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Both Leaflet Versus Posterior Leaflet Preservation in Mitral Valve Replacement

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Abstract

Background: Most cardiac surgeons prefer to preserve only the posterior leaflet of Mitral Valve During Mitral Valve Replacement because preserving both leaves prolong surgery, necessitates a smaller prosthetic valve, and increases the risk of both the prosthetic valve contacting subvalvular structures and obstructing the left ventricular outflow tract (LVOT).

Aim of Study: To Compare the short-term outcomes of preservation of both leaflets versus preservation of the posterior leaflet alone in mitral valve replacement surgery.

Patients and Methods: 24 adult patients undergoing or had mitral valve replacement during this study period and Patients were divided into two groups Group A 12 Patients undergoing or had MVR with preservation of both leaflets, Group B 12 Patients undergoing or had MVR with preservation of Posterior leaflet only as a Control.

Results: In our study the analysis revealed a statistically significant difference in LVEF between the two groups, The study findings indicate that preservation of both leaflets during mitral valve replacement (MVR-P) may result in a comparatively higher LVEF at the postoperative stage compared to preservation of the posterior leaflet only (MVR-NP).

Conclusion: Preservation of both leaflets during mitral valve replacement results in significantly higher left ventricular ejection fraction (LVEF) and better left ventricular end-systolic diameter (LVEDD) and left ventricular end-diastolic diameter (LVEDD) compared to preserving the posterior leaflet only.

Key Words: *Mitral valve — Replacement — Leaflet preservation.*

Introduction

IN the early days of mitral valve replacement (MVR), there was an increased rate of mortality associated with low cardiac output syndrome, as MVR at that time included complete excision of mitral leaflets and sub valvular apparatus, Interruption of ventricular-papillary-annular complex by excision of sub valvular apparatus during MVR causes impairment of left ventricular function and low cardiac output, However, cardiac surgeons have not given both leaflet preservation enough attention. Currently, most cardiac surgeons prefer to preserve only the posterior leaflet because preserving both leaves prolong surgery, necessitates a smaller prosthetic valve, and increases the risk of both the prosthetic valve contacting subvalvular structures and obstructing the left ventricular outflow tract (LVOT). MVR procedure with preservation of both leaflets and all the chordae tendinea, showed that the postoperative ejection fraction (EF) increased and that left ventricle performance improved after operation.

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Patients and Methods

This was a Single Center Comparative Prospective Study with a Retrospective Historical Control group. Eligible, are all patients undergoing or had mitral valve replacement in Department of Cardiothoracic Surgery, Faculty of Medicine, University of Mansoura, in Dakahlia, The study includes cases from March 2019 to March 2021.

Eligibility:

- Age Eligible for Study: 18 Years to 60 Years (Adult, Senior).
- Sex Eligible for Study: All.
- Enrollment size: (24) Patients in the retrospective and prospective arm of the study from (March 2019 — March 2021) including follow-up period.

Inclusion criteria:

Eligible were (24) adult patients undergoing or had mitral valve replacement at Department of Cardiothoracic Surgery, Faculty of Medicine, University of Mansoura during this study period and Patients were divided into two groups.

- Group A: (12) Patients undergoing or had MVR with preservation of both leaflets (MVR-P).

• Group B: (12) Patients undergoing or had MVR with preservation of posterior leaflet only as a control (MVR-NP).

Exclusion criteria:

• Pure mitral stenosis.
• Suitable candidates for mitral valve repair.
• Associated MVR with CABG
• Associated Aortic valve pathology requiring surgery.
• Patients with infective endocarditis.
• Redo mitral valve surgery after failed repair.
• Left ventricular dysfunction (ejection fraction less than 40%)
• Patient Refusing the enrollment in the study.

Methods:

A- Study type: This is a Comparative Prospective Study with a Retrospective Historical Control group whose Primary Purpose istreatment.

B- Study setting: The study was conducted in department of Cardiothoracic Surgery, Faculty of Medicine, University of Mansoura, in Dakahlia, Egypt.

C- Ethical approval: Approval of the institutional research board (IRB) and the medical ethics committee in Mansoura University were obtained. All included patients signed an informed consent for the operation and post-operative echocardiographic examinations, and publication of the clinical data while ensuring confidentiality of personal information.The investigators complied with the World Medical Association Declaration of Helsinki as regards the ethical conduct of research involving human subjects [in.

D- Preoperative assessment: Including patients history, physical examination, and review of all tests and co-morbid conditions to confirm risk stratification for optimal surgical planning

1- *Personal data:* Including, age, gender, body weight, height, body mass index, occupation, and personal habits.

2- *History taking:* Including detailed analysis of patients' symptoms, comorbid medical conditions, previous operations and medications.

3- *Physical examination:* Including vital signs and cardiac, chest auscultation.

4- Laboratory Investigations:

- Complete Blood count, Liver function test, Renal function test, Coagulation profile, Serum electrolytes, Bl grouping, Fasting and post prandial Blood sugar.

5- Electrocardiogram (ECG): 12 leads ECG was done.

6- Radiological Investigations:

- Chest X-Ray: Postero-anterior and lateral plain chest radiographs
- Echocardiography with detailed assessment of the mitral valves and left ventricular function, and Coronary Angiography as a routine in patients above 40 years old to detect any associated coronary heart disease.

E- *Operative technique:* All patients received general anesthesia under full monitoring. Both median stemotomy and less invasive approaches were included.

Standard Cardiopulmonary bypass and Cardioplegia using bicaval cannulation and antegrade intermittent cold hyperkalemic blood cardioplegia under mild systemic hypothermia.

On arrested heart, the mitral valve was accessed through a left atrial or trans-septal incision.

The leaflets and subvalvular structures were explored carefully, and valvuloplasty was performed as a priority and excluded from this study, if suitable. If not, MVR was considered.

Both Leaflet Preservation Technique (Group A): Both the leaflets and subvalvular tissues were spared during MVR and surgery was completed as standard procedure. The sutures for mitral valve prosthesis fixation were taken circumferential to the annulus using interrupted pledgeted non absorbable suture material.

The mitral annulus was measured using dedicated annular sizers and a suitable mechanical valve was chosen in all patients.

Posterior Leaflet Preservation Technique (group B): The anterior leaflet and subvalvular tissues were removed. The posterior leaflet and subvalvular structures were preserved (calcified tissue was removed). The margin of the posterior leaflet was folded if too long. Following implantation in both groups, the prosthesis were tested for range of motion of the occluders, the left atrium was deaired using valsalva maneuver. The atriotomy was closed using continuous non absorbable suture material. Weaning off cardiopulmonary bypass was attempted. Removal of cannulae and hemostasis was done before closure with chest drains.

F- *Post-operative management:* Beside standard management, echocardiography and electrocardiogram was performed on all patients immediately postoperatively. Follow-up echocardiography was performed at 2nd week, and 6th month postoperatively. Routine follow-up was undertaken by the cardiologists.

G- *Outcome measures:* Assessment of outcomes was early postoperative including the possible out-

come benefits of both leaflet preservation in mitral valve replacement.

The primary outcome measure was change of the left ventricular ejection fraction upon follow-up.

The secondary outcome measures included: Hemodynamic stability in the postoperativeperiod, Other Post-operative echo parameters performed 2nd week and 6th months to determine parameters of left ventricular diastolic function, left ventricular end systolic and diastolic dimensions pre and post-operative, Fractional shortening pre and postoperative.

Other outcomes included Hospital morbidity and mortality at 30 days, Cross clamp and cardiopulmonary bypass time, Need for intropic support or Intra-aortic ballon support, Ventilation time in hours, postoperative drain volume in first day, Postoperative atrial fibrillation, ICU stay in days, Hospital stay in days and possible postoperative complications.

H- *Data collection and statistical analysis:*Sample size was calculated as previously mentioned. The findings were analyzed statistically according to the different factors affecting the results into appropriate tables and figures, Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) statistical software v. 23 (SPSS, Inc., Chicago, IL, USA). Qualitative data were described using number and percent. Quantitative data were designated using range, mean and standard deviation.

Comparison between different groups was conducted on categorical variables using Chi-square test. When more than 20% of the cells have expected count less than 5, correlation was conducted using Fisher's exact test or Monte Carlo correction. For normally distributed data, comparison was performed by using student t-test. For abnormally distributed data, the Mann-Whitney Z-test and Wilcoxon signed ranks were used.

Results

Table (1): Reveals significant reduction in LVEF was observed in Group **B** during the postoperative period, with a mean of 46.33±5.694, compared to Group A with a mean of 52.42±7.064 at a significance level of *p=0.030.*

LVEF	Group A (n=12)	Group B (n= 12)	95% CI	
Baseline (%)	52.83±7.247	49.58±6.127	—2.43, 8.93	0.248
Postoperative (%)	52.42±7.064	4633±5.694	0.65, 1152	0.030
Change (%)	—0.42±0.793	—3.25±1.138	2.00, 3.66	<0.001
Change percent (%)	—0.83±1.586	—658±2.275	4.09, 7.41	<0.001

- Data is expressed as mean and standard deviation. 95% CI: 95% confidence interval of the mean difference between both groups. *p* is significant when <0.05.

Table (2): Statistical analysis revealed a significant decrease in LVESD from Group A to Group **B,** with a p-value of 0.043.

LVESD (mm)	Group A (n=12)	Group B (n= 12)	95% CI	
Baseline (mm)	42.83±7.530	38.92±7.452	—2.43, 10.26	0.214
Postoperative (mm)	4233±7.620	35.67±7.620	0.22, 13.12	0.043
Change (mm)	—0.50±0.522	—3.25±0.866	2.14, 3.36	<0.001
Change percent (%)	—1.17±1.337	—8.75±2.800	5.73, 9.44	<0.001

- Data is expressed as mean and standard deviation. 95% CI: 95% confidence interval of the mean difference between both groups. *p* is significant when <0.05.

Table (3): Reveals significant decrease in LVEDD from a mean of 54.17±7.518mm in Group A (MVR-P) to a mean of 47.50±8.062mm in Group **B** (MVR-NP) at a significance level of p=0.048.

LVEDD (mm)	Group A (n=12)	Group B (n= 12)	95% CI	
Baseline (mm)	54.50±7.752	5258±7573	—457, 8.40	0546
Postoperative (mm)	54.17±7.518	4750±8.062	0.07, 13.27	0.048
Change (mm)	—033±0.492	—5.08±0.996	4.08, 5.42	<0.001
Change percent (%)	—0.67±0.985	—10.00±2.796	7.56, 11.11	<0.001

- Data is expressed as mean and standard deviation. 95% CI: 95% confidence interval of the mean difference between both groups. *p* is significant when <0.05.

Table (4): The change percent (%) of WS demonstrated a statistically significant difference between the two groups.

LVS (mm)	Group A (n=12)	Group B (n= 12)	95% CI	
Baseline (mm)	11.53±0.526	1132±0.764	-0.35, 0.76	0.445
Postoperative (mm)	10.52±0.467	10.99±0.687	-0.97, 0.02	0.060
Change (mm)	—1.01±0.257	—032±0.245	-0.90, -0.47	<0.001
Change percent (%)	—8.75±2.261	—2.83±1.992	-7.72, -4.11	<0.001

- Data is expressed as mean and standard deviation. 95% CI: 95% confidence interval of the mean difference between both groups. *p* is significant when <0.05.

Discussion

Preservation of the mitral valve leaflets during MVR has been an area of interest and debate among cardiac surgeons. While the preservation of both leaflets has been advocated by some surgeons, others argue that preservation of the posterior leaflet alone is sufficient to achieve favorable outcomes. Henceforth, extensive research has been conducted on the subject of valve preservation techniques. It has been demonstrated that although MVR, incorporating the complete preservation of leaflets, can yield improved outcomes, its advancement has been hindered by the patient-valve mismatch [1].

Our patients had been divided into two groups: Group A (MVR-P), comprising 12 patients who underwent or had MVR with preservation of both leaflets, and Group B (MVR-NP), comprising 12 patients who underwent or had MVR with preservation of the posterior leaflet only, serving as the control group. By comparing the short-term outcomes of both leaflet preservation techniques, surgeons and clinicians can make more informed decisions regarding the preservation strategy during MVR. Additionally, a thorough understanding of the potential benefits of both leaflet preservation can help optimize patient outcomes and improve the overall success rate of MVR procedures.

Therefore, we conducted a Comparative Prospective Study with the primary aim of this study sought to compare the short-term outcomes of preservation of both leaflets versus preservation of the posterior leaflet alone.The primary outcome measure, change in LVEF, will provide valuable insights into the benefits of both leaflet preservation techniques. The results of this study will contribute to the existing body of knowledge on optimal surgical techniques for mitral valve replacement and help guide clinical decision-making.

The current study showed a significant reduction in LVEF in Group B (MVR-NP) during the postoperative period, with a mean of compared to Group A (MVR-P) at a significance level of p=0.030. which indicates that preservation of both leaflets during mitral valve replacement (MVR-P) may result in a comparatively higher LVEF at the postoperative stage compared to preservation of the posterior leaflet only (MVR-NP).

In accordance with the current study, Ozdemir and his colleagues conducted research on a cohort of 70 patients who underwent mitral valve replacement, and found that preservation of the bileaflet prevented the usual decrease in left ventricular ejection fraction that results from preserving only the posterior leaflet. However, preservation of the posterior leaflet alone yielded favorable outcomes in terms of decreased left ventricular diameter. Consequently, it has been recommended that preservation of the bileaflet should be the preferred method to prevent further decreases in ejection fraction and to avoid mortality in patients who present with significantly impaired left ventricular function **[2].**

Similar to our findings, the study conducted by Kisho in Egypt found that preserving both the bileaflet and posterior leaflet can prevent a decrease in left ventricular ejection fraction (LVEF). However, preserving only the posterior leaflet can effectively reduce the left ventricular diameter. Bileaflet preservation is the preferred method to prevent a decrease in EF and reduce the risk of mortality in patients with impaired left ventricular function [3].

Our study found that, the LVESD (left ventricular end-systolic diameter) and the left ventricular end-diastolic diameter (LVEDD) exhibited a significant change between the studied groups. It is indicated that, preservation of both leaflets during mitral valve replacement (MVR-P) showed better results in LVESD and LVEDD at the postoperative stage compared to preservation of the posterior leaflet only (MVR-NP). The observed significant decrease in LVESD, LVEDD and the larger change in LVESD and LVEDD as an absolute value in Group (MVR-NP) suggest a potential difference in the short-term outcomes between the two surgical approaches.

Our findings also suggest that preserving both leaflets during mitral valve replacement (MVR-P) resulted in a smaller change in LVESD and LVEDD compared to preserving only the posterior leaflet (MVR-NP). The LVESD and LVEDD exhibited a more pronounced reduction in Group B, as evidenced by the larger negative mean value. The statistical analysis confirmed a significant difference in the change percent of LVESD and LVEDD between the two groups, demonstrating the potential advantages of preserving both leaflets for achieving favorable short-term outcomes in terms of LVEDD and LVESD. However, no significant variations in LVEDD and LVESD were observed at the baseline between the groups.

Our findings have been also confirmed and supported by a retrospective study performed by Yilong Guo and his colleagues who found that, The postoperative LVEDD, LVESD, and LVEF of group A who treated with modified total leaflet preservation were significantly better than those of groups B who treated with the posterior leaflet preservation and group C who treated with the no leaflet preservation technique. Also the incidence of low cardiac output syndrome in group A was lower than that in group C. therefore, the short-term effects of the modified total leaflet preservation technique were superior to those of the other techniques **[2].**

Furthermore, a study by Chandra Prakash and colleagues introduced a new technique involving anterior mitral valve leaflet (AML) preservation, aiming to reduce the risk of systolic anterior motion of the anterior leaflet and left ventricular outflow tract obstruction. Their findings align with ours, as they also reported successful outcomes with total chordal preservation during the implantation of various mechanical prostheses. This supports the notion that preserving the integrity of the mitral valve apparatus, including both leaflets, can lead to improved outcomes **[5].**

In our study, we have proved that bileaflet preservation (MVR-P) is a more effective preservation technique compared with posterior preservation (MVR-NP). Also we found that, there were significant differences in the absolute change and change

percent of the interventricular septum (IVS) thickness between the two groups. Preserving both leaflets during mitral valve replacement (MVR-P) resulted in a greater reduction in IVS thickness compared to preserving the posterior leaflet alone (MVR-NP). Nevertheless, there was almost no significant change in IVS thickness at the postoperative stage between preserving both leaflets and preserving the posterior leaflet alone.

The present study provides compelling evidence to support the superiority of bileaflet preservation (MVR-P) over posterior leaflet preservation (MVR-NP) in the context of mitral valve replacement (MVR). This finding is consistent with the results obtained in Erkan Kuralay's study, which also highlighted the beneficial effect of preserving both anterior and posterior leaflets on left ventricular (LV) performance when compared to isolated preservation of the posterior leaflet. Our study, as well as Kuralay's, suggest that preserving both leaflets has a dual benefit; not only does it maintain the integrity of the mitral valve, but it also preserves the papillary muscle-to-anterior mitral annulus continuity, thus contributing to improved LV function [6).

Moreover, our investigation revealed significant differences in the absolute change and change percentage of the interventricular septum (IVS) thickness between the groups. Preservation of both leaflets during MVR (MVR-P) led to a greater reduction in IVS thickness in comparison to preserving the posterior leaflet alone (MVR-NP). Although there was almost no significant change in IVS thickness at the postoperative stage between preserving both leaflets and preserving the posterior leaflet alone, the observed differences suggest a potential advantage of MVR-P in terms of IVS remodeling.

Our findings provide further support and strengthen the evidence regarding the advantages of preserving both leaflets in MVR to maintain mitral valve integrity, papillary muscle-to-anterior mitral annulus continuity, and optimal left ventricular function. The comparison with the aforementioned studies confirms the potential benefits of preserving both leaflets, not only for maintaining mitral valve integrity but also for optimizing LV performance and remodeling. Our collective findings contribute to the growing body of knowledge in the field of mitral valve surgery.

Conclusion:

In conclusion, preservation of both leaflets (MVR-P) during mitral valve replacement results in significantly higher left ventricular ejection fraction (LVEF) and better left ventricular end-systolic diameter (LVESD) and left ventricular end-diastolic diameter (LVEDD) compared to preserving the posterior leaflet only (MVR-NP). Bileaflet preservation demonstrates superiority in maintaining interventricular septum integrity. Surgeons should prioritize bileaflet preservation (MVR-P) to optimize cardiac function and enhance patient outcomes during mitral valve replacement surgeries, based on the study's compelling evidence to support the superiority of bileaflet preservation over posterior leaflet preservation in the context of mitral valve replacement.

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الحفاظ على وريقتى الصمام الميترالى مقابل الحفاظ على الوريقة الخلفية فقط فى جراحات استبدال الصمام الميترالى

استبدال الصمام الميترالى هو إجراء جراحى للقلب يتم إجراؤه بشكل شائع عندما لا يكون الإصلاح ممكنًا. أثناء استبدال الصمام الميترالى غالباً ما لا يتم الحفاظ على الجهاز تحت الصمامى، الذي يلعب دورًا مهماً فى وظيفة البطين الأيسر، مما يؤدى إلى انخفاض كفاءة عضلة القلب ومضاعفاته. تم تطوير تقنيات مختلفة لتقليل هذه المشكلات، بما فى ذلك الحفاظ على الجهاز تحت الصمامى حيث أظهرت الدراسات أن الحفاظ على الجهاز تحت الصمامى أثناء استبدال الصمام الميترالى يمكن أن يقلل من خطر انخفاض كفاءة عضلة القلب، ويقلل من الوفيات، ويحسن وظيفة البطين الأيسر بعد الجراحة. ومع ذلك، فإن الاحتفاظ بوجود شرفتى الصمام الأمامية والخلفية، لم يحظ باهتمام كافٍ بين جراحى القلب بسبب التحديات التقنية والمضاعفات المحتملة.

الهدف من البحث: تهدف هذه الدراسة لتقييم النتائج قريبة المدى للمرضى الذين سيقومون بجراحة استبدال الصمام الميترالى مع الاحتفاظ بشرفتى الصمام الأمامية والخلفية.

تصميم الدراسة: تجري هذه الدراسة الرجعية – المستقبلية على ٢٤ مريضاً ممن سيخضعون او خضعوا بالفعل لجراحة استبدال الصمام الميترالى بقسم جراحة القلب والصدر، بكلية الطب، جامعة المنصورة، خلال الفترة من مارس ٢٠١٩ وحتى مارس ٢٠٢١.

كشفت الدراسة الحالية عن النتائج التالية: يؤدى الاحتفاظ بشرفتى الصمام الأمامية والخلفية أثناء جراحات استبدال الصمام الميترالى إلى ارتفاع ملحوظ فى كفاءة البطين الايسر لعضلة القلب مقارنة بالحفاظ على شرفة الصمام الخلفية فقط ويجب على الجراحين إعطاء الأولوية للحفاظ على شرفتى الصمام الأمامية والخلفية للحفاظ على كفاءة عضلة القلب وتعزيز تحسن المرضى بعد اجراء جراحات استبدال الصمام الميترالى وذلك بناء على الأدلة المقنعة للدراسة.