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Research Article

Moderate Ischemic Mitral Insufficiency at the Time of Coronary Artery Bypass Graft; Repair or Spare?

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ABSTRACT

Background: Approximately 13-59% of myocardial infarction patients develop ischemic mitral regurgitation, impacting left ventricular function and increasing mortality risk. Optimal management of moderate ischemic mitral regurgitation remains controversial, raising the question of whether adding mitral valve surgery to coronary artery bypass graft (CABG) has an overall advantage over revascularization or not.

***Objective*:** To investigate the early and mid-term comparison between the two techniques.

Subjects and Methods: This randomized clinical trial was conducted at Assuit University Heart Hospital, on 50 patients randomized into two groups: Group A: 25 patients underwent CABG and Group B: 25 patients had CABG and mitral valve repair. Inclusion criteria was multi-vessel coronary artery disease, moderate ischemic mitral regurge (MR). All patients were subjected to full history taking, routine physical, laboratory investigations and transthoracic echocardiography. Intraoperative data was collected. Early outcomes included MR degree, and left ventricular (LV) diameters and function, ICU stay duration, and in-hospital mortality. Mid-term outcomes included MR degree, LV diameter and function.

Results: Groups had similar age and gender distribution. Repair procedures showed longer ischemic and operative times than CABG alone (P≤0.0001 and P=0.0012). Early post-operative, repair reduced MR significantly (P≤0.0001). At six months follow-up, CABG group had more rate of improvement than repair group (P≤0.0001).

Conclusions: In moderate ischemic mitral regurgitation with multi-vessel ischemic heart disease, adding mitral valve repair to CABG may reduce mitral regurgitation severity early and at six months compared to CABG alone. However, CABG alone offers shorter ischemic times and operative durations.

Introduction

Approximately 13-59% of myocardial infarction patients develop ischemic mitral regurgitation (IMR). About one-third have mild mitral regurgitation (MR) (1).

IMR has a complex mechanism. It results from left ventricular deformation and remodeling after myocardial infarction, which displaces papillary muscles of the annular plane. This displacement, annular flatness, expansion, and decreased contraction pull on chordae tendineae induces secondary MR by mal-coaptating the otherwise normal mitral valve (1-3).

Secondary MR leaflet tethering can be asymmetric or symmetric (1). Asymmetric tethering occurs when regional LV remodeling displaces the posterior papillary muscle laterally. In contrast, global LV remodeling causes symmetric tethering, which binds anterior and posterior papillary muscles apically. Research shows that revascularization alone seldom resolves severe IMR, and residual MR increases mortality risk (4).

Coronary artery bypass grafting with the addition of mitral valve surgery is recommended for severe IMR. Surgical correction of moderate IMR during coronary revascularization is controversial (5-7). CABG alone may reduce MR at follow-up, but it rarely eliminates it (8).

According to some studies, mitral valve annuloplasty may remove MR after CABG surgery. However, CABG + mitral valve annuloplasty can cause recurrent MR without improving long-term survival (9-10). CABG + mitral valve operations may increase morbidity and death in high-risk moderate IMR patients compared to CABG alone (11).

By the most recent recommendations issued by the American Association for Thoracic Surgery (AATS), patients who have moderate ischemic mitral regurgitation (IMR) may be eligible for coronary artery bypass grafting (CABG) procedures that involve the replacement of the mitral valve with an undersized complete rigid ring annuloplasty. On the other hand, this method is not necessarily advised in comparison to revascularization on its own. There is currently a lack of clarity on the possible advantages of adding mitral valve surgery with CABG for patients with IMR (12-13).

This study compared CABG alone vs CABG plus mitral valve surgery in patients with multi-vessel ischemic heart disease and mild mitral regurgitation. The examination covered early postoperative and six-month follow-up. Ischemic time, early and mid-term postoperative mitral regurgitation severity, and mortality rates were the main outcomes. Secondary outcomes were left ventricular diameter, function, and ICU stay**.**

Subjects and Methods

This randomized clinical trial, conducted between 2019 and 2021 at Assuit University Heart Hospital, on 50 consecutive patients with ischemic heart disease and moderate ischemic mitral regurge who were admitted to Cardiothoracic surgery department. The patients were randomized into two groups: Group A (25 patients) underwent CABG only, while Group B (25 patients) had CABG along with mitral valve repair. Inclusion criteria encompassed patients with multi-vessel coronary artery disease, moderate ischemic (not rheumatic) mitral regurge, and those undergoing elective surgery with cardiopulmonary bypass. Exclusion criteria included off-pump CABG, incomplete revascularization candidates, other valvular affection, and emergency cases.

In this study, data from eligible patients were collected in a data sheet for later analysis without altering their treatment or follow-up. All patients underwent complete history taking (personal details, complaints, drug sensitivity, past medical and surgical history), physical examinations (vital signs and checks for systemic diseases), and investigational studies, including routine laboratory tests (CBC, ESR, C-reactive protein, liver and kidney functions, PT, PTT, and INR).

Radiological investigations included pre-operative transthoracic echocardiography using a Vivid E9 (GE Healthcare, Chicago, US) or Philips iE33 (Royal Philips, Eindhoven, the Netherlands) ultrasound system. The degree of mitral regurgitation (MR) was estimated using the vena contracta method, with values between 3mm and 7mm indicating moderate MR. Other measured parameters included left ventricular diameters and left ventricular function. Operative variables recorded were the type of surgical procedure (CABG only or CABG concomitant with mitral valve repair), ischemic time, and total operative time.

In all cases, a coronary artery bypass grafting (CABG) procedure was performed. This involved making a median sternotomy incision and using hypothermic cardiopulmonary bypass along with intermittent antegrade cardioplegia. The saphenous vein and radial arteries were harvested to serve as secondary conduits, while the left internal mammary artery was used for grafting the left anterior descending coronary artery. In this context, mitral valve surgery and CABG were carried out simultaneously on the patients.

Left atriotomy accessed the mitral valve, and rigid complete ring annuloplasty was performed using 28mm or 30mm rings, the left atrium was accessed by exposing the Sondergaard groove, and proper ring size was

determined using manufacturer-supplied sizers. Ethibond Excel™ (Ethicon, Cincinnati, Ohio, US) sutures tightened the annulus and placed in an interrupted pattern, and the repair was tested with pressurized cold saline before closing the left atrium with polypropylene sutures.

Early outcomes, assessed on the 7thpost-operative day, involved grading the severity of mitral regurgitation (MR) using the vena contracta technique, along with left ventricular (LV) diameters and function, ICU stay duration, and in-hospital mortality. Mid-term outcomes, evaluated in 6th month, included the use of TTE to assess the degree of MR by vena contracta, LV diameters (end-systolic and end-diastolic), and LV function (ejection fraction).

Ethical considerations: The study was approved by the ethical committee of Faculty of Medicine, Assiut University by IRB no:17200405. Every participant was informed about the aim of the study, its benefit to him and to the community. Written consent was taken from all participants. Every participant had the right to withdraw from the study.

The statistical analysis was done utilizing SPSS software (version 26.0). Data were presented as frequencies, medians with ranges, or means ± SD, as appropriate. Key outcome variables included postoperative left ventricular function, the degree of mitral regurgitation (MR), and mortality rates. The prevalence of these outcomes was estimated using non-parametric statistical methods, including the Kaplan-Meier method. Risk factors for these outcomes were identified through multivariable regression analysis, examining demographic and morphological factors. Pre- and post-operative variables were compared using paired t-tests, with a p-value < 0.05 was statistically significant.

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Results

Demographic data

There was no significant difference in age between the CABG group (56.28 ± 9.6 years) and the repair group (58.04 ± 8.37 years), with a p-value of 0.7224. Gender distribution showed no significant difference between groups, with 56% males and 44% females in the CABG group, and 60% males and 40% females in the repair group. The p-value for gender distribution was 0.7799. (Table 1).

Table 1: Demographic data among included subjects in both study groups

	CABG group (N = 25)	Repair group (N = 25)	P. Value
Age (Years)	56.28 ± 9.6	58.04 ± 8.37	0.7224[s.t]
Gender			
Male	14 (56%)	15 (60%)	0.7799[X]
Female	11 (44%)	10 (40%)	

s.t: Skipped T-test, X: Chi square Test

Intra-operative results:

During cardiopulmonary bypass (CPB), ischemic time was significantly longer in the repair group (130.48 ± 13.77 minutes) compared to the CABG group (93.12 ± 17.35 minutes), with a p-value of <0.0001. Similarly, operative time was significantly longer in the repair group (285.16 ± 23.9 minutes) compared to the CABG group (250.84 ± 35.95 minutes), with a p-value of 0.0012. (Table 2)

Table 2: intraoperative data among included subjects in both study groups

	CABG group (N = 25)	Repair group (N = 25)	P. Value
CPB			
Ischemic Time (Minutes)	93.12 ± 17.35	130.48 ± 13.77	<0.0001*[MWU]
Operative time (Minutes)	250.84 ± 35.95	285.16 ± 23.9	0.0012*[MWU]
ICU stay (Day)	3.36 ± 2.06	3.32 ± 3.11	0.4765[MWU]

s.t: Skipped T-test, MWU: Mann-Whitney U Test

In-hospital mortality:

In the CABG group, 8% (2 out of 25) of individuals experienced death, while in the repair group, 4% (1 out of 25) experienced death. However, this difference was not statistically significant, with a p-value of 0.5609 (Chi-square test). (Table 3)

Table 3: In-hospital mortality among included subjects in both study groups

	CABG group (N = 25)	Repair group (N = 25)	P. Value
Death	2 (8%)	1 (4%)	0.5609[X]

X: Chi square Test

Early postoperative results:

Significant differences were observed for the degree of MR (Vena Contracta), with the CABG group showing a mean change of -0.08 ± 0.11 and the Repair group showing a significant decrease of -4.1 ± 0.91 (P < 0.0001). (Table 4)

For LV dimensions, both groups had similar changes in End Systolic Diameter (ESD), with a mean change of -0.06 ± 0.08 in the CABG group and -0.06 ± 0.1 in the Repair group (P = 0.99). There was no change in End Diastolic Diameter (EDD) in either group. (Table 4)

LV function, measured by Ejection Fraction (EF), showed a change of -0.72 ± 2.34 in the CABG group and -0.52 ± 1.55 in the Repair group, with no significant difference between groups (P = 0.9685). (Table 4)

The percentage change from baseline in the degree of MR (Vena Contracta) was -1.43 ± 2.06 in the CABG group and a significant decrease of -74.46 ± 12.25 in the Repair group (P < 0.0001). The percentage change in ESD was -1.35 ± 1.95 in the CABG group and -1.46 ± 2.32 in the Repair group, with no significant difference (P = 0.8994). There was no change in the percentage of EDD in either group. The percentage change in EF was -1.24 ± 4.38 in the CABG group and -0.94 ± 2.99 in the Repair group, with no significant difference (P = 0.7359). (Table 4)

The change in the degree of MR (Vena Contracta) was -1.88 ± 0.36 in the CABG group and significantly decreased to -4.6 ± 0.75 in the Repair group (P < 0.0001). (Table 4)

Table 4: Early Postoperative echocardiographic changes and the percentage change from baseline in both study groups

	CAGB group (N = 25)	Repair group (N = 25)	P. Value
Postoperative Echo change from baseline			
Degree of MR (Vena Contracta)	-0.08 ± 0.11	-4.1 ± 0.91	<0.0001* [MWU]
LV Dimension			
End Systolic Diameter (ESD)	-0.06 ± 0.08	-0.06 ± 0.1	0.99 [MWU]
End Diastolic Diameter (EDD)	0	0	
LV Function (EF)	-0.72 ± 2.34	-0.52 ± 1.55	0.9685 [MWU]
Postoperative Echo percentage of change from baseline			
Degree of MR (Vena Contracta)	-1.43 ± 2.06	-74.46 ± 12.25	<0.000*[MWU]
LV Dimension			
End Systolic Diameter (ESD)	-1.35 ± 1.95	-1.46 ± 2.32	0.8994 [MWU]
End Diastolic Diameter (EDD)	0	0	
LV Function (EF)	-1.24 ± 4.38	-0.94 ± 2.99	0.7359 [t]

t: T-test, MWU: Mann-Whitney U Test

LV dimensions showed an End Systolic Diameter (ESD) change of -0.28 ± 0.22 in the CABG group and -0.37 ± 0.16 in the Repair group, with no significant difference (P = 0.0658). End Diastolic Diameter (EDD) change was -0.57 ± 1.34 in the CABG group and -0.42 ± 1.05 in the Repair group, also showing no significant difference (P = 0.852). (Table 4)

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LV function, measured by Ejection Fraction (EF), increased by 2.74 ± 2.11 in the CABG group and 3.83 ± 2.41 in the Repair group, with no significant difference between groups (P = 0.1118). (Table 4)

Mid-term postoperative results:

The percentage change from baseline in the degree of MR (Vena Contracta) was -0.35 ± 0.05 in the CABG group and significantly decreased to -0.84 ± 0.08 in the Repair group (P < 0.0001). The percentage change in ESD was -0.07 ± 0.05 in the CABG group and -0.08 ± 0.04 in the Repair group, with no significant difference (P = 0.1537). The percentage change in EDD was -0.11 ± 0.26 in the CABG group and -0.07 ± 0.19 in the Repair group, with no significant difference (P = 0.9223). The percentage change in EF was 0.06 ± 0.04 in the CABG group and 0.08 ± 0.05 in the Repair group, with no significant difference (P = 0.1805). (Table 5).

Difference between early and mid-term results:

The change in the degree of MR (Vena Contracta) at 6 months was significantly greater in the CABG group (-1.79 ± 0.36) compared to the Repair group (-0.53 ± 0.48), with a P value < 0.0001. (Table 6).

For LV dimensions, the End Systolic Diameter (ESD) change was -0.22 ± 0.19 in the CABG group and -0.3 ± 0.12 in the Repair group, showing a significant difference (P = 0.0393). The End Diastolic Diameter (EDD) change was -0.57 ± 1.34 in the CABG group and -0.42 ± 1.05 in the Repair group, with no significant difference (P = 0.852). (Table 6)

LV function, measured by Ejection Fraction (EF), increased significantly in both groups, with a change of 2.96 ± 1.94 in the CABG group and 4.29 ± 1.88 in the Repair group (P = 0.0133). (Table 6)

Table 5: Echocardiographic changes at 6 months and the percentage change from baseline in both study groups

	CAGB group (N = 25)	Repair group (N = 25)	P. Value
6 Month Echo change from baseline			
Degree of MR (Vena Contracta)	-1.88 ± 0.36	-4.6 ± 0.75	<0.0001* [w.t]
LV Dimension			
End Systolic Diameter (ESD)	-0.28 ± 0.22	-0.37 ± 0.16	0.0658 [MWU]
End Diastolic Diameter (EDD)	-0.57 ± 1.34	-0.42 ± 1.05	0.852 [MWU]
LV Function (EF)	2.74 ± 2.11	3.83 ± 2.41	0.1118 [s.t]
6 Month Echo percentage of change from baseline			
Degree of MR (Vena Contracta)	-0.35 ± 0.05	-0.84 ± 0.08	<0.0001* [MWU]
LV Dimension			
End Systolic Diameter (ESD)	-0.07 ± 0.05	-0.08 ± 0.04	0.1537 [MWU]
End Diastolic Diameter (EDD)	-0.11 ± 0.26	-0.07 ± 0.19	0.9223 [MWU]
LV Function (EF)	0.06 ± 0.04	0.08 ± 0.05	0.1805 [s.t]

w.t: Wilches T-test, MWU: Mann-Whitney U Test

Table 6: Echocardiographic changes at 6 months and the percentage change from early postoperative echocardiographic data in both study groups

	CAGB group (N = 25)	Repair group (N = 25)	P. Value
6 Month Echo change from Postoperative Echo			
Degree of MR (Vena Contracta)	-1.79 ± 0.36	-0.53 ± 0.48	<0.0001* [MWU]
LV Dimension			
End Systolic Diameter (ESD)	-0.22 ± 0.19	-0.3 ± 0.12	0.0393* [MWU]
End Diastolic Diameter (EDD)	-0.57 ± 1.34	-0.42 ± 1.05	0.852 [MWU]
LV Function (EF)	2.96 ± 1.94	4.29 ± 1.88	0.0133* [MWU]
6 Month Echo percentage of change from Postoperative Echo			
Degree of MR (Vena Contracta)	-30.78 ± 10.26	-34.68 ± 19.9	0.7718 [MWU]
LV Dimension			
End Systolic Diameter (ESD)	-5.11 ± 4.84	-6.89 ± 2.7	0.0557 [MWU]
End Diastolic Diameter (EDD)	-11.26 ± 26.45	-7.48 ± 19.07	0.9223 [MWU]
LV Function (EF)	5.52 ± 5.04	8.36 ± 4.13	0.0093* [MWU]

MWU: Mann-Whitney U Test

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Discussion

Concerning patients who have multi-vessel ischemic heart disease and a moderate degree of mitral regurgitation, the treatment approach that is considered to be the most effective is still up for debate, however complete revascularization appears to have satisfactory outcomes in such patients in most clinical studies, evolution of competent techniques of mitral valve repair adds another option for these patients. We conducted this study trying to find the best possible strategy for our patients and to build our center experience

In our study, pre-operative echocardiographic data indicated that the degree of mitral regurgitation (MR), as measured by Vena Contracta, did not significantly differ between the CABG group (P = 0.7277). This finding aligns with El-Hag-Aly et al. (14), who reported similar mean VC values of 5.2 ± 0.96 for the CABG group and 5.3 ± 0.93 for the CABG + MV repair group in their study.

Comparatively, ByungJin Kim et al. (15) found that the dimensions of the left ventricle (LV) were substantially bigger in patients who underwent CABG + MV surgery than those who underwent CABG alone. This was evidenced by the fact that the LV end-systolic diameter (LVESD) and end-diastolic diameter (LVEDD) were both significantly greater in the former group. In our study, we found significant differences in LV dimensions between groups: ESD was higher in the repair group (4.39 ± 0.25 cm) versus the CABG group (4.05 ± 0.22 cm), p-value = 0.0012; and EDD was larger in the repair group (5.54 ± 0.34 cm) compared to the CABG group (5.12 ± 0.34 cm), p-value = 0.0054 (15). These results underscore the distinct LV dimensional profiles observed in our cohort undergoing different surgical approaches for ischemic heart disease with moderate MR.

Operatively, our study found significantly longer operative and ischemic times in the CABG plus MV repair group compared to the CABG alone group (P=0.0012). Similarly, the mean ischemic time was longer in the repair group compared to the CABG group ($p < 0.0001$). These findings are consistent with those reported by Michler et al. (16), who also noted longer ischemic times in the combined procedure group compared to CABG alone

Early post-operative echocardiographic follow-up in our study revealed a significant change in the degree of mitral regurgitation (MR) between the two groups. The CABG plus MV repair group showed a mean change of vena contracta of -4.1 ± 0.91, significantly more change than the CABG group with a mean change of vena contracta of -0.08 ± 0.11 ($p < 0.0001$). This aligns with findings from El-Hag-Aly et al. (14), where the CABG plus MV repair group had a markedly lower mean vena contracta compared to CABG alone.

Early postoperative echocardiographic data also demonstrated that the degree and percentage of change of the left ventricular (LV) dimensions did not differ significantly in both groups from the baseline data.

Regarding left ventricular function, our study found no significant improvement in early post-operative echocardiographic follow-up compared to pre-operative values. Moreover, there was no significant change in LV function post-operatively (P=0.9685), consistent with findings reported by El-Hag-Aly et al. (14), (P=0.75).

In terms of ICU stay, our findings align with those of Khallaf et al. (17), where no significant difference between the CABG group (3.36 ± 2.06 days) and the CABG plus MV repair group (3.32 ± 3.11 days) (P=0.4765). This suggests comparable post-operative recovery times between the two surgical approaches in our study.

Post-operative mortality was a crucial comparison in our study of surgical strategies. ByungJin Kim et al. (15), reported early deaths in 22 (3.7%) patients in the CABG-only group and 13 (11.2%) in the CABG + MVS group (P=0.001), attributing these findings to prolonged ischemic time and increased incidence of low cardiac output syndrome Conversely, other authors found no significant difference in in-hospital mortality between the strategies (17). Our study recorded two cases of in-hospital mortality in the CABG alone group and one in the CABG + MV repair group, with no significant difference observed (P=0.5609). This may be explained by the good preoperative clinical profiles of our patients, including preserved EF and shorter operative times.

Over six months of follow-up, our study evaluated multiple echocardiographic parameters. We observed a significant change in the degree of MR in the CABG + MV repair group compared to CABG alone in comparison to the baseline data, with mean vena contracta change values of -4.6 ± 0.75versus -1.88 ± 0.36, respectively ($p < 0.0001$). This finding is supported by Khallaf et al., (14), El-Hag-Aly et al., (17), and Chan et al., (18). Regarding LV function, no significant change was found between groups, with a mean change of EF of 2.74 ± 2.11 for CABG alone and 3.83 ± 2.41 for CABG + MV repair (P=not significant). Similar results were reported by Michler et al. (16).

When comparing the results of both techniques in early postoperative terms versus after 6 months, the rate of change of degree of MR estimated by vena contracta was found to be greater in CABG only group with a mean change of -1.79 ± 0.36 than that of CABG in addition to MV repair which had a mean of change of -0.53 ± 0.48, This indicates that complete revascularization alone takes longer time to achieve a significant effect on decreasing the degree of MR

Conclusion

Mitral valve repair may have an advantage when added to CABG in patients with moderate ischemic mitral regurge in terms of less degree of MR when compared to CABG only in both early and midterm follow-up, while having only CABG in such patients is associated with less operative time and less ischemic time, Thus, no overall advantage of any technique over the other had been found.

Limitations: only six months follow-up is the main limitations in our study.

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This research did not receive any specific fund.

Conflict of Interest

Authors declare no conflict of interest.

Data availability

Data are available upon reasonable request.

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