ORIGINAL ARTICLE

Complete Chordae preservation during Mitral Valve Replacement in patients with Rheumatic Mitral Regurgitation with LVESD≥50mm. A single center prospective randomized study

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ABSTRACT

Aim: To compare the echocardiographic results of complete sparing of mitral valve apparatus vs only posterior leaflet sparing in Mechanical Bi-leaflet Mitral valve Prosthesis replacement, in patients with Rheumatic Mitral Regurgitation with LVESD ≥ 50 mm

Methods: This prospective randomized controlled trial was performed at Department of Cardiovascular Surgery, Punjab Institute of Cardiology, Lahore, Pakistan, from January 2010 to March 2015, by a single Surgeon. Forty patients between 26-50 years of age, with LVESD ≥ 50mm and LVEDD ≥ 65mm, were included. Two groups made; Group A (Mitral apparatus sparing) Group B (Posterior Mitral sparing).. The results of final TTE at the end of First year postop were compared for Left Ventricular Ejection Fraction (EF), Left Ventricular End Diastolic Dimension (LVEDD), Left Ventricular End Systolic Dimension, Left Atrial Diameter (LAD), Interventricular Septum Thickness (IVS-T), Pulmonary Artery Pressure Severity (PAP). Statistical analyses were performed using IBM SPSS Version 21.0. Chi-square test and Fisher Exact test was applied to observe the association of qualitative variables with both groups, while quantitative variables with respect to both groups were compared using independent samples t-test. A value of P≤0.05 was considered statistically significant.

Results: Among 40 patients of Rheumatic Mitral Valve, 13 patient were male (32.5%) whereas 27 were females (67.5%). The mean age was 38.3±9.85 years (41.35±9.21 years in Group A, 34.70±9.34 years in Group B). In Group A, EF improved significantly from 48.00±3.23% to 56.75±4.38% (p=0.001), LVESD from 54.45±2.44mm to 49.80±3.61mm (p=0.001), LVEDD dropped from 67.80±2.14mm to 65.30±1.87mm (p=0.001), LA Diameter improved from 59.75±5.47mm to 56.40±4.71mm (p=0.001) and IVS-T got better from 11.25±0.79mm to 10.15±0.37mm (p=0.001).

Conclusion: The bileaflet preservation technique for MVR in patients with rheumatic mitral regurgitation and LVESD ≥ 50mm is superior to posterior leaflet only preservation technique.

Keywords: Chordae preservation, LVESD, mitral valve replacement,

INTRODUCTION

Mitral Valve apparatus consists of two leaflets, the annulus, chordae tendinae and papillary muscles, all working together as a unit for the competence of flow between left atrium and left ventricle[1]. Mitral Regurgitation (MR) can occur as a result of malfunction of any of these components. Once Mitral valve is severely regurgitant and patient is symptomatic, or left ventricular dimension in systole (LVESD) are increasing to 40mm, the Mitral valve Apparatus is either repaired or Mitral valve is replaced[2].

Mitral valve replacement is performed mostly with bi-leaflet mechanical valves, although if indicated bio-prosthesis may be used[2]. Before implanting prosthesis, the surgeons usually dissect the anterior mitral leaflet out of its annulus, along with the chordae, a little above tip of papillary muscle[3]. Mostly surgeons like to preserve the posterior mitral leaflet and its chordae unless it is diseased.[3] Bi-leaflet preservation has been shown to improve left ventricular function[3,5], however, it is not usual procedure of choice for most surgeons[6]. Bi-leaflet preservation appears difficult to perform, with longer duration of surgery, and necessitates the use of comparatively smaller sized prosthetic valve[3,7,8]. Previously it was thought to cause left ventricular outflow tract obstruction and increases chances of malfunction of mechanical valve prosthesis due to sub-valvular structures interfering with mechanical valve leaflets movement[9,10].

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Chordae preservation was proposed some 53 years ago[11]. However recently interest in chordae sparing procedure for MVR has grown remarkably[3-6]. This interest is due to observation that chordae sparing enhances patient survival secondary to decreasing risk of future ventricular dysfunction[4,12]. It has also been demonstrated that left ventricular geometry is changed when the annulo-ventricular continuiry has been interrupted at mitral valve replacement, disturbing the cardiac muslce mechanics, with reduced exercise tolerance due to decreased stroke volume[13].

The morbidity and mortality of mitral valve replacement did not change in spite of the major advances in anesthesia, surgical techniques, myocardial protection, improved prosthesis, and postoperative care. In contrast, mitral valve repair has shown better left ventricular performance postoperatively[14]. Although the superiority of bileaflet preservation over concentional valve excising MVR has been shown by many studies, in contrast, there are few MVR studies that compare bileaflet preservation with posterior leaflet only preservation[14,15,16,17]. Additionally, no such prospective study was performed in our country in recent past, the population being completely different from Caucasians and Africans. Keeping this in mind this study aimed to carry forward the benefits of valve repair, by preserving the chordae, during mitral valve replacement & at the same time reducing the risk of mechanical prosthesis dysfunction.

The objective of the study was to compare the echocardiographic results of complete mitral valve sparing vs only posterior leaflet sparing in Mechanical Bi-leaflet Prosthesis valve replacement at Mitral Position, in patients with Rheumatic Mitral Regurgitation with LVESD ≥ 50mm

MATERIALS & METHODS

This prospective randomized controlled trial was performed at Department of Cardiovascular Surgery, Punjab Institute of Cardiology, Lahore, Pakistan, from January 2010 to March 2015, by a single Surgeon.The study aimed to induct 100 patients for the study prospectively, but due to sad demise of Surgeon, the study was restricted to 40 patients between 26-50 years of age, with LVESD ≥ 50mm and LVEDD ≥ 65mm. The pre-op and post-op functional capacity (New York Heart Association; NYHA classification) were assigned by either consulting cardiologist or operating surgeon. To randomize surgical option, a computer based randomization was performed. Patients with calcifications, Ischemic MR, Mitral Stenosis, atrial fibrillation, and redo MVR, and those who were lost for follow up were excluded. The patients were then divided into two groups. In Group A, patients who underwent MVR with total chordae preservation, were enrolled (20 patients), whereas in Group B, patients with MVR in whom only preservation of posterior leaflet and chordae was done (20 patients). The two groups were matched well regarding preoperative patient characteristics. In-hospital mortality was defined as death during the first 30 days from operation. All patients were followed post operatively, up to 1 year minimum, by physical exams, ECG, trans-thoracic echocardiography (TTE). The results of final TTE at the end of First year postop were compared for Left Ventricular Ejection Fraction (EF), Left Ventricular End Diastolic Dimension (LVEDD), Left Ventricular End Systolic Dimension (LVESD), Left Atrial Diameter (LAD), Interventricular Septum Thickness (IVS-T), Pulmonary Artery Pressure Severity (PAP).

Surgical Technique: Median sternotomy was performed in each case under General Anaesthesia. Cardiopulmonary bypass (CPB) was established via ascending aortic and bicaval venous cannulation. The hematocrit was maintained between 26% and 28%, pump flow rates between 2.0 and 2.5 L/min/m2, and mean arterial pressure between 50 and 60 mmHg during CPB. For Myocardial protection, 1 Liter of cold Hyperkalemic blood: crytalloid (4:1) solution was used every 20-30 minutes. Topical cooling was performed using ice slush solutions. Moderate systemic hypothermia (28 ºC to 32 ºC) was employed during CPB for all cases. The mitral valve was approached through an incision in the left atrium, just posterior to the inter-atrial groove. For Group A, the surgeon preferred to perform sub-valvular preservation, by neither cutting the leaflets nor chordae. For Group B, the surgeon dissected Anterior mitral leaflet with associated chordae, but preserved the posterior mitral leaflet apparatus. Then the mitral valve was sized and appropriate ST Jude Bileaflet Prosthetic Valve was place at annulus of Mitral valve with prolene running suture. The leaflet tissues were folded between prosthesis sewing ring and annulus. No additional plication suture was used.

Statistical Analysis: Statistical analyses were performed using IBM SPSS Version 21.0. Quantitative variables were expressed as mean±standard deviation. Qualitative variables were presented as frequency and percentages. Chi-square test and Fisher Exact test (If cell frequency was less than 5)was applied to observe the association of qualitative variables with both group, while quantitative variables with respect to both groups were compared using independent samples t-test. Difference between the pre-operative and post-operative values within the same group were

compared using paired sample t-test. A value of P ≤ 0.05 was considered statistically significant. All test applied were two tail.

RESULTS

Among 40 patients of Rheumatic Mitral Valve, 13 patient were male (32.5%) whereas 27 were females (67.5%). The mean age was 38.3±9.85 years (41.35±9.21 years in Group A, 34.70±9.34 years in Group B). Twenty seven (27) patients belonged to NYHA class III symptom group. The preop EF was 49.68±4.28%, LVESD being 54.78±2.18mm and LVEDD was 68.10±1.85mm. The EF was lower in Group A patients whereas it was comparatively better in Group B (p=0.0001). Similarly, LVESD was better for Group B (p=0.352), whereas the LVEDD was increased in Group A patients (p=0.311). The preop LA diameter was 59.83±5.58mm, IVS-T was 11.03±0.86mm and 36 patients had severe pulmonary artery hypertension preoperatively (17 in Group A & 19 in Group B). LA Diameter was more in Group A patients (p=0.934) and the IVS-T showed more thickness for Group A (p=0.099).

In Group A, all 20 patients underwent MVR with preservation of both of the leaflets, in contrast patients in Group B underwent MVR with preservation of only posterior leaflet. St Jude Bileaflet Mechanical Valves of sizes 29-35 were used in both groups, where size 31 was most commonly used valve.

Postoperatively, improvement in functional status was observed in 21/27 patients with NYHA III and 12/13 patients with NYHA IV class (p=0.001). No death occurred during 1 year follow up in 40 patients. Transthoracic Echo was performed rountinely on each follow up, but the results were compared 1 years postoperatively in all patients to observe long-term benefits of each technique used. The EF was 51.38±6.79, LVESD was 54.05±5.24, LVEDD being 66.3±2.58, LA diameter was 58.55±5.421 and IVS-T was 10.35±0.62. Twenty five (25) patients had severe pulmonary hypertension even 1 year postoperatively.

Comparing 1 year postoperative Echocardiographic findings in Group A vs Group B, the following results were obtained. In Group B, the EF dropped markedly from 51.35±4.61% to 46.00±3.84% (p=0.001), and so is LVESD from 55.10±1.88mm to 58.30±2.32mm (p=0.001), and IVS-T from 10.80±0.89mm to 10.55±0.mm (p=0.135). However, LVEDD increased from 68.40±1.50mm to 67.95±2.54mm (p=0.449) and LA Diameter from 59.90±5.84mm to 60.70±5.33mm (p=0.446).

In Group A, EF improved significantly from 48.00±3.23% to 56.75±4.38% (p=0.001), LVESD from 54.45±2.44mm to 49.80±3.61mm (p=0.001), LVEDD dropped from 67.80±2.14mm to 65.30±1.87mm (p=0.001), LA Diameter improved from 59.75±5.47mm to 56.40±4.71mm (p=0.001) and IVS-T got better from 11.25±0.79mm to 10.15±0.37mm (p=0.001)

Table 1: Patient characteristics with respect to techniques of Chordal Preservation

Variables			**(Group I)**	**(Group II)**	**P-value**
Age			41.35±9.213	34.70±9.537	0.031
Valve size			31.00±1.589	32.30±0.979	0.003
NYHA class		III	9(45%)	18(90%)	0.022
		IV	11(55%)	2(10%)	
EF(%)		Pre	48.00±3.228	51.35±4.614	0.011
		Post	56.75±4.375	46.00±3.839	0.001
Left Ventricular End Systolic Dimension		Pre	54.45±2.438	55.10±1.889	0.352
		Post	49.80±3.607	58.30±2.319	0.001
Left Ventricular End Diastolic Dimension		Pre	67.80±2.142	65.30±1.867	0.311
		Post	68.40±1.501	67.95±2.544	0.001
Left Atrial Diameter		Pre	59.75±5.466	56.40±4.706	0.934
		Post	59.90±5.839	60.70±5.332	0.010
Interventricular Thickness		Pre	11.25±.786	10.15±.366	0.099
		Post	10.80±.894	10.55±.759	0.040
Pulmonary Artery Pressure	Moderate	Pre	3(15%)	1(5%)	0.292
	Severe		17(85%)	19(95%)	
	Mild	Post	2(10%)	0	0.011
	Moderate		10(50%)	3(15%)	
	Severe		8(40%)	17(75%)	

Table 2: Pre and postop inferential statistics of echocardiographic characteristics at with respect to techniques of Chordal Preservation.

Variables	**(Group I)**		**P-value**	**(Group II)**		**P-value**
	Preop	**Postop**		**Preop**	**Postop**	
EF(%)	48.00±3.228	56.75±4.375	0.001	51.35±4.614	46.00±3.839	0.001
Left Ventricular End Systolic Dimension	54.45±2.438	49.80±3.607	0.001	55.10±1.889	58.30±2.319	0.001
Left Ventricular End Diastolic Dimension	67.80±2.142	65.30±1.867	0.001	68.40±1.501	67.95±2.544	0.449
Left Atrial Diameter	59.75±5.466	56.40±4.706	0.001	59.90±5.839	60.70±5.332	0.446
Interventricular Thickness	11.25±.786	10.15±.366	0.001	10.80±.894	10.55±.759	0.135

DISCUSSION

In 1983, David et al, revised the preservation of chordae tendinae during mitral valve replacement[18]. Quite convincing clinical evidence was reported that favoured maintenance of the annulo-papillary continuity, supporting the previous work by Lillehei et al during 1960s[19]. Later on, the clinical and experimental studies supported this concept and recommending not-to- excise all chordae tendineae in MVR[1-6,12,19-21]. It was found that during isometric contraction phase of cardiac cycle, the papillary muscles contract, the closed mitral valve is brought down into the left ventricle which results in a reduction in longitudinal axis and an increase in short axis. Consequently, this causes increased myocardial fiber stretch, generating greater cardiac muscle tension, its contraction, and thus the stroke volume.[1] However, bileaflet preservation has not gained popularity among cardiac surgeons, who instead are comfortable with posterior leaflet only preservation[7,8].

This study was conducted in patients with rheumatic Mitral regurgitation having LVESD ≥50mm on preoperative echocardiogram. These all patients had mitral valve replacement with St Jude Bileaflet Mechanical valve. Though, after discharge all patients underwent regular and routine followup program, the comparison of bileaflet preservation vs posterior leaflet only preservation was carried out after 1 year postop.

In our study, the Ejection fraction was improved considerably (p=0.001) in patients who underwent bileaflet preservation technique of MVR. This supports the results of Miki S et al[22] who attributed this to improvement in motion of anterolateral wall and apical areas. Similar results were found by Okitta Y et al[23]. These two studies support the version that when continuity between the mitral anulus and the papillary muscle is maintained, the left ventricular performance improves significantly. These two techniques however involved the division of anterior leaflet into anterior and posterior segments, the shifting and re-attachment of the divided segments to the mitral ring of the respective commissural areas. Cingoz F et al[5] described the increase in EF both at rest and during exercise when bileaflet preservation technique was used. This is in contrast to the study conducted by Yun and colleagues[24] who declared no such differences between the two techniques. Similarly. Hennein and coworkers[25] observed no significant difference between their bileaflet preservation and posterior leaflet only preservation groups. Moreover, another study by Rozich JD et al[26] observed the same results. Additionally, Ozdemir et al[14] found no decrease in EF in Bileaflet preservation group, but significant reduction in EF in posterior leaflet only preservation group. Their study was not a prospective randomized one, and the bileaflet preservation was performed mostly in patients with lower EF and higher LVESD and LVEDD.

A meta-analysis of bileaflet preservation reviewed investigations of different preservation techniques but failed to show the superiority of bileaflet preservation over posterior-leaflet- only preservation.[27] In our study LVESD improved in Group A patients (p=0.001) whereas it significantly worsen in Group B (p=0.001). This may define the importance of anchored subvalvular apparatus, in enhancing the stretch and tone of left ventricular muscles. However, both techniques have shown improvement in LVEDD, the significant reduction was revealed in Group A patients, adding again to the important role of preserved subvalvular apparatus. Ucak A et al[3] found an improvement in LVESD and LVEDD in bileaflet preservation group, but this study compared its results with conventional method where no chordae are preserved. Ozdemir et al[14]. However, found no improvement in LVESD for bileaflet preservation, whereas significant improvement was reported for posterior leaflet only preservation technique. Similarly, they were unable to find any significant change in LVEDD of bileaflet preservation, but detected the decrease in LVEDD in posterior leaflet only preservation group. Their study thus concluded that although the bileaflet preservation gives better EF, it is the posterior leaflet only preservation that yields marvellous results in terms of LV diameter. Our study however, showed improvements in not only EF, but also in LV dimensions in bileaflet preservation technique.

This study showed quite an improvement in LA Diameter and IVS-T in patients with preservation of both leaflets, previous studies failed to demonstrate any improvements, however. Ucak A et al[3] assessed the effects of bileaflet preservation versus conventional technique of MVR. That study showed an improvement in LA diameter in both groups. The severity of pulmonary artery hypertension was reduced significantly in Group A patients, which however failed to improve in patients from Group B. In contrast, Ozdemir et al[14] found improvement of pulmonary artery hypertension in both groups.

Study Limitations: The study groups lack similarity. There was a difference between the groups in terms of preoperative LVEF and LVESD. Additionally, though this is a randomized prospective study, the sample groups were small, this may be addressed with help of another surgeon over next 5 years. Moreover, the present study investigated the results of only one of the bileaflet preservation techniques. Different results might be obtained with the use of other preservation techniques.

CONCLUSION

The bileaflet preservation technique for MVR in patients with rheumatic mitral regurgitation and LVESD ≥50mm is superior to posterior leaflet only preservation technique. It significantly prevents the postoperative decrease in LVEF, and improves LVESD, LVEDD, LA diameter, IVS-Thickness and severity of pulmonary artery hypertension. However, more studies are needed to obtain more detailed information on this subject.

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