

Original Article

Effects of subvalvular apparatus preservation in mitral valve replacement among rheumatic patients: early and mid term follow up.

Timala RB, Joshi D, Aryal M, Bhandari K, Singh Y, Sharma J.

Department of cardiovascular surgery, Shahid Gangalal National Heart Center, Bansbari, Kathmandu, Nepal

Correspondence to: Dr. Rabindra Bhakta Timala

Email: rbtimala@yahoo.com

Abstract

Introduction: Annulo-papillary continuity exerts significant impact on postoperative left ventricular function after mitral valve replacement.

Methods: This is a retrospective study of patients who had undergone mitral valve replacement at one of the three units of Shahid Gangalal National Heart Center. Patients were divided into three groups, group I: total resection of subvalvular apparatus, group II: posterior mitral leaflet preservation, group III: total preservation of subvalvular apparatus. Statistical analysis was done to see the differences between three groups in regards to left ventricular dimensions in diastole, systole and ejection fraction.

Results: Total of 93 patients underwent mitral valve replacement from April 14, 2011 to April 13, 2012. Among group I patients, left ventricular diastolic (LVIDd) dimension decreased significantly at 3 months follow-up; group II patients left ventricular systolic dimension (LVIDs) decreased significantly at 3 months, group III patients, both LVIDd and LVIDs decreased significantly at 3 months. At the end of 3 years, the graph showed patient with group I had increasing tendency for LVIDd, whereas patients with group III had decreasing tendency for LVIDd. Similarly patients in group I showed increasing trend for LVIDs, whereas it got stabilized after 2nd year among patients in group III. The ejection fraction was most improved among the patients with group III compared to group I or II.

Conclusion: Total subvalvular apparatus preservation during mitral valve replacement did have positive impact on left ventricular dimensions as well as function in early and midterm follow-up.

Key words: mitral valve replacement, subvalvular apparatus preservation, left ventricular diastolic dimension, left ventricular systolic dimension, ejection fraction

Introduction

Preservation of subvalvular apparatus during mitral valve replacement has been shown in various studies to have good impact on LV function in short term as well as long term. This retrospective analysis of our own study shows the difference among the groups who had undergone mitral valve replacement with total subvalvular apparatus excision, posterior mitral leaflet preservation and total chordal preservation between April 14, 2011 to April 13, 2012 one of the three units of surgical department at Shahid Gangalal National Heart Center, Kathmandu, Nepal.

Methods

Between April 14, 2011 and April 13, 2012; 93 patients underwent MVR in one of the three units of surgical department at Shahid Gangalal National Heart Center. 89 patients had mechanical bileaflet valve implantation and 4 patients had biological valve implantation.

The mean age of patients were 27.3 yrs +/- 12.8 years. Male constituted 38 patients (40.9%) and female constituted 51 (59.1%).

Patients were divided into 3 groups for comparisons:

Group I: complete resection of native valve along with subvalvular apparatus

Group II: posterior mitral leaflet (PML) preserved, anterior mitral leaflet (AML) excised

Group III: preservation of both anterior and posterior mitral leaflet chordae and it's papillary muscle

Surgical Technique

For patients undergoing total chordal preservation, anterior mitral leaflet was excised from the annulus leaving 2-3 mm margin. It was then split into two halves according to the chordae belonging to anterolateral or posteromedial papillary muscles. Excess leaflet tissue not bearing any chordal structure was excised. Anterolateral papillary muscle with it's chordae was implanted at 9 '0' clock from surgeon's view with the pledgetted valve suture. Posteromedial papillary muscle along with it's chordae was attached at 3 '0' clock position from surgeon's view with pledgetted valve suture. Calcified and thick fibrotic portions were shaved off on atrial side with a knife, leaving behind supple leaflet tissue containing chordae. Posterior mitral leaflet often required multiple radial incisions in order to fit in larger sized prosthesis. Mechanical bileaflet valve was implanted with struts running parallel to posterior mitral leaflet. For biological valve, since there's no risk of valve leaflet getting caught underneath, anterolateral papillary muscle was attached at 11 'o' clock position (surgeon's view) and posteromedial papillary muscle was attached at 2 'o' clock position (surgeon's view) for more symmetrical pull on annulus. Crowded subvalvular muscle had to be incised sometimes to gain length of papillary muscle and chordae in order to avoid stuck valve. Before final implantation, valve leaflet were tested by pushing the valve into the position with the help of two long forceps and necessary adjustment or

excision of some chordae or leaflet tissue were carried out if necessary.

Exclusion: Those patients who underwent double valve replacement and concomitant coronary artery bypass grafting along with mitral valve replacement were excluded from the study.

Postop studies: Echo assessment was done at 3 months, 1 year, 2 years and 3 years post replacement. Values were compared regarding ejection fraction, left ventricle internal diameter during diastole and systole.

Statistical Analysis

Student's 't' test was used to identify significant differences between the groups. p value less than 0.05 was considered significant. All data are expressed as mean +/- 1 SD unless otherwise specified.

Results

Mitral regurgitation was the main reason for MVR contributing to 47 patients (50.5%) followed by combined stenotic and regurgitant lesion in 27 (29%) patients, mitral stenosis in 19 (20.4%) patients. Only 55 (59%) patients underwent tricuspid valve repair, mostly suture annuloplasty.

Patients were divided into three groups for comparison:

- Group I: 19 (20.4%) patients had undergone complete resection of subvalvular apparatus.
- Group II : 21 (22.57%) patients underwent MVR with PML preservation
- Group III: 53(56.99%) patients had undergone MVR with preservation of total subvalvular apparatus.

Table 1: Group 1 patients: total chordal resection

	Preop (19)	3m (13)	1 yr (11 pt)	2 yr (6 pt)	3 yr (4 pt)
EF	.60 +/- 0.06	.59+/- 0.07	.60+/-0.05	.57+/-0.04	.59+/-0.07
LVIDd	5.39 +/- 0.93	4.77+/- 1.00 P< 0.05	4.77+/- 0.44	4.40+/-0.60	4.7 +/- 0.60
LVIDs	3.50+/- .77	3.23+/- 0.67	3.3 +/- 0.53	3.1+/- 0.50	3.19 +/- 0.60

(number in the parenthesis denote total no. of patients for that group)

Among group I patients with complete resection of subvalvular apparatus, left ventricular end diastolic dimension (LVEDd) changed significantly at 3 months follow up. However, there was no other significant change in EF, diastolic or systolic dimension during 3 years follow up.

Table 2: Patients with PML preservation

	Pre-op (21)	3m (8)	1yr (5)
EF	0.57+/- 0.10	0.55 +/- 0.13	0.56 +/- 0.30
LVIDd	5.16 +/- 1.00	4.81+/- 0.80	4.68 +/- 0.20
LVIDs	3.58 +/- 1.00	3.25 +/- 0.50 P < 0.04	3.28 +/- 0.30

(number in the parenthesis denote total no. of patients for that group)

Table 3: Patients with total subvalvular apparatus preservation:

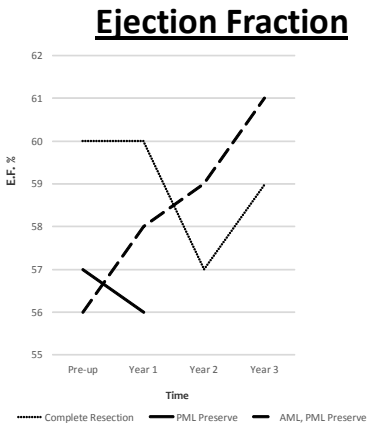
	Preop (53)	3m (39)	1yr (28)	2 yr (15)	3 yr (11)
EF	0.56 +/- 0.09	0.52 +/- 0.90	0.58 +/- 0.70	0.59 +/- 0.80	0.61 +/- 0.70
LVIDd	5.54 +/- 1.00	5.50 +/- 1.01 P< 0.01	4.40 +/- 0.67	4.70 +/- 0.43	4.60 +/- 0.30
LVIDs	3.75 +/- 0.75	3.30 +/- 0.70 P < 0.01	3.10 +/- 0.58	3.1 +/- 0.42	3.1 +/- 0.30

(number in the parenthesis denote total no. of patients for that group)

There were 53 patients who had preservation of total subvalvular apparatus during MVR. They had significant drop in their diastolic and systolic dimension at 3 months followup period.

The above data clearly shows that patients who had total subvalvular apparatus preserved, both left ventricular end diastolic and systolic dimensions were significantly decreased at 3 months follow-up as compared to only significant diastolic dimension decrease in total subvalvular resection and only significant systolic dimension decrease in PML preserved group.

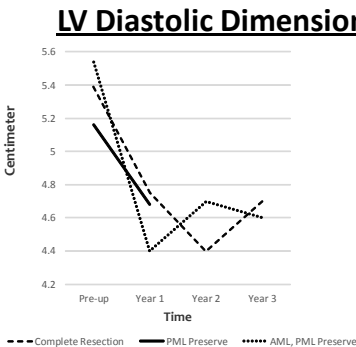
The following graph shows the changes in EF among the three groups of patients:



Ejection fraction, though it started at lowest point among patients with group III, rose to the highest point at the end of 3 years follow-up.

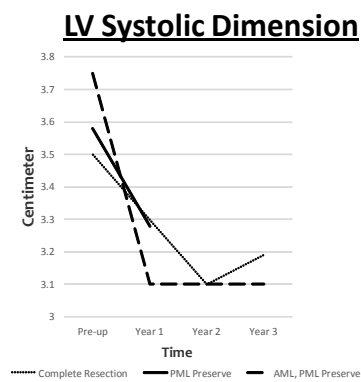
There were 21 patients who had their PML preserved during MVR. The only significant finding was decrease in left ventricular systolic dimension at 3 months followup. Due to inadequate no. of patients available for followup in 2nd and 3rd year post-op, they are excluded from the study.

The following graph shows the changes in left ventricular end diastolic dimension in diastole (LVIDd) among the three groups of patients:



At the end of 3 years, patients with total chordae preservation group demonstrated decreasing trend of LV diastolic dimension, whereas those with total chordal resection demonstrated rising trend of LV diastolic dimension. Also the slope of decline was more rapid among the patients with group III, as compared to group I or group II.

The following graph shows the changes in left ventricular end systolic dimension (LVIDs) among the three groups of patients:



The above graph shows, patients who had total subvalvular apparatus preservation, had lowest and stable left ventricular endsystolic diameter, whereas those who had total resection of subvalvular apparatus, the end systolic dimension showed rising trend at 3 years follow-up. The slope of decline was more rapid among patients of group III, as compared to group I or group II.

The following table shows the changes in ejection fraction and left ventricular dimensions among the patients who had undergone mitral valve replacement for mitral regurgitation in group III patients.

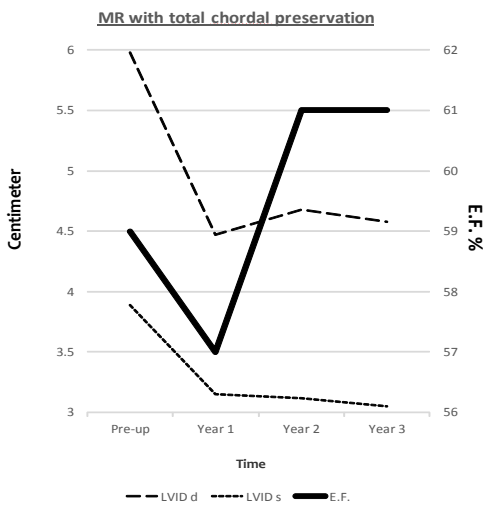
Table 4:

	Preop (18)	3m (25)	1 yr (18)	2 yr (10)	3 yr (7)
EF	0.59 +/- 0.06	0.51 +/- 0.09	0.57 +/- 0.07	0.61 +/- 0.61	0.61 +/- 0.08
LVIDd	5.98 +/- 0.79	4.7 +/- 0.88	4.47 +/-0.78	4.68 +/-0.05	4.58 +/- 0.30
		P<0.01	P< 0.01	P< 0.01	P<0.005
LVIDs	3.89 +/- 0.40	3.4 +/- 0.72	3.15 +/- 0.64	3.12 +/- 0.43	3.05 +/- 0.43
		P<0.01	P< 0.16	P< 0.01	

(number in the parenthesis denote total no. of patients for that group)

This table clearly shows the significant reduction in diastolic dimension throughout the period of follow up for 3 years and significant decrease in systolic dimension at 3months and 2 years period during followup.

The following is the graphical representation of changes in ejection fraction and left ventricular dimensions during diastole and systole among the patients who underwent mitral valve replacement with total chordal preservation among patients with mitral regurgitation.



The ejection fraction though decreased initially, goes up by 2 years period and remained there at 3rd years of follow-up. The diastolic and systolic dimensions decreased and remained there till 3 years of follow-up.

Among the patients of group III who underwent mitral valve replacement for mitral stenosis, the following table shows the changes in ejection fraction and left ventricular dimensions.

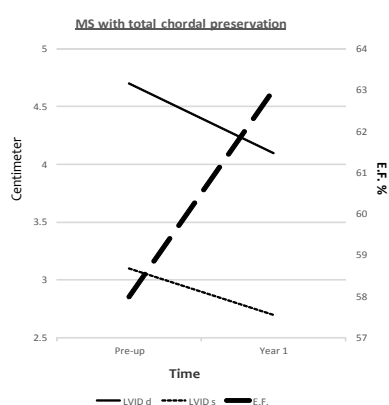
Table 5

	Pre-op (10)	3m (7)	1 yr (10)	2 yr (4)
EF	0.58+/- 1.31	0.58 +/- 0.09	0.63 +/- 0.04 P<0.05	0.63 +/- 0.04 P<0.05
LVIDd	4.7 +/- 1.24	4.14 +/- 0.64	4.1+/- 0.71	4.55 +/- 0.20 P< 0.01
LVIDs	3.1 +/- 1.07	2.7 +/- 0.43	2.77 +/- 0.41	2.9 +/- 0.07 P< 0.01

(number in the parenthesis denote total no. of patients for that group)

Ejection fraction increased significantly at 1st year and 2nd year follow up. LVIDd and LVIDs were significantly reduced at 2nd year follow up.

The figure below shows the graphical representation of patients who underwent mitral valve replacement with total chordal preservation among patients with mitral stenosis.



The graph clearly shows the increasing trend of ejection fraction and decreasing trend of LVIDd and LVIDs.

We did not have any in-hospital deaths, stuck valve due to chordae or left ventricular outflow obstruction among the patients who underwent mitral valve replacement during that period.

Discussion

Early mitral valve replacement with ball and caged valve in 1961 involved complete excision of mitral leaflet, chordae tendinae and tips of papillary muscle¹. That resulted in increased incidence of low cardiac output syndrome and associated mortality. The concept of annulo-ventricular continuity has been proposed by Wiggers and Katz² in 1922. According to the concept, there exists a dynamic interaction between mitral annulus and left ventricular wall which is responsible for LV function and geometry. And papillary

muscle and chordae being the connection between the two plays important role in LV function and geometry.

Hansen & associated demonstrated in canine experiments that LV function was more affected when chordae to the anterior mitral leaflet was excised as compared to those of posterior mitral leaflet, showing greater contribution of anterior mitral leaflet as compared to posterior mitral leaflet chordae in LV function.³

The concept of chordal preservation during mitral valve replacement to reduce post-operative low cardiac output syndrome was adapted by Lillehie in 1964⁴. A reduction in operative mortality from 37% to 14% was reported^{5,6,7}. His findings were largely ignored till in 1994; when David, in a randomized trial, showed that chordal preservation resulted in better LV function than those with no preservation even after 7 years⁸.

Various studies have been published regarding chordal preservation among rheumatic population undergoing mitral valve replacement. Study from All India Institute of Medical Sciences (AIIMS) New Delhi, India, concluded that chordal preservation either posterior or total results in significant improvement in LV function immediately or late postoperatively. The total chordal preservation group did demonstrate greater fractional change of LV end systolic volume as compared to posterior chordal preservation and non-chordal group.⁹

In a randomized trial of partial versus complete chordal preservation, Yun, Sintek et al found that there was larger decline in end-diastolic volume and smaller decrease in long-axis fractional shortening and ejection fraction among completely preserved chordal group¹⁰. Changes in end systolic volume and LV wall stress were also statistically different between 2 cohorts. They didn't find any difference between the group with total preserved chordal structures and mitral repair group in any of the measured parameters.

There are studies which failed to show benefit of chordal preservation among patients with mitral stenosis¹¹. But our study did show the benefit in terms of decreasing left ventricular dimensions in diastole

as well as in systole at the end of second year being significant and increasing ejection fraction at first year and second year being significant statistically.

The LV diastolic and systolic dimensions did decrease among all three groups in our study. However both dimensions tend to show rising trend at the end of three years among total chordal resection group, whereas it remained stable among the patients who underwent total chordal preservation at the end of 3 years post op.

In comparison to PML preserved group, the total chordal preservation group had sharper fall in LV dimensions. Because of low follow-up numbers statistical difference couldn't be found out. However, graph did show the trend, which can't be ignored.

The ejection fraction though it started at lower level became normal by 3 years time among total chordal preservation group, it declined among total chordal resection group. Compared to PML preserved group, which showed decline in ejection fraction at the end of one year total chordal preserved group showed increasing ejection fraction at the same time, though it started at lower point.

Among the patients of mitral regurgitation who had total chordal preservation, ejection fraction did decrease at the end of one year, but it became normal by 2nd year and remained so at 3 years follow-up. The decrease in LVIDd remained statistically significant till the end of 3rd year. The decrease in LVIDs remained significant at 3 months and 2nd year follow-up.

Rupture of left ventricle following mitral valve replacement is an infrequent but highly lethal complication, occurring in 0.5-2% of patients operated on. Rupture in some patients can best be prevented by preserving these chordae to posterior mitral leaflet as per "untethered loop" hypothesis proposed by Cobbs in 1980, based on autopsy findings¹².

Anterior chordal transection was found to be associated with significant impairment of apicoseptal region of the right ventricle, which may contribute to the lack of improvement in right ventricle function after mitral valve replacement with anterior mitral leaflet chordae transection, as per study done by Le Tourneau, Grandmougin et al.¹³

According to the microsimulation study done by Christopher Rao et al¹⁴, patients survive longer if the sub-valvular apparatus are preserved and also the

quality of life years gained over a 10 year period were greater after subvalvular apparatus preservation.

Conclusion

This study has shown that complete chordal preservation during mitral valve replacement for rheumatic mitral valve disease whether it be for mitral regurgitation, mitral stenosis or mixed lesions, offers significant advantage to the patient by reducing LV dimensions and increasing ejection fraction as compared to posterior leaflet preservation or total chordal resection.

These things have special implications among our young population, where they have decades to live after surgery.

Study Limitations

This is a retrospective study of patients who had undergone mitral valve replacement in one of units of surgical department of tertiary care cardiac hospital in Nepal. The procedure of chordal resection, posterior mitral valve preservation or total chordal preservation totally depended upon the operating surgeon at the time of surgery. We did not classify the patients in regards to whether the tricuspid valve was repaired or not ; whether suture annuloplasty was done or ring was inserted among those patients who had undergone mitral valve replacement. These variables may have some significance regarding heart function and ventricular dimensions in follow-up. Because of remote living, difficulty with transportation, poor economic situation the follow-up numbers were not great. As the follow-up numbers were inadequate, statistical significance couldn't be demonstrated in most of the variables. However, the graphical representation did show the trend, which seemed alarmingly different among the three groups. Multiple echocardiographers and echo machines were used during study. However, all the echocardiographers were certified cardiologists.

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