

Left Atrial Reduction Plasty and Sinus Rhythm Restoration in patients undergoing Mitral Valve Surgery with Chronic Atrial Fibrillation

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ABSTRACT

Objective: To assess outcome of Left Atrial reduction plasty and sinus rhythm restoration in patients undergoing Mitral valve surgery with chronic Atrial Fibrillation.

Study Design: Longitudinal study.

Place and Duration of Study: Adult Cardiac Surgery Unit, Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi Pakistan, from Jan 2017-Jun 2022.

Methodology: Thirty three (n=33) patients with mitral valve disease were recruited via convenience sampling, all of whom exhibited an enlarged left atrium and pre-operative Atrial Fibrillation (AF). Pre-operative cardiac evaluations were performed using Transthoracic Echocardiography (TTE). Pre- and post-surgery trans-esophageal echocardiography studies were conducted as a routine procedure. Follow-up echocardiographic assessments were carried out at intervals of 1 month, 3 months, and 6 months, alongside Electrocardiograms (ECGs). During surgery, median sternotomy was done. Cardiopulmonary Bypass (CPB) time was established followed by cardiac arrest. After Mitral valve Repair/Replacement (MVR), Left Atrial (LA) plication was done by a double needle.

Results: Out of thirty three (n=33) patients, 25(75.7%) females and 8(24.2%) male patients, with mean age of 44.3±15.5 years, underwent mitral valve surgery(repair/replacement) followed by LA reduction & sinus rhythm restoration procedure. Complete restoration of sinus rhythm with re-appearance of “a” wave on echocardiography, signifying LA transport function through mitral valve was observed in 31(93.9%) patients on 3rd month and only 1(3.0%) individual continued to have persistent AF after 6 months. A significant reduction in LA size before and after procedure was noticed in all patients (83.70±2.50 mm vs. 47.50±1.08 mm) ($p<0.001$).

Conclusion: Left atrial reduction by “Plication technique” followed by “Diathermy Fulguration” as a part of mitral valve surgery has yielded promising results in managing patients with mitral valve disease and enlarged left atrium. This approach can potentially lead to improved cardiac rhythm and better outcomes in selected cases.

Keywords: Chronic Atrial Fibrillation, Left Atrial Reduction, Mitral Valve Surgery, Sinus Rhythm

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INTRODUCTION

Rheumatic heart disease is the most common cardiovascular disease among individuals aged <25 years, worldwide. In Pakistan, rheumatic fever & rheumatic heart disease is endemic. Prevalence of rheumatic heart disease in Pakistan is 5.7/1000 individuals.¹ In 65-70% cases, it affects mitral valve. While in 25% cases, either aortic or both aortic and mitral valve are affected. In younger individuals, mitral regurgitation is common, but mitral stenosis becomes more prevalent with age due to scarring and calcification of tissues.² Patients with Atrial Fibrillation (AF) and large LA are at higher risk of thrombo-

embolic events and mechanical valve failure after surgery. Reducing the size of LA not only prevents pooling of blood in LA but also reduces the risk of late thromboembolic events through restoration of normal sinus rhythm.³

In a resource constrained environment and limited access to healthcare facilities, patients often present late in their disease course with advanced structural changes in cardiovascular system. Long standing mitral valve disease is often accompanied with left atrial dilatation and atrial fibrillation. According to Di Eusano *et al.*, about 19% of patients requiring an operation for mitral valve disease had Giant LA (LA 65 mm or more) with AF.^{3,4} Mitral valve repair or replacement does not address rhythm issues. Various procedures such as Cox-Maiz III & IV are

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technically demanding, requiring prolonged surgery and specialized radiofrequency equipment.

De-novo “Diathermy fulguration” procedure is further used to electrically isolate potential ectopic foci (LA appendage & pulmonary veins openings in LA).^{5,6}

LA reduction plasty and sinus rhythm restoration is relatively a new idea which has gained popularity in last decade. It was previously believed that mere valve surgery would ultimately restore LA dimensions and sinus rhythm, was over simplified.^{7,8} This technique of LA plication with a running 3-0 Prolene suture results in significant, quick and measurable reduction in LA size.^{9,10} Limited data is available on the surgical outcomes related to LA reduction plasty followed by sinus rhythm restoration in our population. This study aimed to assess outcome of LA reduction plasty and sinus rhythm restoration procedure in patients who underwent Mitral valve surgery with chronic AF.

METHODOLOGY

This Longitudinal study was conducted at Adult Cardiac Surgery Unit, Armed Forces Institute of Cardiology/National Institute of Heart Diseases, Rawalpindi Pakistan, from January 2017-June 2022. Patients were included in the study by using non-probability convenience sampling technique. Study was conducted after taking approval from Institutional Ethical Review Board under letter no. (IERB letter # 9/2/R&D/2023/283)

Sample size n=33 was taken by including all the patients who met the eligibility criteria during study period.

Inclusion Criteria: All patients having mitral valve disease with enlarged LA and Pre-operative AF were included in the study.

Exclusion Criteria: Patients who had multiple valve disease, ischemic heart disease, previous valve surgery, COPD and critically ill patients were excluded from the study.

Routine blood work and diagnostic tests were performed before procedure. Pre-operative consent was taken before including patients in the study. Basic demographic information including name, age and gender was recorded. Pre-operative cardiac evaluation was done with transthoracic echocardiography. Transesophageal echo studies were done as a routine procedure in all patients in operating room during and after surgery. Follow-up echocardiographic studies were done at 1 month, 3 months & 6 months interval along with ECG.

Surgery was performed through median sternotomy. Cardiopulmonary bypass was established through standard aortic and bicaval cannulation. Antegrade cold blood cardioplegia was used for myocardial protection. After carrying out mitral valve procedure (repair/replacement), LA plication was carried out by a double needle running 3-0 prolene suture in a circumferential fashion. Plication was started from posterior LA wall, extending across LA appendage & closing it, and finally across LA roof & anterior wall. Similarly, LA plication was extended posterior- inferiorly with another limb of 3-0 prolene suture. Finally, both arms of 3-0 prolene suture were tied thus plicating & closing anterior LA wall.

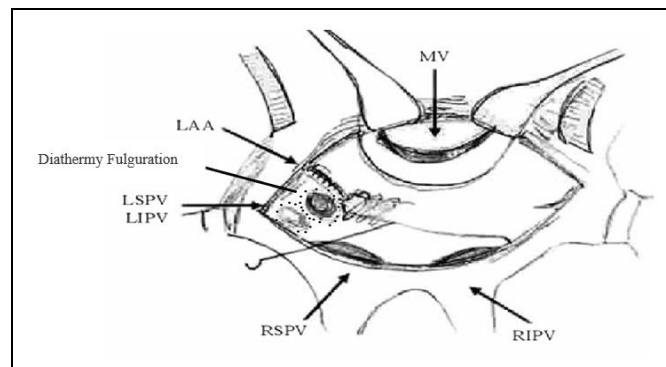


Figure: Left Atrial Plication with “Diathermy Fulguration”

A balloon filled with 40 ml of saline was used as a “Sizer” for optimum LA reduction. A novel procedure “diathermy fulguration” (Figure) with long diathermy tip was used to induce “thermal injury”, thus isolating the ectopic foci along the margins of pulmonary veins orifices & at the base of LA appendage.

Data was analyzed using Statistical Package for Social Sciences (SPSS) version 24:00. Descriptive statistics were used to calculate Mean±SD for continuous variables (age and pre-operative LA size). Frequencies and Percentages were calculated for categorical variables like (gender and post-operative atrial wave). LA size and atrial wave were the outcome variables. Chi square & paired t-test were used to find association and mean differences of study variables with AF restoration. *p*-value ≤0.05 was considered statistically significant.

RESULTS

Out of thirty three (n=33), 25(75.7%) were females and 8(24.2%) were males. These patients, with an average age of 44.30±15.50 years, underwent mitral valve surgery, which included repair or replacement,

Left Atrial Reduction Plasty

as well as procedures to reduce the size of the Left Atrium (LA) and restore normal heart rhythm.

Among the patients, 29(87.9%) presented with rheumatic heart failure, while 4(12.1%) had degenerative mitral valve insufficiency. All patients in this subgroup exhibited enlarged LA (83.7±14.1mm) and chronic atrial fibrillation 33(100.0%). Common symptoms included palpitations in 25(75.7%) patients, dyspnea classified as NYHA class II & III in 22 (66.6%) and 11(33.3%) patients respectively. 2(6.06%) patients had a history of thromboembolic episodes, and 1(3%) individual experienced residual hemiparesis.

In 25(75.5%) patients, the mitral valve was approached through the Sondergaard's groove, while in 8(24.2%) patients; a trans-septal approach was employed for ease of procedure Table-I.

Majority of patients developed AV nodal block 18(54.5%) in the immediate post-operative period. There were no recorded cases of mortality, and all patients were electively placed on dual chamber external pacing (DDD Mode) during the first 24-48 hours. 2(6%) patients required re-exploration due to mediastinal bleeding. Most patients 25(75.7%) were extubated within 8 hours, while 8(24.2%) needed overnight ventilatory support. The post-operative hospital stay averaged 6.5±1.5 days.

Amiodarone (a class IV antiarrhythmic) was continued for all patients up to 3 months, and oral anticoagulation in the therapeutic range (INR 2-3.5) was maintained for all patients. After 3 months, oral anticoagulants were discontinued for patients who underwent mitral valve repair surgery (n=4).

Table-I: Demographic and Intra-operative details of study participants (n=33)

Variables		Frequency(%)	
Gender	Male	8(24.2%)	
	Female	25(75.7%)	
Age (years) (Mean±SD)		44.30±15.50	
Rheumatic heart failure		29(87.9%)	
Mitral valve insufficiency		4(12.1%)	
Pre-operative	LA size (Mean±SD)	83.70±14.10	
	Chronic AF	33(100.0%)	
Symptoms	Palpitations	25(75.7%)	
	Hemiparesis	1(3.0%)	
	NYHA	Class II	22(66.6)
		Class III	11(33.3%)
Surgical Approach	Sondergaard's Groove	25(75.7%)	
	Trans-septal approach	8(24.2%)	

LA=Left Atrium; AF=Atrial Fibrillation

Sinus rhythm was regained in most patients 26(78.7%) between 48 to 72 hours post-operatively. A minority of individuals 7(21.2%) experienced self-limiting paroxysmal AF episodes of variable duration after 72 hours. 28(84.8%) patients completely reverted to sinus rhythm at the time of discharge from the hospital (between 5-7 post-operative day). However, 5(15.1%) individuals had episodic or persistent AF at the time of discharge. Follow-up echocardiographic studies were conducted at 1 month, 3 months, and 6 months interval. Complete restoration of sinus rhythm with the re-appearance of the "a" wave on echocardiography, signifying LA transport function through the mitral valve was observed in 31(93.9%) individuals after 3 months. Only 1(3%) individual continued to have persistent AF after 6 months ($p=0.04$) (Table-II).

Table-II: Chronic Atrial Fibrillation Restoration during Follow-up (n=33)

Follow-up	Chronic Atrial Fibrillation Restoration		p-value
	Yes Frequency(%)	No Frequency(%)	
48-72 hours	26(78.7)	7(21.2)	0.14
3rd post-operative day	26(78.7)	7(21.2)	0.88
At time of discharge	28(84.8)	5(15.1)	0.58
3 Months Follow-up	31(93.9)	2(6.0)	0.13
6 Months Follow-up	32(96.9)	1(3.0)	0.04

Significant reduction in LA size before and after procedure was noticed on post-operative echo (83.73±2.52 mm vs. 47.55±1.08 mm) ($p<0.001$), as mentioned in Table-III.

Table-III: Comparison of Mean Difference of pre- & post-procedural Left Atrial size (n=33)

LA Size(mm)	Mean±SD	p-value
Pre-operative	83.73±2.52	<0.001
Post-operative	47.55±1.08	

LA=Left Atrium

DISCUSSION

AF is a common finding in patients with long standing mitral valve disease, especially with LA enlargement. LA size more than 45mm is one of the independent predictive factors for the appearance and recurrence of AF. AF is rare in patients with LA size less than 40 mm.¹¹⁻¹⁴ The tendency of LA to fibrillate is determined by the relation between the effective refractory period of the atrial myocardium and atrial area available for the development of macro recurrent circuit.¹⁵ Therefore, a "critical mass" or "critical area" of LA myocardium is needed for the appearance of AF. It is thus logical that a strategic part of surgery to eliminate AF must include reduction in size of LA.¹⁶⁻¹⁸

Different procedures are in practice for LA volume reduction surgery. This includes simple plication techniques (circumferential plication, T plasty).^{5,10,19} and variants of “cut & sew” techniques, such as circumferential LA resection or “CLAR”, Tangential Triangular Resection or “Mercedes plasty” and variants of Cardiac auto-transplantation for LA volume reduction introduced by Battista *et al.*¹⁷

Our study had important implications regarding the effects of LA size reduction on cardiac rhythm. LA reduction surgery also contributes towards improvement in mechanics and reversed remodeling of the LA.²⁰⁻²² This technique was used in n=33 patients in current study with excellent results, achieving complete remission from AF and sinus rhythm restoration after 6-months of follow-up.

In our study, common symptoms were found as palpitations in 25(75.7%) patients, dyspnea classified as NYHA class II & III in 22 (66.6%) and 11(33.3%) patients respectively. Whereas dyspnea 14(70.0%) classified as NYHA class III was identified as the main symptom in the previous study conducted by Raghavendra *et al.*,²³

The post-operative hospital stay of patients averaged 5.75±1.07 days, was reported in a study reported by Adnan Yalcinkaya *et al.*, while similar hospital stay duration was found in current study as 6.5±1.5 days. Surgical reconstruction of the left atrium was not only responsible for restoration of the sinus rhythm but also decreases the risk of future AF. Similar study showed that 21(65.6%) patients regained sinus rhythm who underwent mitral valve surgery.⁵ Almost similar findings were observed in our study as sinus rhythm was regained in most patients 26(78.7%) during 48 to 72 hours post-operatively.

Raghavendra *et al.*²³ did a study in India which showed significant decrease in LA size in patients undergoing mitral valve surgery, (ranging from 60.4±8.04 mm to 44.8±6.8 mm) ($p<0.001$). These outcomes were similar to existing study’s findings, where a significant decrease in LA size was observed on post-operative echo both before and after the surgery (83.73±2.5 mm vs. 47.55±1.08 mm) ($p<0.001$).

In current study, on 5-7 post-operative days, sinus rhythm was restored in 28(84.8%). Whereas, 5 cases (15.1%) had either episodic or persistent AF. A research done by Dzemali *et al.*, found that individuals with persistent AF undergoing mitral valve surgery experienced changes in heart rhythm,²⁴ which

corroborated our study’s findings i.e. in 1% of patients at discharge and in 63% of patients with chronic AF, the addition of left atrial size reduction to mitral valve surgery was successful in restoring sinus rhythm and predominate SR one year after surgery.

M. Scherer *et al.*, mentioned in his study that 13(65.0%) of the 20 patients had sinus rhythm throughout follow-up, however 6(22.0%) reported arrhythmic events, and 7(35.0%) had persistent AF at one, three, and six-month intervals.²⁴ In our study after three months, 31(93.9%) people had fully recovered their sinus rhythm, which indicated that the LA transport function through the mitral valve was functioning. In our study after six months, only one person (3.0%), still had chronic AF. The difference in outcomes is attributed to varied sample size in both studies and also different follow-up times.

Anubhav Gupta, *et al.*, reported in a different study that the preoperative LA size was 78.75± 2.79 mm and the postoperative LA size was 40.83± 3.69 mm, indicating a 48.15% decrease in size.²⁵ This investigation supported our findings, which showed a decrease in LA size both before and after the surgery (83.73±2.5mm vs 47.55±1.08mm respectively) ($p<0.001$). Similar study after a 3-month follow-up revealed that 4 out of 12 patients, (33.0%), had improved LV function; however, our study found that 93.9% of patients had improved LV function following full sinus rhythm restoration.

Literature provided evidence that LA reduces in size whenever it coexists with mitral valve disease and AF. LA reduction techniques involving “cut and sew” method besides technically demanding, are fraught with bleeding and prolonged operative time. Simple plication technique and De novo “Diathermy Fulguration” at nodal points are “Easy to Learn and Reproduce” method of restoring LA size and sinus rhythm, without added risk of bleeding and prolonged bypass time.²⁵

LIMITATIONS OF STUDY

Our study had several limitations; it was a single centered study with small sample size and few patients couldn’t be followed due to loss of contact. Further large and multicentric studies should be considered to validate and expand upon the findings presented in this research.

CONCLUSION

LA reduction by plication method and AF ablation by de-novo “Diathermy Fulguration” technique is a safe and effective procedure for sinus rhythm restoration, without affecting peri-operative morbidity and mortality.

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Conflict of Interest: None

Authors' Contribution

Following authors have made substantial contributions to the manuscript:

NA & AN: Study concept, Manuscript writing, Formatting, Study design, Data collection.

IAC MIA: Critical review, Study design, Final approval, Data acquisition.

SAH, RM, & MAK: Study design, Manuscript writing, Formatting, Critical review, Proof reading

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.

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