 in a tertiary academic center were analyzed retrospectively. A total of 135 patients underwent MVS, and 40 patients who underwent MVS with the STS approach were enrolled into the study as the STS group. In the same period, we selected 40 patients who underwent MVS with LA to serve as the control group (LA group). The two groups were operated on by the same surgeon. To minimize the bias related to the lack of randomization in this observational study, the LA group patients were selected using propensity score matching. Matching variables included gender, age, mitral valve pathology, comorbidities, NYHA classification, ejection fraction, and left atrium diameter. Inclusion criteria were patients between ages 18 to 80 years old, with mitral valve stenosis and mitral insufficiency. Exclusion criteria were patients with missing data, patients age under

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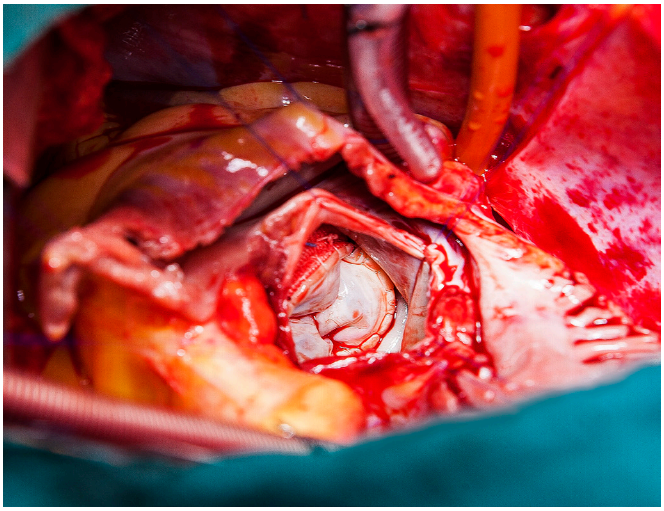

Figure 1. Bioprothesis replasman via superior transseptal approach.

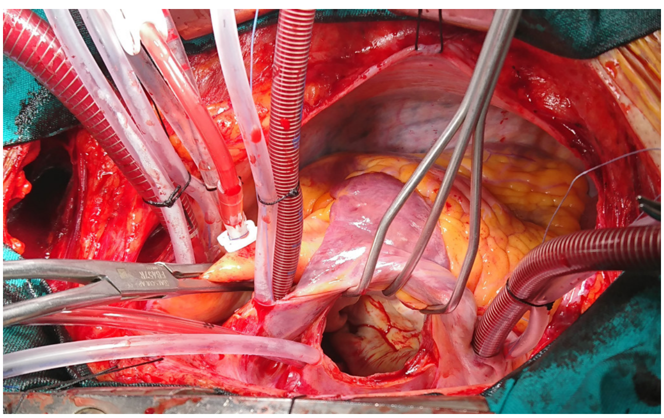

Figure 2. Left atrial approach.

18 years, patients with low ejection fraction (<30 percent), and patients with a history of MVS. Additionally, patients with dysrhythmia or patients who required concomitant surgeries were excluded from the study.

This study presents a single-center, single-surgeon experience in a retrospective design and there are limitations related to such a design. We prefer to report single surgeon experience in order to standardize the technique.

Surgical technique: Superior transseptal approach

After insertion of one cannula in the inferior vena cava and one cannula in the superior vena cava, an incision was made in the right atrium in parallel to the atrioventricular groove and was expanded to the superior pole of the atrial septum. To achieve appropriate cardioplegia infusion, coronary sinus cannulation was performed under direct visualization. After obtaining cold blood cardioplegia, a septal incision including the fossa ovalis was performed, and the incision was continued to the left atrium. At the end of the mitral valve surgery, the roof of the left atrium and the septal incision were closed with a 3-0 prolene suture. Then, the air was cleared from the left side, and the aortic clamp was opened. The right atriotomy was closed with a 4-0 prolene suture (Figure 1).

Table 1. Demographic Patient Data

	Groups		
	Superior Transseptal (n = 40)	Left Atriotomy (n = 40)	*P*
Gender (Male/Female)	22/18	26/14	.368
Age (years)*	64.1±12.3	64.4±12.1	.920
Mitral Stenosis	17 (42.5%)	12 (30.0%)	.250
Mitral Insufficiency	28 (70.0%)	35 (87.5%)	.057
Mitral Stenosis and Insufficiency	6 (15.0%)	8 (20.0)	.562
Diabetes mellitus	10 (25.0%)	10 (25.0%)	1.000
Hypertension	16 (40.0%)	9 (22.5%)	.094
NYHA Classification			.507
Class III (n, %)	17 (42.5%)	20 (50.0%)	
Class IV (n, %)	23 (57.5%)	20 (50.0%)	
Ejection Fraction (%)*	49.4 ± 6.1	49.6 ± 5.6	0.879
Left Atrium Diameter (cm)*	6.1 ± 1.1	6.2 ± 1.0	0.425
Preoperative Complication	0	0	NA

*mean ± standard deviation; n: number.

Surgical technique: Left atrial approach

After insertion of cannulas in the inferior and superior vena cavae, an incision was created in the left atrium, one centimeter from and parallel to the groove between the left and right atria. Then, the incision was expanded from the inferior vena cava to the superior vena cava. At the end of the MVS, the roof of the left atrium was closed with a 4-0 prolene suture (Figure 2).

Statistical Package of Social Sciences for Windows (SPSS) version 20 was used for statistical analysis. We divided patients into two groups based on the operation technique. Categorical variables were presented as numbers and percentages and were compared with a Chi square test. Continuous variables were presented as the means and standard deviations and then were compared with an independent sample t test. Correlation analyses were evaluated using Pearson's correlation coefficient. Statistical significance was defined as a two-tailed P value < .05.

RESULTS

According to the study design, the preoperative characteristics of gender, age, mitral valve stenosis and mitral valve insufficiency were matched (P = .368, P = .920, P = .250, and P = .057, respectively). A total of 37 patients had NYHA class III (17 patients in the STS group and 20 patients in the LA group), and a total of 43 patients had NYHA class IV (23 patients in the STS group and 20 patients in the LA group). The mean ejection fraction was 49.4 ± 6.1 in patients

Table 2. Operative Patient Data

	Groups		
	Superior Transseptal (n = 40)	Left Atriotomy (n = 40)	*P*
CPB Time (min)*	91.2±12.1	72.8±6.4	<.001
Clamp Time (min)*	73.3±14.1	62.0±5.3	<.001
Mechanical/Bioprosthetic Valve	38/2	37/3	.649

*mean ± standard deviation; CPB: Cardiopulmonary bypass Min: minutes.

who underwent the STS approach and 49.6 ± 5.6 in patients who underwent the LA approach (*P* = .879). Similarly, the thickness of the left atrium diameter was comparable between groups (*P* = .425). The patients' preoperative characteristics are summarized in Table 1.

The CPB time was 91.2 ± 12.1 min in the STS group and 72.8 ± 6.4 min in the LA group (*P* < .001). Additionally, duration of clamp time was significantly shorter in the LA group (*P* < .001). The type of mitral valve that was used in the operation (mechanical/bioprosthetic) was similar between groups (*P* = .649) (Table 2).

In the postoperative period, atrial fibrillation occurred in 14 patients in the STS group and in 12 patients in the LA group (*P* = .638). Additionally, the AV block rate was similar between groups (*P* = .462). A pacemaker was required in six patients (four in the STS group and two in the LA group, *P* = .402). For the subjects in the STS group, 14 patients were with atrial fibrillation. Six of them were discharged with sinus rhythm, however the remaining eight patients were discharged with atrial fibrillation. Five patients were with AV block. Four of them were discharged with sinus rhythm, but one remaining patient was discharged with a pacemaker.

For the subjects in the LA group, 12 patients were with atrial fibrillation. Six were discharged with sinus rhythm, and the remaining six patients were discharged with atrial fibrillation. Two patients were with AV block. Both were discharged with sinus rhythm.

Duration of stay in the intensive care unit and hospitalization time were significantly longer in patients who underwent the STS approach compared with patients who underwent LA (*P* < .001 versus *P* < .001, respectively). Kidney failure developed in only three patients who underwent the STS approach (7.5 percent). Death was observed in six patients and was not significantly different between groups (10.0 percent in the STS group and 5.0 percent in the LA group, *P* = .092) (Table 3). For the subjects in STS group, two patients died from acute renal insufficiency, one patient died from pneumonia related to acute respiratory insufficiency, and one patient died from a cerebrovascular hemorrhage. For the subjects in LA group, one patient died from pneumonia related acute respiratory insufficiency and another patient died from a cerebrovascular hemorrhage.

Table 3. Postoperative Patient Data

	Groups		
	Superior Transseptal (n = 40)	Left Atriotomy (n = 40)	*P*
Postoperative Cardiac Rhythm (Sinus/AF)	26/14	28/12	.638
AV Block	5 (12.5%)	3 (7.5%)	.462
Pacemaker Requirement	4 (10.0%)	2 (5.0%)	.402
Extubation Time (hours)*	9.6±2.5	7.5±1.5	<.001
Intensive Care Unit Time (days)*	3.8±2.7	2.3±1.0	.002
Hospitalization Time (days)*	7.5±1.9	5.5±1.0	<.001
Estimated blood loss (ml)*	658.0±139.6	535.8±131.3	<.001
Cerebrovascular Disease	1 (2.5%)	1 (2.5%)	1.000
Kidney Failure	3 (7.5%)	0	.079
Mortality	4 (10.0%)	2 (5.0%)	.392

*mean ± standard deviation; AF: atrial fibrillation.

DISCUSSION

Currently, LA and STS are the most common approaches for MVS with acceptable complication and success rates. Masuda et al analyzed patients who underwent MVS with LA (69 patients) and STS approaches (83 patients), and they claimed that both techniques were safe and effective for MVS (mortality rate was 1.4 percent for the LA group and 1.2 percent for the STS group, *P* > .005) [Masuda 1996]. In another study by Masiello et al, neither of the approaches were identified as factors for bleeding and death [Masiello 1999]. In parallel with the studies mentioned above, our study found a similar mortality rate in patients who underwent MVS with LA and STS (*P* = .392).

Sinus node dysfunction is one of the main concerns following MVS with the STS approach. Berdajs et al claimed that possible injury of the sinus node artery during the STS approach is related to ischemia of the sinus node and results in sinus node dysfunction [Berdajs 2003]. In another hypothesis, Lukac et al stated that the incision in the STS approach creates a barrier to impulses from the sinus node, which is located on the posterior of the right atrium, preventing them from reaching the other side of the heart [Lukac 2005].

Previous studies that compared the effect of LA and STS approaches on post-operative sinus node dysfunctions had controversial outcomes. Takeshita et al found a significant relationship between the STS approach and sinus node dysfunction; moreover, they claimed that the negative influence persisted for more than one year after the operation [Takeshita 1997]. Utley et al stated that the STS approach increased sinus node dysrhythmia compared with the LA approach; however, the difference was not statistically significant [Utley 1995].

In contrast, Guadino et al evaluated 146 patients who underwent MVS with 12 lead electrocardiography, 24-hour

Holter monitoring, and transthoracic and transesophageal echocardiography. They did not find any significant difference in rhythm disturbances resulting from either approach [Gaudino 1997]. Similar to the findings described by Guadino et al., we did not obtain any significant difference in sinus node dysrhythmia depending on approach.

Many authors noted the prolonged CPB time and cross-clamp time for MVS with the STS approach. Aydın et al achieved 96.0 min and 83.4 min cross-clamp times with the STS and LA approaches (P = .003) and 128.3 min and 118.3 min CPB times with the STS and LA approaches (P = .02), respectively [Aydin 2014]. Similarly, Masuda et al. found a longer cross-clamp time after the STS approach compared with the LA approach; however, they did not give a P value to evaluate the significance of the difference [Masuda 1996]. Additionally, Ansar et al reported significant associations with prolonged CPB time and cross-clamp time for the STS approach (P = .04 and P = .02, respectively) [Ansar 2017]. In the present study, we achieved a significantly shorter CPB time and cross-clamp time with the LA approach.

Hemorrhage is an inevitable undesired condition in MVS. Masiello et al stated that surgical bleeding was higher with the STS approach than with the LA approach [Masiello 1999]. Similarly, Guadino et al had 466 mL and 425 mL mean blood loss with the STS approach and LA approach in MVS, respectively [Gaudino 1997]. In accordance with these results, we observed a larger amount of bleeding with the STS approach in MVS (658 mL for the STS approach versus 538 mL for the LA approach, $P < .001$). However, there is no clinically significant difference in estimated blood loss and transfusion requirements between two groups.

The present study has some limitations. The retrospective nature and small sample size were accepted as limitations for our study. However, we used propensity score matching to overcome bias between groups. Our study only focused on short-term outcomes. We believe future studies with long-term follow-up results will clarify which technique is superior. This study presents a single-center, single-surgeon experience in a retrospective design, and there are limitations related to such a design. We prefer to report a single-surgeon experience in order to standardize the technique. Lastly, we did not compare the effect of each technique on the patient's life quality and the cost of each procedure.

The present study demonstrated that both STS and LA were safe and effective surgical approaches for MVS. However, MVS with LA decreased cardiopulmonary bypass time, duration of clamp time, amount of hemorrhage, duration of intensive care unit stay and hospitalization time compared to MVS with STS.

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