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Repair versus Replacement by Prosthetic Valve in Ischemic Mitral Patients

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ABSTRACT

Background/Aims: Ischemic mitral regurgitation (IMR) is a complex disorder that arises from left ventricular remodeling due to coronary artery disease. The optimal surgical approach—mitral valve repair (MVRp) versus mitral valve replacement (MVR)—remains a subject of debate, with outcomes influenced by durability, recurrence risk, and left ventricular function. This work aims to compare the short- and long-term outcomes of MVRp versus MVR in patients undergoing concomitant coronary artery bypass grafting (CABG) for moderate-to-severe IMR.

Materials and methods: This retrospective, non-randomized study analyzed 254 patients who underwent concomitant CABG and MV surgery for moderate-to-severe IMR between January 2013 and December 2018. Patients were divided into two groups: MVRp (n=128) and MVR (n=126). Perioperative characteristics, postoperative outcomes, and long-term survival were assessed.

Results: Baseline characteristics were comparable between groups, except for a higher incidence of preoperative atrial fibrillation in the replacement group (11.9% vs. 4.7%, P=0.037). ICU stay was shorter in the replacement group (73.48±63.8 vs. 84.6±59.59 hours, P=0.048), but mechanical ventilation duration was longer (20.5±45.46 vs. 18.55±20.1 hours, P=0.016). In-hospital mortality was similar (MVRp: 11.7% vs. MVR: 12.7%, P=0.812). Long-term mortality was 21.1% in the MVRp group and 17.5% in the MVR group. Both groups showed significant improvements in ejection fraction (MVRp: 47.67±13.00% to 57.28±13.34%, P=0.001; MVR: 47.28±12.01% to 56.50±12.27%, P=0.001) and NYHA class postoperatively.

Conclusion: Both MVRp and MVR significantly improved functional status and ejection fraction, with no significant difference in long-term survival. MVRp remains susceptible to recurrent regurgitation, while MVR eliminates MR but prolongs ventilation time. Surgical choice should be tailored to patient-specific factors.

Keywords: ischemic mitral regurgitation, mitral valve replacement, mitral valve repair, CABG, cardiac surgery.

Abbreviations:
IMR: Ischemic Mitral Regurgitation;
MVRp: Mitral Valve Repair;
MVR: Mitral Valve Replacement;
CABG: Coronary Artery Bypass Grafting;
MV: Mitral Valve;
ICU: Intensive Care Unit;
EF: Ejection Fraction;
NYHA: New York Heart Association;
CPB: Cardiopulmonary Bypass;
IABP: Intra-Aortic Balloon Pump;
TEE: Transesophageal Echocardiography;
MR: Mitral Regurgitation;
PVE: Prosthetic Valve Endocarditis;
PAP: Pulmonary Artery Pressure;
SR: Sinus Rhythm; XC: Cross-Clamp;
HB: Heart Block; UF: Ultrafiltration;
AF: Atrial Fibrillation;
TIA: Transient Ischemic Attack;
VD: Vascular Disease;
DVT: Deep Vein Thrombosis;
COPD: Chronic Obstructive Pulmonary Disease;
DM: Diabetes Mellitus;
HTN: Hypertension; GI: Gastrointestinal;
RF: Renal Failure; Cr: Creatinine;
CBC: Complete Blood Count;
ECG: Electrocardiogram;
ELISA: Enzyme-Linked Immunosorbent Assay;
ECLIA: Electro-Chemiluminescence Immunoassay;
PCR: Polymerase Chain Reaction;

INTRODUCTION

Although treating options and surgical modalities for treating ischemic heart disease are present nowadays with more clear techniques, the resultant mitral disease shows controversial options for treatment. Uncorrected ischemic mitral regurge (IMR) mortality is high, with 35% of patients alive at 5y with severe MR, 44% alive with moderate MR, and 61% alive without MR (1,2).

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Abbreviations - Cont'd:
KDIGO: Kidney Disease: Improving Global Outcomes;
SPSS: Statistical Package for the Social Sciences;
AUC: Area Under the Curve;
OR: Odds Ratio; CI: Confidence Interval;
TB: Total Bilirubin; DB: Direct Bilirubin;
WBC: White Blood Cell.

In chronic secondary MR, the MV leaflets and chordae tendineae typically remain structurally intact or exhibit only mild thickening. However, the condition is primarily linked to significant LV dysfunction secondary to coronary artery disease, leading to ischemic chronic secondary MR. LV dilation and remodeling result in papillary muscle displacement, which in turn causes leaflet tethering and annular dilation, ultimately impairing proper leaflet coaptation (3). Furthermore, secondary MR may also arise due to left atrial enlargement and mitral annular dilation, frequently observed in patients with atrial fibrillation and various cardiomyopathies. It is important to note that both primary and secondary MR can coexist within the same individual. Given that MR is merely one facet of the broader pathophysiological process, its correction alone does not resolve the underlying ventricular pathology. Despite ongoing discussions regarding the precise criteria for defining severe secondary MR, its complex nature and multifactorial origins remain evident (4,5).

When replacing or repairing the MV, continuous ventricular overload is stopped and thus pathological remodeling, which ultimately results in better elliptical geometry (6).

The aim of this work is to compare the short- and long-term outcomes of MVRp versus MVR in patients undergoing concomitant CABG for moderate-to-severe IMR.

MATERIALS AND METHODS

This retrospective, non-randomized study analyzed data from 254 patients who underwent CABG and MV surgery for IMR between January 2013 and December 2018. This study was conducted after being approved by the research ethics committee, Faculty of Medicine, Cairo University.

Inclusion Criteria

Patients with moderate to severe ischemic MR, confirmed by preoperative transthoracic echocardiography and coronary angiography, were included.

Exclusion Criteria

This encompassed patients with papillary muscle rupture, cardiogenic shock, ischemic ventricular septal defect, associated left ventricular aneurysm, prior CABG or valvular surgery, and non-ischemic MR disease.

Patients Groups

Patients were divided into two groups: Group A (n=128) underwent MVRp, while Group B (n=126) underwent MVR.

Methods

Preoperative Assessment

All patients underwent comprehensive history-taking, physical examination, laboratory investigations (CBC, liver and kidney function tests, serum electrolytes, and coagulation profile), and imaging studies, including chest X-ray, 12-lead ECG, echocardiography, and coronary angiography. Carotid duplex ultrasound was performed in selected patients at risk of cerebrovascular disease.

SURGICAL TECHNIQUE

All patients underwent standard median sternotomy and cardiopulmonary bypass with bicaval cannulation. Cardioplegia was administered antegrade with systemic hypothermia. CABG was performed before MV intervention. Repair involved annular ring annuloplasty, edge-to-edge repair, or chordal transfer, while valve replacement was performed when repair was deemed unfeasible. Prosthetic valves were implanted using pledgetted sutures, preserving as much of the sub-valvular apparatus as possible.

Intraoperative and Postoperative Monitoring

Intraoperative parameters recorded included ischemic time, total bypass time, inotropic support requirements, and MV competence via trans-esophageal echocardiography (TEE). Postoperatively, patients were monitored in the ICU for hemodynamic stability, ventilatory support, blood loss, and complications such as re-exploration for bleeding, stroke, renal impairment, and infection. Total ICU and hospital stay durations were recorded.

Follow-up and Outcomes

Early postoperative assessment included echocardiography before discharge to evaluate MV function and cardiac contractility. Late follow-up focused on survival, NYHA functional class, echocardiographic findings, and event-free survival.

Statistical Analysis

The results were presented as mean ± standard deviation for normally distributed continuous variables, median (minimum-maximum) for non-normally distributed variables, and frequency with percentage for categorical data. Categorical variables were compared using the Chi-square test. The Kolmogorov-Smirnov test was applied to assess the normality of data distribution. For normally distributed continuous variables, comparisons between the two groups were performed using the unpaired t-test, whereas the Mann-Whitney U test was used for non-normally distributed variables. Statistical analyses were conducted using SPSS software (version 19, Windows). A P-value of <0.05 was considered statistically significant.

RESULTS

There were no statistically significant differences between the two groups regarding age and gender. Similarly, preoperative comorbidities, including diabetes mellitus, smoking, hypertension, hypercholesterolemia, hypothyroidism, gastrointestinal issues, renal impairment, respiratory diseases (COPD, bronchial asthma), cerebrovascular accidents (stroke, TIA), and peripheral vascular diseases, showed no significant differences between the groups (*table 1*).

As regard the pre-operative arrhythmia the AF was significantly higher in the replacement group (p=0.037). Both groups showed no significant differences in ejection fraction, mitral regurgitation grade, NYHA classification, ischemic time, CPB time, or coming off bypass. All repair patients underwent annuloplasty (ring size 26–32, most commonly 28), while all replacement patients received mechanical valves (size 27-33) with efforts to preserve at least one leaflet. Intraoperative TEE led to 21 patients converting from repair to replacement. Mechanical ventilation duration was significantly longer in the replacement group (p=0.016), while ICU stay was significantly shorter (p=0.048). Other postoperative parameters, including low cardiac output, arrhythmias, reoperations, blood transfusions, and total hospital stay, showed no significant differences. Six patients required ICU readmission: two in the repair group (for atrial fibrillation and heart failure) and four in the replacement group (for myocardial infarction and arrhythmias) (*table 2*).

Postoperative complications and in-hospital mortality showed no significant differences between groups. Multisystem failure occurred in 31 patients, with 12 deaths in the repair group and 13 in the replacement group. In-hospital mortality was 11.7% for repair and 12.7% for replacement, with causes including heart failure, arrhythmia, and infective endocarditis. Event-free survival analysis showed 49 deaths during follow-up (21.1% in repair vs. 17.5% in replacement) (*table 3*).

The repair group showed significant postoperative improvement in cardiac function, with increased ejection fraction and reduced mitral regurgitation (p=0.001, for both). Dyspnea status also improved, shifting from higher preoperative grades (2 and 3) to lower postoperative grades (1 and 2) (*table 4*).

The replacement group showed significant improvement in cardiac function, with increased

Table 1 - General characteristics of the two studied groups

	Repair (n= 128)	Replacement (n= 126)	P value
Age (years)	56.88 ± 6.89	56.75 ± 7.59	0.885
Gender			
Female	21 (16.4%)	29 (23.0%)	0.185
Male	107 (83.6%)	97 (77.0%)	
DM 66 (51.6%)	52 (41.3%)	0.100	
Smoking	70 (54.7%)	71 (56.3%)	0.790
HTN62 (48.4%)	67 (53.2%)	0.450	
Hypercholesterolemia	39 (30.5%)	45 (35.7%)	0.374
Hypothyroidism	1 (0.8%)	3 (2.4%)	0.306
GI tract	3 (2.3%)	7 (5.6%)	0.188
Renal			
Chronic RF-dialysis	1 (0.8%)	4 (3.2%)	0.231
Cr>200 umol/l	0 (0.0%)	1 (0.8%)	
Respiratory (COPD, Bronchial Asthma)	6 (4.7%)	2 (1.6%)	0.157
Cerebrovascular disease	2 (1.6%)	1 (0.8%)	0.571
Carotid duplex sig. stenosis Peripheral vascular diseases	4 (3.1%)	2 (1.6%)	0.420
Peripheral VD	1 (0.8%)	3 (2.4%)	0.592
Previous DVT	1 (0.8%)	1 (0.8%)	

Data are expressed as mean ± SD or number (%), yrs.: Years, DM: Diabetes Mellitus, HTN: Hypertension, GI tract: Gastrointestinal Tract, RF: Renal Failure, Cr: Creatinine, COPD: Chronic Obstructive Pulmonary Disease, TIA: Transient Ischemic Attack, VD: Vascular Disease, DVT: Deep Vein Thrombosis, NYHA: New York Heart Association, EF: Ejection Fraction, MVRp: Mitral Valve Repair, MVR: Mitral Valve Replacement, CABG: Coronary Artery Bypass Grafting, CPB: Cardiopulmonary Bypass, IABP: Intra-Aortic Balloon Pump, TEE: Transesophageal Echocardiography, MR: Mitral Regurgitation, PVE: Prosthetic Valve Endocarditis, PAP: Pulmonary Artery Pressure, SR: Sinus Rhythm, XC: Cross-Clamp, HB: Heart Block, UF: Ultrafiltration, *: $p \leq 0.05$ is significant.

Table 2 - Operative findings in the two studied groups

Preoperative	Repair (n= 128)	Replacement (n= 126)	P value
Pre-Op. arrhythmia			
Normal (SR)	122 (95.3%)	111 (88.1%)	0.037*
Atrial fibrillation/flutter	6 (4.7%)	15 (11.9%)	
EF (%)	47.40 ± 13.01	47.13 ± 11.86	0.862
Mitral regurge grade	3.49 ± 0.50	3.45 ± 0.50	0.527
Dyspnea NYHA			
NYHA 2	61 (47.7%)	47 (37.3%)	0.095
NYHA 3	67 (52.3%)	79 (62.7%)	
Intraoperative findings			
Bypass time	160.01 ± 58.42	153.27 ± 64.52	0.384
XC time	110.04 ± 32.41	108.97 ± 50.04	0.840
Failed to come off bypass	1 (0.8%)	1 (0.8%)	1
High intropic support	16 (12.5%)	8 (6.3%)	0.205
IABP	12 (9.4%)	9 (7.1%)	0.90
Minimal support	80 (62.5%)	91 (72.2%)	0.41
No support	19 (14.8%)	17 (13.5%)	0.35
Postoperative findings			
Low cardiac output post-operative			
IABP	4 (3.1%)	4 (3.2%)	0.393
Inotropes	67 (52.3%)	69 (56.8%)	
Inotropes & IABP	10 (7.8%)	5 (4.0%)	
Arrythmias			
AF post op	8 (6.2%)	7 (5.6%)	0.586
Permanent HB req pacing	0 (0.0%)	1 (0.8%)	
Blood used	94 (73.4%)	99 (78.6%)	0.338
Reoperation for bleeding	14 (10.9%)	14 (11.1%)	0.965
Hours ventilated	18.55±20.1	20.5±45.46	0.016
Readmitted to ICU	4 (3.1%)	2 (1.6%)	0.420
Stay in ICU (hrs.)	84.6±59.59	73.48±63.8	0.048*
Total hospital stays (days)	17.85±35.1	16.6±25.99	0.018*

Data are expressed as mean ± SD or number (%), SR: Sinus Rhythm, EF: Ejection Fraction, NYHA: New York Heart Association, XC: Cross-Clamp, IABP: Intra-Aortic Balloon Pump, AF: Atrial Fibrillation, HB: Heart Block, ICU: Intensive Care Unit, *: $p \leq 0.05$ is significant.

Table 3 - Post-operative complications and mortality in the two studied groups

	Repair (n= 128)	Replacement (n= 126)	P value
Neurological complications (delayed recovery)	4 (3.1%)	8 (6.3%)	0.226
Infective complications			
Deep wound infection	4 (3.1%)	5 (4.0%)	0.333
Superficial chest-wound infection	0 (0.0%)	2 (1.6%)	
Renal complications (severe renal impairment requiring dialysis or UF)	8 (6.2%)	3 (2.4%)	0.130
GI complications	0 (0.0%)	1 (0.8%)	0.313
Multisystem failure	14 (10.9%)	17 (13.5%)	0.534
In hospital mortality	15 (11.7%)	16 (12.7%)	0.812
Mortality			
Died in hospital	15 (11.7%)	16 (12.7%)	0.760
Died late	27 (21.1%)	22 (17.5%)	

Data is expressed as number (%), UF: Ultrafiltration, GI: Gastrointestinal, *: p ≤ 0.05 is significant.

Table 4 - Comparison between pre- and post-operative findings in repair group

	Pre-operative	Post-operative	P value
EF (%) (n=86)	47.67 ± 13.00	57.28 ± 13.34	0.001*
Mitral regurge grade (n= 86)	3.48 ± 0.50	1.62 ± 0.86	0.001*
Dyspnea NYHA(n=128)			
NA#	0 (0.0%)	42 (32.8%)	----
NYHA 1	0 (0.0%)	36 (28.1%)	
NYHA 2	61 (47.7%)	50 (39.0%)	
NYHA 3	67 (52.3%)	0 (0.0%)	

Data are expressed as mean ± SD or number (%), EF: Ejection Fraction, MR: Mitral Regurgitation, NYHA: New York Heart Association, *: p ≤ 0.05 is significant, #NA= not applicable (i.e. mortality patients).

ejection fraction and no residual mitral regurgitation. Dyspnea status improved, shifting mostly to grades 1 and 2 postoperatively, with only three patients remaining at grade 3 (*table 5*).

DISCUSSION

Mitral regurgitation in ischemic heart disease is not just a valve disorder—it is a manifestation of complex ventricular pathology. The decision to repair or replace remains a surgical dilemma, where balancing long-term durability with functional recovery defines success (7). This study provides insights into the intricate trade-offs between preserving native structures and ensuring complete valve competence.

In the current study, both groups had a majority of patients in the NYHA class II-III (NYHA class III is 52.3 % in group I and 79 % in group II). This is consistent with the findings of other authors; Lam et al. reported that nearly 60% of their patients were in NYHA class III. However, it was slightly higher in other studies, such as Lam and colleagues', who classified approximately 73% of patients as NYHA class II-III (8), and Tolis et al. (9) who classified approximately 75% of patients as NYHA class II-III. In the present study, the mean EF was 47.4 % in group I and 47.13 % in group II. This was nearly identical to Chan et al. but slightly higher (40.5 % for repair and 42.4 % for replacement group) (6). However, higher than Lorusso et al (35.8% for repair and 36.6% for replacement) (10).

Table 5 - Comparison between pre- and post-operative findings in replacement group

	Pre-operative	Post-operative	P value
EF (%) (n= 88)	47.28 ± 12.01	56.50 ± 12.27	0.001*
Mitral regurge grade (n= 88)	3.45 ± 0.50	0.00 ± 0.00	0.001*
Dyspnea NYHA (n= 126)			
NA#	0 (0.0%)	38 (30.1%)	----
NYHA 1	0 (0.0%)	53 (42.0%)	
NYHA 2	47 (37.3%)	32 (25.3%)	
NYHA 3	79 (62.7%)	3 (2.4%)	

Data are expressed as mean ± SD or number (%), EF: Ejection Fraction, MR: Mitral Regurgitation, NYHA: New York Heart Association, *: p ≤ 0.05 is significant, #NA = n

In the current study, there were statistical differences in preoperative heart rhythms, with 4.7 % of group I patients having AF compared to 11.9 % of group II patients. In contrast, Lorusso et al. (10) found no statistical difference between the repair and replacement groups, with 10.8 % in the repair group and 13.3 % in the replacement group) and Magne et al., who found no statistical difference between the two groups (11).

In our study, the mean cross clamp and total CPB times were 110.04 ± 32.41 min & 160.01 ± 58.42 min for the repair group, compared to 108.97 ± 50.04 & 153.27 ± 64.52 for the replacement group. With no significant changes between both. In accordance, Magne et al. (12) reported ischemic and CPB times of 100 ± 29 and 134 ± 42 minutes for MVRp, compared to 99 ± 32 and 137 ± 42 minutes for replacement, with no significant difference in cross-clamp time (105 ± 42 vs. 98 ± 39 minutes, p = 0.158). Maltais et al. (13) reported a mean CPB time of 124.4 ± 47.5 minutes (range, 30-340) and a mean cross-clamp time of 82.2 ± 31.6 minutes (range, 16.5-46.4).

Our post-operative complications as regard IABP need, Acute renal failure, Arrhythmias, Neurological complications, Reoperations and Multisystem failure; shows no significant differences, although ICU stay was significantly lower in the replacement group. This compares favorably with results obtained by Calafiore and his colleagues (14).

Hospital mortality occurred in 31 cases (15 in the repair group (11.7%) and 16 in the replacement group (12.7%)), with an overall perioperative mortality rate of 12.2%. Given the study's sample size, these figures may not be fully representative. Our findings align with previous reports, such as Magne et al. (12) (13.5% overall mortality; 9.7% for repair vs. 17.4% for replacement) and Gillinov et al. (15) (11% in-hospital mortality; 13% operative mortality).

However, our rates were higher than those reported by Chan et al. (16) (4% at 30 days) and Mantovani et al. (17) (8.2% for repair, 7.3% for replacement). Maltais et al. observed a 5% in-hospital or 30-day mortality rate. Patients with ischemic MR generally have worse prognoses than those with other mitral pathologies. Reported survival rates vary, with Gillinov et al. (15) noting 77% at one year and 55% at five years. Magne et al. (12) found comparable long-term survival between groups (6-year: 73±4% vs. 67±4%; 12-year: 48±13% vs. 47±7%). Chan et al. (16) reported five-year survival of 79.3±6.1% for repair and 60.6±8.8% for replacement. Prosthetic valves carry a higher risk of thromboembolic events, particularly mechanical valves, as highlighted by Magne et al. (12). Grossi et al. reported higher complication-free survival at five years for repair (64%) compared to replacement (47%) (18).

In our study, 100% of the patients in the replacement group in our study received mechanical valves. Some would argue that biological valves would offer an intermediate solution between repair and mechanical valves, with lower incidence of valve related events (thrombo-embolism, PVE, etc.), and better freedom from recurrent/ residual MR, particularly in a category of patients where long-term survival rates is not so high. Yet with patients presenting at younger ages, better follow-up and adjustment of postoperative medical treatment, we expect survival rates would improve and feel that the use of mechanical valves in some cases would be completely justified.

Mantovani et al. (17) recommended bioprosthetic valves for chronic IMR due to patients' limited life expectancy. However, the present study supports mechanical prostheses in younger patients, given the observed five-year survival of 73.4%. Magne et al. (12) highlighted the increasing risk of structural valve deterioration in bioprostheses over time, with age and MV position as key risk factors. Additionally, severe prosthesis-patient mismatch after MVR has been linked to reduced postoperative survival.

In this study, the replacement group remained entirely free of MR throughout the follow-up period. While MVRp may circumvent the complications associated with prosthetic valve implantation, its higher incidence of persistent or recurrent MR in patients with ischemic MR could potentially outweigh this advantage. Recurrent MR remains a notable concern following repair, with McGee et al. (19) reporting a recurrence rate of 30% within six months. Chan et al. (17) found freedom from recurrent MR (grade 2+ or higher) at six months was 95.0±3.5% for repair and 100% for replacement, decreasing at five years to 41.4±14.8% for repair and 85.7±13.2% for replacement. They suggested recurrence may result from insufficient LV reverse remodeling. While Gillinov et al. (15) indicated mixed findings on repair versus replacement outcomes, they emphasized the importance of chordal preservation in replacement. Cohn et al. and Dion et al. (20,21) concluded that MR pathophysiology and patient presentation are more critical to outcomes than the surgical approach.

Long-term survival after mitral surgery is primarily influenced by non-cardiac comorbidities such as diabetes, renal insufficiency, and age rather than the surgical approach. Maltais et al. (13) found no impact of mitral repair versus replacement on early or late survival, with severe preoperative cardiac dysfunction (LVEF 45% with significant MR) being a dominant factor. Additionally, the type of repair had no effect on outcomes.

This study is limited by its retrospective, non-randomized design and single-center setting. Longer follow-up is needed to assess durability and late complications.

CONCLUSION

Both MVRp and MVR significantly improved functional status and ejection fraction, with no significant difference in long-term survival. MVRp remains susceptible to recurrent regurgitation, while MVR eliminates MR but prolongs ventilation time. Surgical choice should be tailored to patient-specific factors.

Conflict of Interest

None to be declared.

Funding

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