

## Original Research Article

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# A study to assess the impact of left atrial size reduction in outcome of the patients undergoing mitral valve surgery for mitral valve disease with left atrial enlargement in a tertiary care hospital

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## ABSTRACT

**Background:** Rheumatic mitral valve disease (mitral stenosis or regurgitation) remains the common heart disease in developing countries. Mitral valve is involved in 99% of cases. The prognostic implication of LA (left atrium) size has also been shown in high-risk subgroups, such as patients with acute myocardial infarction, atrial arrhythmia, LV dysfunction, or dilated cardiomyopathy, and patients undergoing valve replacement for aortic stenosis and mitral regurgitations. Objective of the study was to study the impact of left atrial size reduction in patients undergoing mitral valve surgery for mitral valve disease with left atrial enlargement on clinical outcome and echocardiographic parameters.

**Methods:** A prospective study was done at department of cardiovascular and thoracic surgery, Sri Venkateshwara institute of medical sciences, Tirupati from June 2012 and June 2013. The study population consisted of patients with rheumatic mitral valve disease with or without tricuspid valve disease with left atrial size enlargement who underwent mitral valve surgery alone and mitral valve surgery with left atrial reduction. Twenty consecutive subjects were taken in each group during the study period.

**Results:** The age range is 21 to 61 years. There means age is  $39.7 \pm 10.3$  years. in the study group. Following MVR significant improvement in the NYHA (New York Heart Association) functional class was noted in all the patients. The decrease in RVSP, LA size, and TR was noted in all the patients.

**Conclusions:** It seems reasonable to suggest that patients who undergo LA reduction along with MVR have significant improvement in clinical outcome and NYHA functional class with less thromboembolic complications during long term follow up.

**Keywords:** Mitral valve, Rheumatic fever, NYHA left atrium, Sinus rhythm

## INTRODUCTION

Rheumatic heart disease (RHD) is a permanent sequela of rheumatic fever (RF).<sup>1,2</sup> Globally, there are >15 million cases of rheumatic heart disease, with 233,000 deaths each year and 282,000 new cases per year.<sup>3</sup> The overall prevalence of RHD in our country is estimated to be

about 1.5-2/1000 in all age groups (total population about 1.27 billion) which suggests that there are about 2-2.5 million patients of RHD in our country.<sup>4</sup>

Rheumatic fever affects all the valves microscopically, but clinically significant disease is observed mostly in mitral valve. Rheumatic mitral valve disease (mitral

stenosis or regurgitation) remains the common heart disease in developing countries. Mitral valve is involved in 99% of cases. Pathologically rheumatic MS leads to leaflet thickening, commissural fusion, chordal shortening and fusion. Rheumatic mitral regurgitation leads to LA enlargement along with rise in pulmonary arterial pressure.<sup>5,6</sup>

The LA is far from being a simple passive transport chamber. It is highly dynamic and responds to stretch with the secretion of atrial natriuretic peptides.<sup>7</sup> The counterbalance of natriuretic, vasodilatation, and inhibition of the sympathetic and renin-angiotensin-aldosterone systems allows partial restoration of fluid and hemodynamic balance.<sup>8</sup> Left atrial geometry and mechanical function exert a profound effect on LV function and cardiovascular performance.<sup>9,10</sup>

Enlargement of the LA has been shown to be a reliable predictor of adverse cardiovascular outcomes. The LA diameter has also been shown to independently predict death in the general population.<sup>9</sup> In other population-based studies, the association of LA enlargement with mortality has been attenuated when diastolic function, LV mass, or LV hypertrophy has been considered.<sup>9,10</sup>

The prognostic implication of LA size has also been shown in high-risk subgroups, such as patients with acute myocardial infarction, atrial arrhythmia, LV dysfunction, or dilated cardiomyopathy, and patients undergoing valve replacement for aortic stenosis and mitral regurgitations.<sup>9-11</sup>

The relationship between LA enlargement and stroke is complex. LA size has been shown to predict ischemic stroke in subjects without atrial fibrillation (AF) and mitral valve disease in the Framingham heart study. The LA size is an independent predictor factor for thromboembolism.<sup>12</sup>

AF is closely related with the LA enlargement. AF and LA enlargement cause several morbidities and mortalities. Stroke is the most feared complication of AF.<sup>13,14</sup>

Most of the patients who undergo mitral valve surgery also have LA enlargement and chronic AF.<sup>11,13,14</sup>

Mitral valve surgery alone mostly does not restore sinus rhythm or prevent recurrence of AF after surgery. The idea that mitral valve surgery alone will result in remodeling and atrial size reduction is considered wrong by most studies.<sup>12-16</sup>

After atrial size reduction, sinus rhythm was restored in 77.3% of patients, whereas in the group without reduction it was restored only in 61.1% of patients.<sup>17</sup> Addition of LA size reduction to mitral valve surgery is effective in 63% of patients with chronic AF in reducing the risk of stroke and thromboembolic complications.<sup>14,17</sup>

The concept of left atria size reduction was developed primarily to improve left atrial geometry and to reduce thromboembolic risk in patients with left atrial enlargement and mitral valve disease, left atrial size is critically important for the restoration of the sinus rhythm, and LA reduction alone may augment the maintenance of the sinus rhythm.

There is increasing evidence that LA size is potentially modifiable with medical therapy, but whether LA size reduction in patients undergoing mitral valve surgery translates to improved outcomes remains to be established. This has been the basis of study to know the impact of LA size reduction in mitral valve diseases.

Objective of the study were to study the impact of left atrial size reduction in patients undergoing mitral valve surgery for mitral valve disease with left atrial enlargement on clinical outcome and echocardiographic parameters.

## METHODS

A prospective study was done at department of cardiovascular and thoracic surgery, Sri Venkateshwara institute of medical sciences, Tirupati from June 2012 and June 2013.

During the study period a total of 40 study subjects were enrolled in our study hence these 40 study subjects were grouped into two categories with 20 study subjects.

The study population consisted of 40 study subjects with twenty patients in each group patients with rheumatic mitral valve disease with or without tricuspid valve disease with left atrial size enlargement who underwent mitral valve surgery alone and mitral valve surgery with left atrial reduction.

### ***Inclusion criteria***

Inclusion criteria included patients with rheumatic valvular heart disease with left atrial enlargement a) mitral stenosis b) mitral regurgitation c) mitral stenosis and mitral regurgitation d) MS/MR with tricuspid regurgitation.

### ***Exclusion criteria***

Exclusion criteria excluded patients with valvular heart disease undergoing mitral valve surgery along with aortic valve replacement, CABG and for other conditions.

Patients were evaluated by history, physical examination, biochemical tests, ECG and transthoracic echocardiography. CAG was done for patients above 40 years of age according to guidelines. Diagnosis of valvular heart disease with left atrial enlargement was established by echocardiography and graded accordingly.

Subjects with mitral valve disease and left atrial enlargement with or without tricuspid valve disease undergoing mitral valve surgery were included in the study.

The present study included 40 patients. Among these subjects undergoing mitral valve surgery and left atrial size reduction were included in group A-LA reduction group. Subjects undergoing mitral valve surgery without left atrial size reduction were included in group B-No LA reduction group.

Twenty consecutive subjects were taken in each group during the study period. Under GA CPB, mitral valve surgery and left atrial size reduction were done. The techniques of surgical reduction were lateral wall plication, dome plication, exclusion of left atrial appendage, resection of left atrial redundant wall and restoring. The choice of the technique was dependent on the assessment and at surgeon's preference.

#### **Surgical procedure**

All patients underwent median sternotomy to assess the heart. Pericardial trough was made. Heparin was given in the dose of 3 mg per kg body weight IV and the dose was monitored by activated clotting time (ACT). The aim was to achieve complete hemostatic paralysis. Pulmonary artery and left atrial pressures were recorded pre- and post-cardiopulmonary bypass. Aortic and bicaval cannulation was done and cardiopulmonary bypass was instituted. Surgeries were carried out under mild hypothermia (30-32°C). Aorta was cross clamped and warm ante grade intermittent blood cardioplegia was used for arresting the heart which was repeated at every 20 minutes. In addition, topical ice-slush was used for myocardial protection. The mitral valve was assessed in majority of the patients through left atriotomy. Right atrial trans septal approach was used for two patients who had concomitant tricuspid valve annuloplasty and in patients with small left atrium. Patients who had left atrial/left atrial appendage clot was removed and left atrial appendage exclusion was done. The method of replacement of mitral valve was decided preoperatively on the pliability and extent of calcification of the native mitral valve and the sub-valvular crowding. Modified mitral valve replacement with preservation of posterior mitral leaflet was carried out in all patients.

Regular follow up was done at regular intervals within fifteen days after discharge, every month for the first three months, every two months for the next six months and every three months thereafter. Detailed history, physical examination and ECG, transthoracic echocardiography was done during follow up. Rhythm on ECG, LA dimension, LVEDD, LVESD, LVEF, RVSP, mitral valve gradients, tricuspid regurgitation jets were evaluated and compared between pre-op, immediate post-op and follow up at six to twelve months. Any complications were treated and necessary drugs for

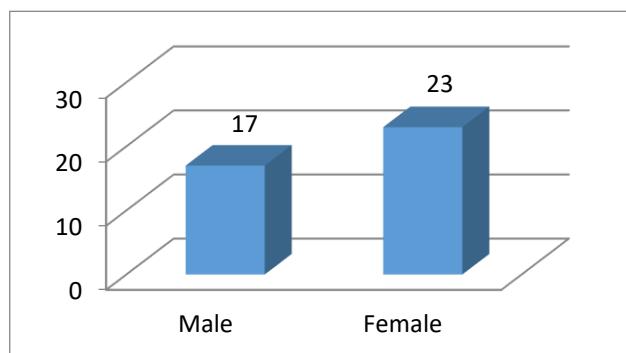
anticoagulation were given with proper advice. The ethical approval was taken from the ethical committee of the institute.

#### **Statistical analysis**

The data was entered in MS excel and analyzed using SPSS V 21. The continuous variables were represented using Mean and Standard deviation and categorical data was represented in the form of frequencies and proportions and chi square test will be used to check for association between quantitative data. P value less than 0.05 is considered to be statistically significant.

## **RESULTS**

The age range is 21 to 61 years with 60% of them between 30 to 40 years of age, 26.5% of them between 41 to 50 years, 12.5% of them more than 50 years and 1% of them less than 30 years of age. The mean age is  $39.7 \pm 10.3$  years. in the study group. The total no of males was 17 (42.5 %) and females were 23 (57.5%) in the study group. There were more females in the study groups. More patients belonged to low socio-economic status.



**Figure 1: Gender wise distribution of study subjects.**

All patients are rheumatic in etiology in both groups. In group A, LA reduction group, the main pathology in mitral valvular diseases is mitral stenosis in 8 number of patients, mitral regurgitation in 4 patients, mixed lesion in 8 patients. In group B, no LA reduction group, the main pathology in mitral valvular diseases is mitral stenosis in 9 patients, mitral regurgitation in 5 patients and mixed lesion in 6 of patients.

All patients underwent mitral valve replacement with prosthetic valves in both groups. Mechanical bi-leaflet valve prosthesis was used in all the patients in our study. Medtronic ATS was used in 17 patients in group A and 12 in group B patients respectively. St. Jude mechanical bi-leaflet valve prosthesis was used in 3 patients in group A and for 8 in group B patients. Tricuspid repair was done in one patient, annuloplasty was done in one patient in group A.

**Table 1: Mitral valve prosthetic size-groups.**

MVP size	Groups		Total
	Group A	Group B	
23	N 1	1	2
	% 5.00	5.00	5.00
25	N 6	11	17
	% 30.00	55.00	42.50
27	N 11	7	18
	% 55.00	35.00	45.00
29	N 2	1	3
	% 10.00	5.00	7.50
<b>Total</b>	<b>N 20</b>	<b>20</b>	<b>40</b>
	% 100.00	100.00	100.00

**Table 2: Comparison of dyspnea on exertion before and after the surgery.**

Comparison of dyspnea	Groups			Total
	Group A	Group B		
<b>Doe NYHA class (I-IV) before surgery</b>				
	II N 2	2		4
		% 10.00	10.00	10.00
Doe	III N 14	15		29
		% 70.00	75.00	72.50
NYHA	IV N 4	3		7
		% 20.00	15.00	17.50
<b>Doe NYHA functional class (I-IV) after surgery</b>				
	I N 10	4		14
		% 50.00	20.00	35.00
Doe	II N 10	15		25
		% 50.00	75.00	62.5
NYHA	III N 0	1		1
		% 0.0	5.00	2.5

Dyspnea was the predominant symptom in the study population. In group A, 2 were in NYHA class II, 14 patients were in NYHA class III and 4 patients were in NYHA class IV. In group B, 2 patients were in NYHA class II and 15 were in NYHA class III and 3 were in NYHA class IV. Post operatively, at six to twelve months there was improvement in group A, 10 were in NYHA class I and 10 were in class II. 10 patients improved from NYHA class III-IV to class II.

In group B, there was improvement from class NYHA class III-IV to class II in 15 of the patients, 4 number of patients were in class I and 1 patient was in class III. The mean NYHA functional class improvement was significant in patients of both groups at sixth day and at sixth to twelve months follow up postoperatively.

Total no. of patients were in AF pre-operatively in both groups. Two of the patients were in sinus rhythm in both groups. Following LA reduction, 2 patients reverted to sinus rhythm postoperatively while the rest continued to be in AF in group A. During follow up at six months one more patient reverted to sinus rhythm in this group. In

group B, sinus rhythm was not restored. There was difference in conversion to sinus rhythm in both groups. During the early postoperative period, the persistence of AF in group B patients was more apparent than in group A. Patients were discharged from the hospital in 7 to 10 days. None of the patients had prolonged stay.

**Table 3: Comparison of atrial fibrillation before and after the surgery.**

Comparison of atrial fibrillation	Groups			Total
	Group A	Group B		
<b>AF pre-operatively</b>				
	N 18	18		36
AF		% 90.00	90.00	90.00
	N 2	2		4
	% 10.00	10.00		10.00
<b>AF post-operatively</b>				
	N 16	18		34
AF		% 80.00	90.00	85.00
	N 4	2		6
	% 20.00	10.00		15.00

In group A, a significant decrease in LA size was noted postoperatively which was not observed in group B.

Between 6 and 12 months post-operatively, LA size reduction was prominent in group A with a decrease from  $60.4 \pm 8.04$  mm to  $44.8 \pm 6.8$  mm ( $p < 0.01$ ). The reduction of LA was more significant in patients with pre-operative LA dimensions over 60 mm. In group B, at six months of follow up, LA size had reduced from  $56 \pm 6.12$  mm to  $51 \pm 5.1$  mm, there was no further change in LA dimension with subsequent follow up, LA size remained same.

#### **Left atrial enlargement-electrocardiography**

Left atrial enlargement (LAE) is seen in patients with mitral and aortic valvular disease, IHD, hypertension and some cardiomyopathies. Typically, the p wave is bimodal in some leads and  $\pm$  in  $V_1$  with evident final negative mode.

The diagnostic criteria of LAE are as follows: p wave with a duration 0.12 second especially seen in leads I or II, generally bimodal, but with normal height; diphasic P wave in  $V_1$  with evident final negativity of at least 0.04 second of duration because the second part of the loop is directed backward due to LAE). These two criteria have good specificity (close to 90%; few false-positive cases) but discrete sensitivity (<60%; more false-negative cases).

The  $\pm$  p wave morphology in II, III, and VF with a  $p = 0.12$  second is very specific and has a high positive predictive value (100% in valvular heart disease and cardiomyopathies). However, it has a low sensitivity and low negative predictive value for LAE.

**Table 4: Comparison of echocardiographic data before and after the surgery.**

Comparison of echocardiographic	Pre op		At 6 days		6-12 months		F value	P value
	Mean	S. D.	Mean	S. D.	Mean	S. D.		
<b>Group A</b>								
LVEF (%)	52.850	6.420	55.800	5.490	58.550	5.450	4.818	0.012
LVEDD	51.400	9.360	47.700	8.420	43.200	7.135	4.830	0.012
LVESD	35.450	7.030	32.800	5.940	30.100	6.480	3.388	0.041
LA Dim	60.400	8.042	47.750	6.850	44.850	6.830	25.920	0.000
RVSP	79.450	24.650	47.350	11.860	30.500	11.470	42.153	0.000
<b>Group B</b>								
LVEF (%)	53.100	6.782	54.350	5.284	54.900	6.257	0.452	0.639
LVEDD	47.300	5.658	45.700	6.098	43.350	4.880	2.547	0.087
LVESD	33.150	4.837	32.500	5.960	29.450	4.236	3.046	0.055
LA Dim	56.000	6.122	52.900	5.241	51.000	5.171	4.137	0.020
RVSP	73.950	26.659	44.450	9.944	41.050	12.046	20.575	0.000

**Table 5: Comparison of mitral valve gradients pre- and post-operatively in both the groups.**

Mitral valve gradients	Pre-op		At 6 days		3-6 months		F value	P value
	Mean	S. D.	Mean	S. D.	Mean	S. D.		
<b>Group A</b>								
MV Gr. (peak)	28.100	6.265	8.250	2.337	8.650	2.110	157.127	0.000
MV Gr. (mean)	18.700	6.114	4.650	1.309	4.600	1.667	94.627	0.000
<b>Group B</b>								
MV Gr. (peak)	26.200	5.917	9.750	1.860	11.350	3.048	103.361	0.000
MV Gr. (mean)	15.600	5.154	5.050	1.317	6.000	2.675	57.632	0.000

Mitral valve gradients decreased in both groups after surgery.

## DISCUSSION

All patients are rheumatic in etiology in both groups. The mean NYHA functional class improvement was significant in patients of both groups at sixth day and at sixth to twelve months follow up post operatively. The improvement was from NYHA class III and IV to class II or class I. There were no patients left in NYHA class III-IV at six to twelve months of follow up in group A. One patient remained in NYHA class III in group B.

Özerdem et al in their study on Left atrial reduction by posterior wall plication combined with mitral valve surgery noted at follow-up 6 to 28 months after surgery 87% were in NYHA class I, 13% were in NYHA class II. Kutay et al observed that the patients with enlarged left atrium had similar functional class improvement.<sup>18,19</sup>

Erdogan et al reported similar findings of improvement pre operatively from NYHA functional class III (65%), and 35% were in class II to NYHA class I at six months on follow up.<sup>20</sup>

AF usually accompanies MV disease at the time of surgery, especially when the LA is enlarged. This is the main determining factor in the occurrence and

maintenance of chronic AF. MV surgery does not result in relief of AF. During the early postoperative period, the persistence of AF in group B patients was more apparent than in group A. Following LA reduction 2 patients reverted to sinus rhythm postoperatively while the rest continued to be in AF in group A. During follow up at six months one more patient reverted to sinus rhythm in this group.

Dzemali et al reported that left atrial size reduction affects cardiac rhythm in patients with chronic AF undergoing mitral valve surgery.<sup>21</sup> The addition of left atrial size reduction to mitral valve surgery was effective in restoring sinus rhythm in 19% at discharge and in 63% of patients with chronic AF, restoring predominant SR at one year postoperatively. Marui et al reported that by LA volume reduction using plication technique sinus rhythm restoration was significantly better in the volume reduction group at 12, 24 and 36 months of follow-up ( $p<0.05$ ) Kutay et al, observed that during the early post-operative period after MVR, patients with enlarged LA persisted to be in AF while SR was restored in significant of patients without LA enlargement.<sup>19,22</sup>

Johnson et al in their study on Plication of the enlarged left atrium at operation for severe mitral regurgitation noted post operatively conversion of AF to sinus rhythm.<sup>23</sup> Özerdem et al done a study on left atrial reduction by plication method along with mitral valve

replacement and noted that 39% patients had sinus rhythm at discharge.

Erdogán et al reported similar finding following partial cardiac auto transplantation and cardiac auto transplantation and noted restoring of sinus rhythm in 65% of patients and 75% of patients respectively.<sup>20</sup>

In group A, a significant decrease in LA size was noted postoperatively which was not observed in group B. Between 6 and 12 months postoperatively, LA size reduction was prominent in Group A with a decrease from  $60.4 \pm 8.04$  mm to  $44.8 \pm 6.8$  mm ( $p < 0.01$ ). In group B, at six months of follow up LA size had reduced from  $56 \pm 6.12$  mm to  $51 \pm 5.1$  mm, there was no further change in LA dimension with subsequent follow up, left atrial size remained same.

Özerdem et al in their study on left atrial reduction by posterior wall plication combined with mitral valve replacement, an important statistically significant reduction was observed in the LA diameters after reduction. When the postoperative sixth-day and sixth-month measurements were compared, no significant differences were found.<sup>18</sup>

Dzemali et al reported similar findings of significant left atrial size reduction at one year after surgery.<sup>21</sup> Erdogan et al used the technique of partial cardiac auto transplantation to reduce left atrial volume and noted that mean left atrial diameter decreased by 45%.<sup>20</sup>

Tonguç et al reported no differences in left atrial size between plicated and non-plicated patients.<sup>24</sup> Pande et al found a decrease in LA size after 5 years of follow-up following MVR in enlarged LA patients, but other studies have reported a reduction in LA size in the immediate post-operative period.<sup>25</sup>

Right ventricular systolic pressure decreased significantly following surgery. It decreased from  $79.5 \pm 24.7$  to  $47.3 \pm 11.9$  mmHg during the 1<sup>st</sup> six days after surgery. RVSP further decreased to  $30.5 \pm 11.47$  mmHg in group A at six months. In group B, there was reduction in RVSP from  $74 \pm 26.7$  to  $44 \pm 9.9$  mmHg during the 1<sup>st</sup> 6 days after surgery, it further reduced to  $41.05 \pm 12.04$  mmHg at six months. On comparison, the decrease observed in the LA reduction group was more than the decrease observed in group B over 6 months. This difference observed was statistically significant ( $p < 0.01$ ). This is due to the reversible nature of pulmonary arterial hypertension in rheumatic mitral valvular heart disease.

#### Limitations

The study group was small. The follow up was of six months to one year only. Long term follows up and large numbers in the study group is needed to see the effect of LA reduction for restoration of sinus rhythm and thromboembolic complications. Very few patients

reverted to sinus rhythm following LA reduction, hence definite conclusion could not be drawn regarding atrial fibrillation

#### CONCLUSION

Following MVR significant improvement in the NYHA functional class was noted in all the patients. The decrease in RVSP, LA size, and TR was noted in all the patients. The decrease noted in RVSP, TR and LA size were more in patients who underwent LA reduction. This decrease was noted up to six months to twelve months after follow up. Patients in AF with large LA, after reduction only 20% reverted to sinus rhythm. The plication technique is effective in reducing LA size, without much increase in cross clamp time, and there was no complication due to surgery.

It seems reasonable to suggest that patients who undergo LA reduction along with MVR have significant improvement in clinical outcome and NYHA functional class with less thromboembolic complications during long term follow up. Hence, LA reduction is advisable in patients with enlarged LA along with MVR.

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