

## EARLY MORTALITY & MORBIDITY IN MITRAL VALVE REPLACEMENT WITH TOTAL SUB-VALVULAR APPARATUS PRESERVATION, PARTIAL PRESERVATION AND NO PRESERVATION - A COMPARATIVE STUDY

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### ABSTRACT

**Objective:** To compare the early morbidity & mortality of total sub-valvular apparatus preservation technique vs partial preservation technique and no preservation technique in mitral valve replacement.

**Study Design:** Cross-sectional comparative study.

**Place and Duration of Study:** Department of Cardiac Surgery, Armed Forces Institute of Cardiology Rawalpindi, from Jan 2017 to Dec 2018.

**Methodology:** One hundred fifty seven patients who underwent Mitral valve replacement were included in study. These patients were divided into three groups; group "A" comprised of those patients with total sub-valvular apparatus preservation (n1=46), group "B" comprised of those patients with partial sub-valvular apparatus preservation (n2=70), group "C" comprised of those patients with no sub-valvular apparatus preservation (n3=41).

**Results:** There were no statistical difference in the pre-operative data of the patients. No statistical difference noted in cross clamp & bypass time ( $p>0.05$ ). The early morbidity in terms of ICU stay, Ventilation time, Inotropic supports, post-operative bleeding, Blood transfusion, postoperative rhythm abnormality & Re-exploration were statically significant ( $p<0.05$ ). The mortality rate of patients with total sub-valvular apparatus preservation was 2.17% which is significantly less than those with partial preservation (2.85%) & no preservation (9.75%).

**Conclusions:** Mitral valve replacement with total subvalvular apparatus preservation had low postoperative morbidity & mortality in comparison with partial and no preservation techniques.

**Keywords:** Mitral Valve Replacement, Subvalvular Apparatus preservation, Operative Techniques.

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### INTRODUCTION

Mitral valve is a complex anatomical structure which not only plays an important role in maintaining the left ventricular functions but also effects the right ventricular functions as well<sup>1</sup>. Mitral Valve Replacement started in 1961, where Starr-Edward Prosthetic valve was used after excision of the native valve leaflets along with chordae tendineae & papillary heads, leading to drastic early complication of low cardiac output & ultimately death<sup>2</sup>. Therefore, the concept of sub-valvular apparatus preservation was introduced. The components of sub-valvular apparatus are ventricular free wall, papillary muscle & chordae tendineae. Significance of sub-valvular

apparatus during ventricular systole is to prevent mitral leaflets prolapse in left atrium and improving the left ventricular contraction; process called as annulo-ventricular continuity<sup>3</sup>. In recent past its established that the effective modality of treatment in mitral valve surgery is valve repair with preservation of its sub-valvular apparatus<sup>4</sup>. In certain condition where Mitral valve replacement (MVR) is inevitable because of anatomical & etiological reasons<sup>5</sup>, different techniques of preservation were developed to restore Left ventricular functions and Atrioventricular anatomy<sup>6</sup>. Some surgeons are against the concept of preservation because of grossly calcific valves, fibrosis of leaflets & papillary heads, small sized left ventricle & placement of smaller prosthetic valve<sup>1</sup>. But Its proven from different studies that destruction of Atrioventricular connections leads to early

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heart failure because Left ventricle adopts spherical shape causing poor contraction & low cardiac output with high mortality<sup>7</sup>. Gomes adopted preservation of both leaflets preservation technique along with the sub-valvular apparatus<sup>8</sup>. Al Saddique reported two main drawbacks of total preservation that were left ventricle outflow obstruction due to extensive tissue and better application of technique in mitral regurgitation patients<sup>9</sup>. To encounter this difficulty Puig *et al* introduced division of anterior & posterior leaflets into hemileaflets via trimming of the extra tissue<sup>10</sup>. Keeping in view the importance of chordal preservation, the current study compared the early morbidity & mortality in MVR with total sub-valvular apparatus preservation technique vs partial preservation technique and no preservation technique.

To compare the early morbidity & mortality of total sub-valvular apparatus preservation technique vs partial preservation technique and no preservation technique in mitral valve replacement.

## METHODOLOGY

A cross-sectional comparative study was conducted in the Department of Cardiac Surgery, Armed Forces Institute of Cardiology-National Institute of Heart Diseases (AFIC-NIHD), Rawalpindi. Data of patients who underwent MVR from 1<sup>st</sup> January 2017 to 31<sup>st</sup> December 2018 was collected from the institutional database. Patients of any gender with age ranging from 20-80 years & isolated mitral valve disease predominantly Mitral Stenosis was included in the study while patients with multiple valve disease, redo cases, mitral valve disease with coronary artery disease, left atrial size >60 mm, infective endocarditis, moderate-severe pulmonary hypertension & BMI <18 were excluded from the study sample. Finally, 157 patients who fulfilled the inclusion criteria was included in the study. These patients were divided into three groups; group "A" comprised of those patients with total sub-valvular apparatus preservation (n1=46), group "B" comprised of those patients with partial sub-valvular apparatus preservation (n2=70), group "C"

comprised of those patients with no sub-valvular apparatus preservation (n3=41).

**Total Sub-valvular apparatus preservation technique:** In this technique the anterior mitral leaflet (AML) was cut in the center at least 2-3mm away from the annulus. The excised leaflet is trimmed in such a way to make two buttons like tissues, connected with the main chordae tendinae. The preserved tissue of AML is stitched with the mitral annulus by pledgeted Ethibond 2/0 at anterolateral & posteromedial positions. Posterior leaflet is either trimmed or left as such if not hindering the implantation of appropriate size mitral prosthesis.

**Partial sub-valvular apparatus preservation technique:** In this technique the AML is excised completely along with the sub-valvular apparatus while the posterior mitral leaflet (PML) along with the sub-valvular apparatus is preserved as such. In case of calcific thickened posterior leaflet, it was either trimmed or incised in such a way that two heads were made which was stitched to the annulus with pledgeted Ethibond 2/0.

**No preservation technique:** In this approach both the AML & PML along with the sub-valvular apparatus was excised completely without any preservation.

Standard operative technique was adopted for all the patients which included median sternotomy, cardiopulmonary bypass with moderate hypothermia (32°C) & intermittent antegrade blood cardioplegia. Approach to Mitral valve was either through Left atrium or Right atrium-trans septal approach. Technique used for prosthetic mitral valve implantation was either through continuous or interrupted suturing. During the procedure it was ensured that no leaflet or sub-valvular tissue interfere in the valve function by checking the movements of the valve disc. The decision regarding the preservation techniques was taken intra-operatively by visualization of the valve anatomy. Demographic data like age, gender, body mass index (BMI), pre-operative ejection fraction and comorbidities were recorded. Peri-operative data of cardiopulmonary

bypass time & cross clamp time was noted. Post operatively the ventilation time, Intensive care unit (ICU) stay, bleeding, arrhythmias & number of deaths were also recorded. Early morbidity & mortality were recorded till 7th post-operative day. Outcome variables were analyzed in order to determine the mortality and morbidity in each group. Primary outcome in our study was mortality and secondary outcomes were ICU stay, ventilation time, inotropic support & post-operative new onset of Atrial Fibrillation.

## RESULTS

The demographic profile of the patient is tabulated in table-I. No statistically significant

operative Ejection Fraction & Rhythm was also found to be insignificant.

There was no significant difference noted in peri-operative cardiopulmonary bypass time, cross clamp time as shown in table-II. Statistically significant difference noted in the mitral valve prosthesis size ( $p=0.010$ ).

There was significant difference recorded in ventilation time & intensive care unit stay, which is less in group A than B & C ( $p=0.01$  &  $p=0.001$  respectively).

Requirement of blood transfusion was a significant factor and more blood transfused in the no preservation group ( $p=0.024$ ) as shown in

**Table-I: Demographic profile of patients in groups.**

	Group "A" (n=46)	Group "B" (n=70)	Group "C" (n=41)	p-value
<b>Gender</b>				
Male	26 (56.52%)	37 (52.85%)	20 (48.78%)	0.774
Female	20 (43.48%)	33 (47.15%)	21 (51.22%)	
Mean Age $\pm$ SD	49.00 $\pm$ 13.362	50.96 $\pm$ 13.702	51.29 $\pm$ 13.316	0.675
BMI	26.49 $\pm$ 4.259	25.95 $\pm$ 3.981	26.48 $\pm$ 4.004	0.715
LVEF (%)	50.11 $\pm$ 8.141	50.49 $\pm$ 9.023	50.88 $\pm$ 10.943	0.929
LVEDD (mm)	54.87 $\pm$ 7.902	55.63 $\pm$ 6.804	55.38 $\pm$ 8.562	0.443
LVESD (mm)	43.54 $\pm$ 4.312	44.01 $\pm$ 3.205	45.23 $\pm$ 4.753	0.313
Diabetes	1 (2.17%)	6 (8.57%)	2 (4.87%)	0.341
Hypertension	16 (34.78%)	21 (30%)	11 (26.82%)	0.721
Smoking	5 (10.86%)	8 (11.42%)	3 (7.31%)	0.778
Atrial Fibrillation	19 (41.30%)	34 (48.57%)	18 (43.90%)	0.733

LVEF = Left Ventricular Ejection Fraction, LVEDD = Left Ventricular End Diastolic Diameter, SD = Standard Deviation, LVESD = Left ventricular End Systolic Diameter, BMI = Body Mass Index, p-value less than 0.05 = Statistically significant.

**Table-II: Peri-operative data of patients in groups.**

	Group "A" (n=46)	Group "B" (n=70)	Group "C" (n=41)	p-value
CBP TIME (mins)	135.11 $\pm$ 27.126	136.94 $\pm$ 40.015	120.59 $\pm$ 34.078	0.961
CXT (mins)	99.17 $\pm$ 22.244	103.79 $\pm$ 30.330	92.49 $\pm$ 25.893	0.639
Mitral valve size (mm)	27.35 $\pm$ 1.464	28.40 $\pm$ 1.459	29.20 $\pm$ 1.470	0.010

CBP = Cardiopulmonary Bypass, CXT = Cross Clamp Time, p-value less than 0.05 = Statistically significant.

**Table-III: Short-term outcome of patients in groups.**

	Group "A" (n=46)	Group "B" (n=70)	Group "C" (n=41)	p-value
ICU Stay (Hours)	28.26 $\pm$ 12.664	33.44 $\pm$ 15.070	40.76 $\pm$ 17.926	0.001
Vent-Time (Hours)	9.09 $\pm$ 5.807	10.57 $\pm$ 6.854	16.85 $\pm$ 10.056	0.001
Bleeding (mL)	532.71 $\pm$ 251.187	537.39 $\pm$ 291.416	687.93 $\pm$ 354.894	0.016
Atrial Fibrillation	9 (19.6%)	19 (27.1%)	13 (31.7%)	0.011
Re-Exploration	2 (4.34%)	5 (7.14%)	8 (19.15%)	0.036
Death	1 (2.17%)	2 (2.85%)	4 (9.75%)	0.020

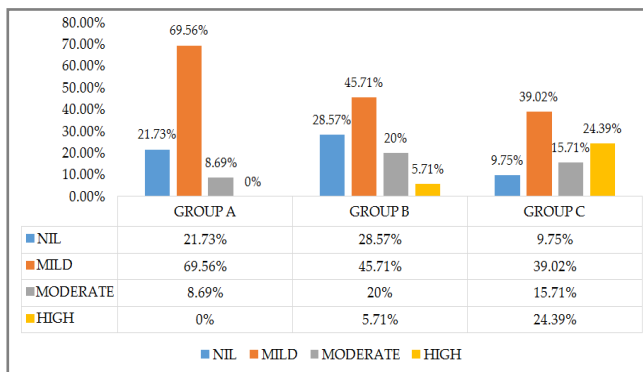
p-value less than 0.05 = Statistically significant, ICU = Intensive Care Unit.

difference is noted between age, gender, comorbidities like diabetes, hypertension & smoking, NYHA class & mitral valve disease type. Pre-

table-II. The pre-operative rhythm was insignificant because on average same number of patients were in sinus vs atrial fibrillation (AF). But post-

operatively significant rhythm abnormalities like new onset of AF, supra ventricular tachycardia (SVT) & Ventricular paroxysmal contractions (VPCs) were encountered in the no sub-valvular apparatus group ( $p=0.011$ ).

The requirement of post-operative inotropes was significantly more in group C versus group A & B ( $p=0.001$ ). Post-operative bleeding was more in group C (mean 687.93ml) versus group A & B (mean 532-537ml) with  $p$ -value of 0.016. There were 2 re-explorations in group A, 5 in group B & 8 in group C which were statistically significant ( $p=0.036$ ).



**Figure: Inotropic support.**

The early mortality was noted to be high in those patients with no sub-valvular apparatus preservation as group C ( $n=8$ ) >group B ( $n=4$ ) >group A ( $n=2$ ).

## DISCUSSION

Mitral valve & its sub-valvular apparatus is a complex anatomical structure with significant effects on Left as well as right ventricular functions<sup>1</sup>. With time it was realized that sub-valvular apparatus is an important determinant in outcome of patient with mitral valve replacement, in reducing early and long term morbidity & mortality<sup>11</sup>. Different techniques were developed & practiced in time to time to achieve maximum restoration of normal anatomy & physiology of mitral valve, like complete preservation without any excision, repositioning of the papillary muscle heads, partial excision of the anterior & posterior leaflets<sup>12</sup>.

The purpose of our study was to prove that the total sub-valvular apparatus preservation technique had low early mortality & morbidity in comparison with partial and no preservation. In our study the mortality rate of patients with total sub-valvular apparatus preservation was 2.17% which is significantly less than those with partial preservation (2.85%) & no preservation (9.75%). A study conducted in St. Mary Hospital, London reported mortality of 2.6% in patients of mitral valve replacement with preservation vs 12.1% in those without preservation<sup>13</sup>. Another study showed in-hospital mortality of 2.6% in the preservation group while 8.9% in the non-preservation group-3 figure showed the inotropic support of patients in all the three groups with requirement of high supports in the no preservation group indicating that patients were in low cardiac output. Similar results were shown by a study conducted in Karachi, where 12.6% of the patients with preservation required inotropic support while 52.4% of patients with no preservation needed inotropic support. Therefore, complete and partial preservation was better than no preservation in terms of lesser post-operative complication like low cardiac output, high inotropic support requirement & mortality<sup>14</sup>.

The reported mortality in different studies conducted on mitral valve replacement with or without preservation demonstrated that main cause of mortality was myocardial pump failure in the postoperative period leading to increased requirement of inotropic support<sup>13</sup>, same cause of high mortality was established in our study because those patients who had no preservation remained in low cardiac output with prolonged ICU stay in comparison with patients of total & partial preservation. Similar results were reported by Athanasiou *et al* with significant decrease in requirement of inotropic supports in patients with subvalvular apparatus preservation<sup>13</sup>. Another study showed 7.7% of patients with preservation required high inotropic support in comparison with 12.6% of patients in the non-preservation group-3.



Some researchers believed that total preservation of sub-valvular apparatus prolongs the time of surgery & implantation of small size prosthesis<sup>15</sup>, but findings of our study contradict with the reported evidence as there was no statistically significant difference noted in cardiopulmonary bypass time & cross clamp time ( $p < 0.05$ ) as shown in table-II. Millers *et al* reported a significant decrease in mortality of patients with preservation of posterior leaflet & sub-valvular apparatus<sup>16</sup>. Chowdhury *et al* in their research showed a significant improvement in the Left Ventricular functions & reducing the incidence of dilated cardiomyopathy in MVR patients with total preservation of sub-valvular apparatus<sup>17</sup>. Coutinho *et al* reported mortality of 0.9% in the preservation group while 1.4% in the non-preservation group-1. Our study results were similar to these studies proving the fact that subvalvular apparatus preservation was an important determinant in better outcome of patients with MVR. Re-exploration rate in our study in group "A" was 4.3% while group "C" it was 19.1%, similar results were shown by a study in which 1.8% of MVR patients with preservation of sub-valvular apparatus were re-explored while 4.0% in the non-preservation group were re-opened<sup>1</sup>.

In addition to other morbidities in our study, significant decrease in previous AF was noted in the preservation group while in the non-preservation group no such appreciable decrease was noted in patients but also rate of new onset AF was high in group "C". Similar results were reported by a study in which rate of new onset AF in the preservation group was 19.1% while in the non-preservation group it was 21.2%<sup>1</sup>. Another study showed AF in 38.5% in preservation group vs 52.7% in non-preservation group-3.

Postoperative bleeding was another morbidity in our study leading to requirement of RCC transfusion was significantly high in the non-preservation group; group A < group B < group C. Similar high level of postoperative bleeding was reported in previous research<sup>3</sup>. The concept of preservation was highly recommended in the recent era of cardiovascular surgery, not only

preservation of the posterior leaflet & apparatus but the anterior leaflet & its subvalvular apparatus is also important for the improvement of LV functions<sup>18</sup>.

## CONCLUSION

From the results of our study it was proved that early mortality & morbidity was significantly low in those patients with total sub-valvular apparatus preservation. In comparison with the other techniques it requires high surgical experience to avoid the complications of total sub-valvular apparatus preservation. Hence it was suggested that surgeons should know about the different techniques of preservation and its expected complication.

## CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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