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Early Clinical Outcomes After Mitral Valve Repair Versus Replacement Combined With Coronary Artery Bypass Grafting in Patients With Ischemic Mitral Regurgitation

Mohammad Saeed Gassar[1], Ahmed Hassan Zaid[1], Ramadan Ibrahim Mohamed Ibrahim Auf [2], Eslam Elshafey [3], Ahmed Mohamed Elsonbaty[4], Mohamed Moaz Hasanain[1]

[1]Cardiology Department, National Heart Institute, General Organization for Teaching Hospitals and Institutes (GOTHI), Egypt
[2]Cardiothoracic Surgery Department, Al-Ahrar Teaching Hospital, General Organization for Teaching Hospitals and Institutes (GOTHI), Egypt
[3]Clinical Pathology Department, Al-Ahrar Teaching Hospital, General Organization for Teaching Hospitals and Institutes (GOTHI), Egypt
[4]Anesthesia, ICU and pain management Department, Assiut University Hospital, Egypt
*Corresponding author: Eslam Elshafey
Email: eslamelshafeyelsaid245@gmail.com

ABSTRACT

Background: Ischemic mitral regurgitation (IMR) is linked to poor left ventricular remodeling and worse long-term outcomes, and it commonly exacerbates coronary artery disease.

Aim: To compare the early postoperative outcomes of mitral valve repair versus replacement combined with coronary artery bypass grafting (CABG) in patients with ischemic mitral regurgitation.

Patients and Methods: This prospective comparative study included 80 patients with ischemic mitral regurgitation undergoing CABG at Al-Ahrar Teaching Hospital and National Heart Institute. Patients were equally assigned to mitral valve repair with ring annuloplasty (Group I, n = 40) or mitral valve replacement with a mechanical or bioprosthetic valve (Group II, n = 40), both combined with CABG. Baseline characteristics, preoperative findings, intraoperative variables, postoperative course and complications, and discharge echocardiographic outcomes were compared between groups.

Results: The replacement group had significantly longer aortic cross-clamp time (86.1 ± 18.7 vs. 69.2 ± 15.4 min, P = 0.001) and a longer ICU stay [median 3 days (range 2–7) vs. 3 days (range 1–5), P = 0.046], with a trend toward longer cardiopulmonary bypass time (P = 0.06). Other postoperative outcomes, including ventilation time, hospital stay, inotrope or IABP use, complications, and 30-day mortality (2.5% in each group), were comparable. Discharge LVEF was also similar (P = 0.744), whereas the median residual MR grade was significantly lower after replacement.

Conclusion: Mitral valve repair and replacement showed similar 30-day mortality and surgical morbidity in patients with ischemic mitral regurgitation undergoing concomitant CABG. Replacement was associated with longer ICU and cross-clamp times but provided more reliable early correction of MR, whereas repair had shorter operative courses but a higher rate of residual moderate-to-severe MR. The choice should therefore be individualized based on valve morphology, subvalvular pathology, and operative risk.

KEYWORDS: Ischemic Mitral Regurgitation; Mitral Valve Repair; Mitral Valve Replacement; Coronary Artery Bypass Grafting; Cardiopulmonary Bypass..

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INTRODUCTION

Ischemic mitral regurgitation (IMR) is a common consequence of global or regional left ventricular (LV) remodeling associated with chronic coronary artery disease. It results from ischemia-induced structural and functional changes in the LV that increase mitral leaflet tethering and reduce coaptation forces, rather than from primary valvular disease. IMR occurs in approximately 50% of patients with congestive heart failure and 20% of those with acute myocardial infarction (MI), and is associated with adverse clinical outcomes and poorer prognosis in patients with coronary artery disease **[1].**

It is crucial to differentiate primary MR caused by organic factors from secondary MR, which is indicative of LV illness rather than valve disease. Functional MR brought on by coronary artery disease or cardiomyopathy remodeling of the left ventricle is known as secondary MR; in this context, secondary functional MR is referred to as IMR. Its pathophysiologic principles explain the remodeling of the segmental/global left ventricle, which causes papillary muscle displacement and leaflet tethering. These mechanisms result in leaflet malcoaptation and MR of varying degrees. The illness affects the myocardium rather than the valve itself, and the leaflets themselves are normal **[2]**.

Mortality and morbidity following myocardial infarction are independently correlated with the occurrence of IMR. It is a dynamic condition whose severity is influenced by residual ischemia, cardiac rhythm, and loading conditions. IMR is associated with a higher incidence of acute pulmonary edema in patients with left ventricular systolic failure and is more prevalent following myocardial infarction, particularly inferior wall MI **[3].**

Despite advancements in surgical techniques for ischemic heart disease (IHD), optimal treatment strategies for the resulting mitral disease remain controversial **[4].**

Untreated severe ischemic mitral regurgitation is associated with poor long-term survival. Persistent mitral regurgitation imposes chronic volume overload on the left ventricle, leading to ventricular dilatation, increased wall stress, and adverse remodeling. Mitral valve repair or replacement can reduce this volume overload and limit further ventricular remodeling **[5].**

Mitral valve replacement (MVR) has been associated with survival outcomes comparable to those of mitral valve repair, while providing greater freedom from recurrent mild-to-moderate mitral regurgitation (MR). These findings support MVR as a viable surgical option for patients with ischemic mitral regurgitation (IMR) **[6].**

A randomized trial demonstrated that mitral valve repair for severe ischemic mitral regurgitation was associated with a significantly higher rate of recurrent moderate or severe MR than mitral valve replacement, with recurrence evident during follow-up and substantially greater at 2 years **[7].**

This study aimed to compare the early postoperative outcomes of mitral valve replacement versus repair in patients with ischemic mitral regurgitation undergoing concurrent coronary artery bypass grafting.

METHODS

This prospective comparative study was conducted at Department of Cardiothoracic Surgery, Al-Ahrar Teaching Hospital and Department of Cardiology, National Heart Institute, Egypt on eighty patients receiving coronary artery bypass grafting (CABG) for ischemic mitral regurgitation (IMR). Based on the mitral valve surgery strategy, patients were divided into two groups: Group I (Repair + CABG): Mitral valve repair with ring annuloplasty plus CABG and Group II (Replacement + CABG): Mitral valve replacement with a mechanical or bioprosthetic prosthesis plus CABG. The choice of repair or replacement was based on preoperative echocardiographic assessment and intraoperative evaluation of leaflet mobility, annular dimensions, and degree of tethering. Every participant provided written informed permission.

The inclusion criteria included ischemic patients of both sexes, aged between 30 and 70 years, diagnosed through CT or coronary angiogram, with moderate or severe chronic IMR, and an ejection fraction ≥30%.

The exclusion criteria included patients who declined participation in the study, those with alternative causes of MR, individuals requiring urgent coronary artery bypass graft, patients undergoing redo cardiac surgeries, those with co-morbidities like chronic renal or liver disease, and patients with other valve diseases.

Preoperative Assessment

Every patient had clinical evaluation, laboratory investigations and a 12-lead ECG. The degree of mitral regurgitation (graded 1–4), left ventricular ejection fraction (LVEF), left ventricular end-diastolic and end-systolic diameters (LVEDD, LVESD), and pulmonary artery systolic pressure were all measured using transthoracic echocardiography. Coronary angiography was carried out on each patient to assess the degree of coronary disease and identify potential transplant targets.

Intraoperative data included the type of cardioplegia, comparison of pre and intraoperative echocardiograms regarding the degree of MR, cross-clamp and bypass times, number of bypass grafts, type of mitral surgery, type of MV in case of replacement, weaning from bypass, inotropic support, IABP usage, and arrhythmias.

Operative Technique

Every procedure was carried out using a median sternotomy while undergoing mild to moderate hypothermia and cardiopulmonary bypass. Cold blood cardioplegia was used to protect the heart.

Coronary Artery Bypass Grafting: The left internal mammary artery and/or saphenous vein grafts were used in an attempt to achieve complete revascularization.

Mitral Valve Repair (Group I): An undersized rigid or semi-rigid annuloplasty ring was placed as part of the repair. When necessary, subvalvular methods (such as papillary muscle relocation and chordal shortening) were employed to enhance leaflet coaptation.

Mitral Valve Replacement (Group II): Whenever possible, one or both leaflets were preserved during valve replacement in order to preserve left ventricular geometry. The patient's age and anticipated anticoagulant compliance were taken into consideration while selecting the type of prosthesis (mechanical vs. bioprosthetic).

The anesthesiologist plays a crucial role in the perioperative management of patients with ischemic mitral regurgitation undergoing combined mitral valve surgery and coronary artery bypass grafting (CABG). Preoperative assessment includes evaluating ventricular function, pulmonary hypertension, comorbidities, and overall surgical risk. Intraoperatively, anesthetic management focuses on maintaining hemodynamic stability, optimizing myocardial oxygen supply and demand, and coordinating with the surgical team during cardiopulmonary bypass and separation from bypass. Postoperative management focuses on adequate analgesia, respiratory support, hemodynamic optimization, and early recognition of complications.

Postoperative Care and Follow-Up

In the cardiac intensive care unit, every patient got routine postoperative monitoring. Anticoagulation therapy was instituted in accordance with valve type and institutional guidelines. Clinical evaluation and transthoracic echocardiography were performed before hospital discharge.

The main outcome of the study was early postoperative mortality, which was defined as any death that happened within 30 days of surgery. The incidence of postoperative complications, including stroke, atrial arrhythmias, renal impairment, and low cardiac output syndrome, as well as changes in mitral regurgitation severity, improvement in left ventricular function, duration of mechanical ventilation, length of stay in the intensive care unit and total hospital stay were secondary endpoints.

Statistical Analysis

The collected data was computerized and statistically analyzed using SPSS software (Statistical Package for Social Science) version 27.0. Normality of quantitative data was assessed using the Shapiro–Wilk test. Qualitative data was presented using frequencies and percentages. The Chi-square test was used to compare qualitative variables, and Fisher's exact test was used when expected cell counts were small. Normally distributed quantitative data was expressed as mean ± SD (standard deviation), while ordinal or non-normally distributed data was summarized as median (minimum–maximum). The independent t test was used to compare normally distributed quantitative variables between two groups. The Mann–Whitney U test was used for ordinal or non-normally distributed variables, including preoperative and discharge MR grades. A two-sided P value <0.05 was considered statistically significant.

RESULTS

Table (1): Comparison of Demographics & Risk Factors data between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
Age (years)	Mean ± SD	51.3 ± 11.4	50.4 ± 11.2	0.714
BMI (kg/m²)	Mean ± SD	29.5 ± 4.1	29.7 ± 3.7	0.856
EuroSCORE II (%)	Median (range)	3.58 (1–7.67)	3.69 (1–7.06)	0.837
Sex	Male, Number (%)	23 (57.5%)	26 (65.0%)	0.647
Hypertension	Number (%)	25 (62.5%)	21 (52.5%)	0.498
Diabetes Mellitus	Number (%)	21 (52.5%)	29 (72.5%)	0.105
Smoking	Number (%)	19 (47.5%)	22 (55.0%)	0.655
Dyslipidemia	Number (%)	27 (67.5%)	25 (62.5%)	0.815

CABG: Coronary Artery Bypass Grafting, BMI: Body Mass Index, EuroSCORE II: European System for Cardiac Operative Risk Evaluation II, SD: Standard Deviation, n: Number of patients, P: Probability value.

In this study, In terms of baseline clinical and demographic traits, both groups were similar. Demographic and risk variables did not significantly differ between the two groups (all P > 0.05) (Table 1).

Table (2): Comparison of Preoperative Echocardiography between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
LVEF (%)	Mean ± SD	39.2 ± 6.1	40.1 ± 6.4	0.516
LVEDD (mm)	Mean ± SD	57.0 ± 6.2	56.7 ± 5.7	0.863
LVESD (mm)	Mean ± SD	47.5 ± 6.2	45.8 ± 4.7	0.173
PASP (mmHg)	Mean ± SD	46.1 ± 11.6	42.0 ± 8.5	0.076
MR Grade (Preoperative)	2	16 (40.0%)	9 (22.5%)	0.1
	3	12 (30.0%)	21 (52.5%)	

	4	12 (30.0%)	10 (25.0%)	

LVEF: Left Ventricular Ejection Fraction, LVEDD: Left Ventricular End-Diastolic Diameter, LVESD: Left Ventricular End-Systolic Diameter, PASP: Pulmonary Artery Systolic Pressure, MR: Mitral Regurgitation, MW: Mann–Whitney U test, SD: Standard Deviation, P: Probability value.

The preoperative echocardiographic parameters and preoperative MR grade were comparable between the two groups (Table 2).

Table (3): Comparison of baseline laboratory findings between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
Hemoglobin (g/dL)	Mean ± SD	12.7 ± 1.3	12.6 ± 1.5	0.818
Creatinine (mg/dL)	Mean ± SD	1.0 ± 0.2	1.0 ± 0.2	0.628
HbA1c (%)	Mean ± SD	6.3 ± 1.2	6.4 ± 1.3	0.917

CABG: Coronary Artery Bypass Grafting, HbA1c: Glycated Hemoglobin, g/dL: Grams per deciliter, mg/dL: Milligrams per deciliter, SD: Standard Deviation, P: Probability value.

Regarding baseline laboratory results, there were no significant differences between the two groups (all P > 0.05) (Table 3).

Table (4): Repair-Only Details

Variable		Repair + CABG (n=40)
Ring Size (mm)	Mean ± SD	29.4 ± 2.4
Subvalvular Technique	Number (%)	17 (42.5%)

CABG: Coronary Artery Bypass Grafting, SD: Standard Deviation.

The mean annuloplasty ring size was 29.4 ± 2.4 mm, and subvalvular techniques were used in 42.5% of repair cases (Table 4).

Table (5): Replacement-Only Details

Variable		Replacement + CABG (n=40)
Valve Type	Mechanical	23 (57.5%)
	Bioprosthetic	17 (42.5%)
Leaflet Preservation	Anterior	7 (17.5%)
	Posterior	16 (40.0%)
	Bileaflet	8 (20.0%)
	None	9 (22.5%)

CABG: Coronary Artery Bypass Grafting, SD: Standard Deviation.

Mechanical valves were used in 57.5% of replacement cases, and posterior leaflet preservation was the most frequently used technique (40.0%) (Table 5).

Table (6): Comparison of Angiography & CABG Plan between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
Number of Diseased Vessels	Number (%) 1 vessel 2 vessels 3 vessels	 1 (2.5%) 17 (42.5%) 22 (55.0%)	 6 (15.0%) 9 (22.5%) 25 (62.5%)	0.051
Number of Grafts	Number (%) 1graft 2 grafts 3 or more grafts	 6 (15.0%) 11 (27.5%) 23 (57.5%)	 3 (7.5%) 9 (22.5%) 28 (70.0%)	0.430
Left Main Disease	Number (%)	8 (20.0%)	15 (37.5%)	0.137

CABG: Coronary Artery Bypass Grafting, n: Number of patients, P: Probability value. The Number of Diseased Vessels comparison used the Fisher–Freeman–Halton exact test.

Angiographic characteristics and the revascularization strategy were comparable between the two groups.
The distributions of diseased vessels and bypass grafts were similar between groups (Fisher–Freeman–Halton exact P = 0.051 and Chi-square P = 0.430, respectively); left main disease was also comparable (P = 0.137) (Table 6).

Table (7): Comparison of Intraoperative Data between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
CPB Time (min)	Mean ± SD	103.9 ± 23.3	114.5 ± 26.6	0.06
Cross-Clamp Time (min)	Mean ± SD	69.2 ± 15.4	86.1 ± 18.7	**0.001**
Cardioplegia Type	Blood	23 (57.5%)	22 (55.0%)	0.99
	Crystalloid	17 (42.5%)	18 (45.0%)	

CABG: Coronary Artery Bypass Grafting, CPB: Cardiopulmonary Bypass, SD: Standard Deviation, P: Probability value.
While CPB time and cardioplegia type did not differ substantially, cross-clamp time was significantly longer in the replacement group (P = 0.001). (Table 7).

Table (8): Comparison of ICU & Hospital stay between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
Ventilation Time (hours)	Median (range)	12.9 (4–25.3)	12.7 (4–29.1)	0.923
ICU Stay (days)	Median (range)	3 (1–5)	3 (2–7)	**0.046**
Hospital Stay (days)	Median (range)	9 (4–17)	9 (4–16)	0.905

CABG: Coronary Artery Bypass Grafting, ICU: Intensive Care Unit, P: Probability value.
ICU stay was significantly longer in the Replacement group (P = 0.046), while ventilation time and hospital stay were comparable (Table 8).

Table (9): Comparison of Postoperative Complications (≤30 days) between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
Inotropes Used	Number (%)	16 (40.0%)	24 (60.0%)	0.117
IABP Used	Number (%)	4 (10.0%)	1 (2.5%)	0.359
Atrial Arrhythmia	Number (%)	13 (32.5%)	11 (27.5%)	0.808
Stroke	Number (%)	2 (5.0%)	2 (5.0%)	1.000
Renal Impairment	Number (%)	1 (2.5%)	6 (15.0%)	0.108
Low Cardiac Output Syndrome	Number (%)	6 (15.0%)	7 (17.5%)	1.000
Mortality (30 days)	Number (%)	1 (2.5%)	1 (2.5%)	1.000

CABG: Coronary Artery Bypass Grafting, IABP: Intra-Aortic Balloon Pump, n: Number of patients, P: Probability value.
Postoperative complications and 30-day mortality did not differ significantly between the two groups (all P > 0.05) (Table 9).

Table (10): Comparison of Discharge Echocardiography between the studied groups.

Variable		Repair + CABG (n=40)	Replacement + CABG (n=40)	P value
LVEF (%) at Discharge	Mean ± SD	41.3 ± 6.3	41.8 ± 6.9	0.744
MR Grade at Discharge	0	0 (0.0%)	7 (17.5%)	**< 0.001**
	1	7 (17.5%)	13 (32.5%)	
	2	16 (40.0%)	17 (42.5%)	
	3	9 (22.5%)	3 (7.5%)	
	4	8 (20.0%)	0 (0.0%)	

CABG: Coronary Artery Bypass Grafting, LVEF: Left Ventricular Ejection Fraction, MR: Mitral Regurgitation, MW: Mann–Whitney U test, SD: Standard Deviation, P: Probability value.
LVEF at discharge was comparable between groups, whereas the replacement group had a significantly lower residual MR

grade [Mann–Whitney U test, P < 0.001] (Table 10).

DISCUSSION

This prospective comparative study was conducted on patients with ischemic mitral regurgitation (IMR) undergoing surgical revascularization to assess and compare the early postoperative outcomes of mitral valve repair (ring annuloplasty) versus mitral valve replacement (mechanical or bioprosthetic), both carried out concurrently with coronary artery bypass grafting (CABG). 80 patients with IMR who needed CABG were divided into two groups: Group I (n = 40) had mitral valve repair plus CABG, while Group II (n = 40) received mitral valve replacement plus CABG. and the two surgical strategies were compared with respect to baseline demographic and clinical characteristics, preoperative echocardiographic and laboratory findings, intraoperative parameters, and early postoperative clinical and echocardiographic outcomes.

In the present study, at baseline, the two groups were well matched, with comparable age, body mass index, EuroSCORE II, male proportion, and frequencies of dyslipidemia, smoking, diabetes, and hypertension (all P > 0.05). Left ventricular end-diastolic diameter (LVEDD), left ventricular end-systolic diameter (LVESD), and preoperative left ventricular ejection fraction (LVEF) were statistically comparable. Baseline MR grade was also comparable, with a median of 3 (range 2–4) in both groups (Mann–Whitney U test, P = 0.451), indicating similar preoperative ventricular and valvular severity profiles. After propensity score matching, the mitral valve repair and replacement groups showed comparable baseline characteristics, supporting a more balanced comparison of perioperative and long-term outcomes **[8]**.

Aortic cross-clamp time was significantly longer in the replacement group (86.1 ± 18.7 minutes) than in the repair group (69.2 ± 15.4 minutes; P = 0.001) and CPB time was longer in the replacement group, although the difference did not reach statistical significance (P = 0.060).

According to **Michler et al. [9],** in patients with moderate ischemic mitral regurgitation, adding mitral-valve repair to CABG produced a more long-lasting correction of mitral regurgitation, but it had no effect on survival, left ventricular reverse remodeling, or overall negative outcomes at two years. In addition to increasing cardiopulmonary bypass and aortic cross-clamp periods, mitral-valve repair was linked to an early rise in neurologic episodes and supraventricular arrhythmias. Previous studies have reported shorter aortic cross-clamp and cardiopulmonary bypass times when off-pump coronary revascularization is combined with mitral valve surgery, compared with conventional on-pump revascularization **[10].**

In the present study, postoperative ventilation time was comparable between the repair and replacement groups [median 12.9 hours (range 4–25.3) vs. 12.7 hours (range 4–29.1), P = 0.923], indicating similar early respiratory recovery regardless of surgical strategy. ICU stay, however, was significantly longer in the replacement group [median 3 days (range 2–7)] than in the repair group [median 3 days (range 1–5); P = 0.046], while the total hospital stay was comparable between the repair and replacement groups [median 9 days (range 4–17) vs. 9 days (range 4–16), P = 0.905].

Andrási et al. [11], reported that despite variations in early recovery characteristics, there was no significant difference in the total duration of hospital stay between the two surgical approaches.

In the present study, there was no significant difference between the two group regarding rates of inotropic support, intra-aortic balloon pump (IABP) use, atrial arrhythmia, stroke, renal impairment, and low cardiac output syndrome. 30-day mortality was low and identical in both groups (2.5% each, P = 1.000).

This result is in line with that of **Acker et al. [12],** who discovered no significant difference in 30-day or 12-month mortality between mitral valve replacement and repair for severe IMR (30-day mortality was 4.0% in the replacement group and 1.6% in the repair group), despite replacement being a technically more extensive procedure.

In the present study, discharge LVEF was comparable between groups (41.3 ± 6.3% vs. 41.8 ± 6.9%, P = 0.744). In contrast, residual mitral regurgitation grade at discharge was significantly lower after replacement: the median was 1.5 (range 0–3) in the replacement group versus 2 (range 1–4) in the repair group (Mann–Whitney U test, P < 0.001).

This result is highly consistent with **Goldstein et al. [7],** who discovered that, despite similar survival and left ventricular reverse remodeling between the two groups, the recurrence of moderate or severe MR over a two-year period was significantly higher after repair than after replacement (58.8% vs. 3.8%, P < 0.001).

Mitral valve repair has been associated with a higher incidence of recurrent moderate or severe mitral regurgitation compared with mitral valve replacement during follow-up **[7].**

CONCLUSION

Mitral valve repair and replacement with concomitant CABG were associated with comparable 30-day mortality and early postoperative morbidity. Replacement was associated with longer aortic cross-clamp and ICU durations but a lower residual MR grade at discharge, whereas repair was associated with shorter cross-clamp and ICU durations but a higher

prevalence of residual moderate-to-severe MR. These findings support individualized surgical decision-making according to valve morphology, subvalvular pathology, and patient risk.

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