Original Article

Assessment of early outcome of coronary artery bypass grafting with and without mitral valve surgery in moderate ischemic mitral regurgitation: A multicenter comparative cohort study

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ABSTRACT

Background: Some experts believe that revascularization alone for moderate ischemic mitral regurgitation, due to improvements in global and regional left ventricular function and geometry after coronary artery bypass grafting (CABG), can decrease rates of mitral regurgitation, however, the value of adding mitral valve repair or not to the CABG surgery remains controversial.

Aim: To compare the early peri-operative results of surgical management of moderate ischemic mitral regurgitation by revascularization alone versus revascularization plus mitral valve surgery.

Patients and Methods: This prospective cohort comparative study was conducted at Suez Canal University Hospitals, and Suez Hospital for Health Insurance, Cardiac Surgery Department from January 2020 to January 2023. This study was conducted on 100 patients with IHD undergoing CABG with moderate ischemic mitral regurge attending our clinic in Suez Canal University Hospital and Cardiac Surgery Department in Suez Hospital for Health Insurance.

Results: The New York Heart Association (NYHA) classification showed statistically significant difference between both groups (*P=0.008*). Also, group I had a higher mean of left ventricular ejection fraction than group II with statistically insignificant differences (*P>0.05*). Group I had significantly lower segmental wall-motion abnormalities than group II with statistically significant differences (*P=0.042*). Also, the severity of mitral regurgitation was significantly lower among group I than group II (*P=0.028*). Among group I, the severity of NYHA classification distribution showed a statistically significant decrease (*P<0.001*).

Conclusion: Moderate mitral regurgitation in patients undergoing isolated CABG adversely NYHA functional class and mitral regurgitation does not reliably improve after CABG alone.

Key Words: Coronary artery bypass, mitral valve surgery.

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INTRODUCTION

Currently, there is widespread agreement that moderate to severe (grade III to IV) chronic ischemic mitral regurgitation (cIMR) should be addressed during coronary artery bypass grafting (CABG), but trace-to-mild (grade I) cIMR does not require surgical intervention. On the other hand, the appropriate management of moderate (grade II to III) cIMR is still debated[1].

Although ischemic mitral regurgitation in CABG patients is associated with poor outcomes, the advantages of including mitral-valve repair are questionable. Advocates of CABG alone in the treatment of mild IMR say that revascularization may enhance regional left ventricular performance and lower the left ventricular chamber size, therefore restoring the functional integrity of the subchordal mitral-valve apparatus[2].

Advocates for mitral-valve surgery in addition to CABG cite the adverse consequences of persistent IMR. They also argue that in patients with reduced left ventricular function, mitral-valve surgery may prevent progressive adverse remodeling, improve cardiac function, and reduce the risk of heart failure[3].

Operative mortality linked with either technique has consistently dropped over the last 5 years, but the open-heart exposure and longer periods of aortic cross-clamping and cardiopulmonary bypass associated with mitral valve surgery enhance perioperative risk[4].

Thus, the inclusion of mitral-valve surgery in CABG is still debatable. This disagreement is based in part on the absence of evidence from rigorous studies that may help decide if the potential advantages of mitral valve surgery exceed the higher risks of the combination treatment[5].

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Therefore, this study aimed to assess the early outcome of CABG without mitral valve surgery in moderate IMR through a multicenter comparative cohort study.

PATIENTS AND METHODS:

Study setting and study population

This prospective cohort comparative study was conducted at Suez Canal University Hospitals, and Suez Hospital for Health Insurance, Cardiac Surgery Department from January 2020 to January 2023.

This study was conducted on 100 patients with IHD undergoing CABG with moderate ischemic mitral regurge attending our clinic in Suez Canal University Hospital and Cardiac Surgery Department in Suez Hospital for Health Insurance. These patients are candidates to be included in this study. Patients with mild or severe IMR, patients with nonischemic mitral regurge, and those with another valve disease warranting intervention were excluded from the study. Additionally, patients with associated left ventricular aneurysm or ischemic VSD, having a history of previous cardiac surgery (redo patients), or suffering from renal or hepatic failure were also excluded.

All patients were evaluated thoroughly preoperatively, intraoperatively, and postoperatively. Particular attention were paid to clinical findings of the presence of mitral regurge, its nature, preoperative echocardiographic findings of mitral regurge and its nature, degree of mitral regurge, postoperative ICU events including (the duration of mechanical ventilation, ICU stay, the need of inotropic support, use of IABP, renal dialysis, postoperative bleeding), hospital stay, in-hospital morbidity and mortality.

The patients were divided into two groups after Dobutamine Echocardiography:

Group I: 50 patients with IHD and moderate IMR undergoing pump CABG for revascularization and mitral valve surgery.

Group II: 50 patients with IHD and moderate IMR undergoing pump CABG for revascularization only.

Methods

Preoperative assessment

(i) History taking.

(ii)Clinical examination.

(iii) Investigations which included:

(a) Laboratory investigations (complete blood count, liver function test, kidney function test, lipid profile).

(b) ECG.

(c) Chest radiography: to evaluate the cardiothoracic ratio and the different cardiac chambers.

(d) Echocardiography: to evaluate other valves, the mitral regurgitation jet area in cm2, and the grade of mitral regurgitation (MR Grade).

(e) Coronary angiography: the number of diseased vessels and site of lesions were estimated as well as the site of diseased vessels.

(f) Dobutamine stress echocardiography: to assess viability and degree of mitral regurge.

(g) Trans-esophageal echocardiography: was done for all patients intraoperative for assessment of the ejection fraction and the mitral regurgitation jet area in cm2 and the grade of mitral regurgitation (MR Grade) after cardiopulmonary bypass.

Intraoperative procedures

Anesthetic technique

The intraoperative anesthetic technique was the same for all patients and consisted of Fentanyl 5–10 µg/Kg and endotracheal intubation was facilitated with the use of Pancuronium 0.02 mg/Kg. A transesophageal ECHO probe was used to assess mitral function.

Surgical technique

The incision will begin approximately 2 cm below the sternal notch and extend approximately 2 cm beyond the distal tip of the xiphoid process and extend with electrocautery down to the sternal periosteum.

The sternum will be then divided in a cephalad to caudal direction. Then we will prepare for the internal thoracic artery and the great saphenous vein harvesting immediately afterward. The pericardium will be opened after dissecting the thymus gland and identifying the left innominate vein cold cardioplegia will be used.

After initiation of cardiopulmonary bypass, the sequence of anastomoses will be according to the decision of the surgeon, with the pedicled left internal thoracic artery to left anterior descending artery anastomoses will be performed last to avoid tension and potential injury.

Angiographically identified distal target locations will be confirmed by visual inspection and epicardial examination. The previously prepared and beveled conduit will be brought to the field, a 7–0 polypropylene suture will be passed inside-out on the conduit and inside-out at the corresponding location near the heel of the arteriotomy

and anchored by a bulldog, and the other needle will be passed inside-out on the arteriotomy and then outside-in at the conduit.

After completing the last distal anastomoses (LIMA to LAD), in the revascularization alone group (group II), the aortic root vent will be used to de-air the heart, and the cross-clamp will be then removed.

While in the combined-procedure group (group I), left atriotomy will be done by applying the left atrial retractor for proper inspection and examination of the mitral valve using p2 as the reference point for examination.

After meticulous examination of the pathology existing, measuring the intercommisural distance and the anteroposterior distance of the anterior mitral leaflet. According to pathology if just annulus dilatation, mitral ring annuloplasty will be done. But if there is leaflet prolapse or needs a complex technique, mitral valve replacement will be done. Then meticulous closure of the left atriotomy and deairing.

A partial occlusion clamp will be then applied on the anterior surface of the aorta to place the proximal anastomoses. A 6–0 polypropylene suture will be used. After completion of all anastomoses and establishing a stable intrinsic or paced cardiac rhythm, metabolic optimization, appropriate pharmacologic support, and the initiation of effective mechanical ventilation, the patient will be weaned from cardiopulmonary bypass.

Once weaned from cardiopulmonary bypass, all cannulae will be removed and all surgical sites will be appropriately reinforced and adequate hemostasis will be confirmed. Thoracostomy drainage tubes will be carefully placed, pacing wires will be inserted and the chest, and leg, will be closed in layers.

Postoperative assessment

One week after surgery, patients were evaluated after surgery with the following:

(a) New York Heart Association (NYHA) functional class.

(b) 12 leads ECG: 12 leads ECG was done for all patients to detect new ECG changes in the form of ischemia1, infarction and arrhythmias.

(c) Echocardiography: M mode, two dimensions, and Doppler echocardiography were performed for all patients.

(d) Wound infection.

3- and 6-months evaluation

Patients were evaluated 6 months after surgery by the following:

(a) New York Heart Association (NYHA) functional class.

(b) Echocardiography.

Statistical analysis

Data was collected through pre and postoperative history questionnaires and clinical assessment. Data collected was coded, entered, and analyzed using Microsoft excel program software. Data analysis was done by Statistical analysis was done using IBM SPSS statistics for windows, Version 22.0. Armonk, NY: IBM Corp.

Normally distributed continuous data was expressed as mean±SD; non-normally distributed data was expressed as median and range. Outcome percentages will be expressed as the percentage. Categorical data was expressed as absolute numbers and proportions. Clinical profiles were compared using the Fisher exact test (a statistical significance test).

Chi square is used to compare different frequencies. T test similarly used for mean correlation. The level of significance using the *P value* as a result was statistically significant if *P value* was less than 0.05.

RESULTS:

In group I, the mean age was 68.4±7.6 years, and this group included 15 (30%) females and 35 (70%) males. Regarding comorbidities, 62% of the patients have DM, 86% have hypertension, 34% have dyslipidemia and 38% among them are smokers. As for group II, the mean age of the studied group was 66.5±7.9 years. The studied group included nine (18%) females and 41 (82%) males. Regarding comorbidities, 38% of the patients have DM, 78% have hypertension, 30% have dyslipidemia and 54% among them are smokers (Table 1).

In terms of the preoperative echo parameters, (Table 2) showed the presence of statistically insignificant differences between both groups. While dobutamine echo showed statistically significant difference between both groups. In group II degree of MR was improved with dobutamine in all patients. However, in group I degree of MR was improved in only 13 patients and was moderate in 37 patients.

Regarding the intraoperative findings, group I had a significantly longer duration of CBP and aortic class time than group II with statistically significant differences (*P<0.05*). Also, a group I had a higher percentage of use of intra-aortic balloon pump, and inotropic drugs than

group II, but with statistically insignificant differences as *P* greater than 0.05 (Table 3).

The post-operative assessment showed that group I had a significantly longer duration of ventilator time, ICU, and hospital stay than group II with statistically significant differences (*P<0.05*). Also, group II had a lower percentage of use of inotropic drugs than group I with statistically insignificant differences (*P=0.102*). Moreover, there were no statistically significant differences between the two groups regarding postoperative complications (Table 4).

The 1-week follow-up assessment showed that the NYHA classification distribution showed statistically insignificant differences between both groups. Also, group I had a significantly lower median of left ventricular ejection fraction (LVEF) than Group II with statistically insignificant differences (*P=0.109*) (Table 5).

As for the 6 months follow-up assessment, the NYHA classification distribution showed a statistically significant difference between both groups (*P=0.008*). Also, group I had a higher mean of left ventricular end systolic diameter (LVESD), left ventricular end diastolic diameter (LVEDD), and higher mean of LVEF than group II with statistically insignificant differences (*P>0.05*). Also, the severity of MR was significantly lower among group I than group II (*P=<0.001*) (Table 6).

Table 1: Demographic and clinical characteristics (n=50)

	Group I (*n*=50)	Group II (*n*=50)	*P* value
Age $_{(years)}$	68.4±7.6	66.5±7.9	0.228[1]
Gender			
Male	35 (70%)	41 (82%)	0.295
Female	15 (30%)	9 (18%)	
NYHA Classification			
I	11 (22%)	13 (26%)	0.790[2]
II	16 (32%)	19 (38%)	
III	17 (34%)	13 (26%)	
IV	6 (12%)	5 (10%)	
Smoking	19 (38%)	27 (54%)	0.129[2]
DM	31 (62%)	29 (38%)	0.781[2]
Hypertension	43 (86%)	39 (78%)	0.587[2]
COPD	7 (14%)	6 (12%)	0.909[2]
Dyslipidemia	17 (34%)	15 (30%)	0.699[2]
Obesity	7 (14%)	5 (10%)	0.678[2]
Previous MI	31 (62%)	28 (56%)	0.576[2]
PCA	7 (14%)	9 (18%)	0.693[2]

1Student t test.
2Chi square test.
*Statistically significant as *P<0.05*.
Abbreviations: COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; MI, myocardial infarction; NYHA, New York Heart Association; PCA, Percutaneous coronary angioplasty.

Table 2: Preoperative echocardiographic data (n=50)

	Group I (*n*=50)	Group II (*n*=50)	*P* value
LVESD, $_{cm}$	5.2±0.59	4.9± 0.62	0.502[1]
LVEDD, $_{cm}$	6.1±0.50	5.8± 0.48	0.451[1]
LVEF $_{(\%)}$	44.89±3.20	45.92±2.61	0.465[1]
FS $_{(\%)}$	24.4±4.87	25.7±6.23	0.440[1]
SPAP $_{(mmHg)}$	33.1±5.7	32.4±6	0.120[1]
LA, $_{cm}$	4.29±0.32	4.22±0.41	0.101[1]
No. diseased vessels			
Two	7 (14%)	2 (4%)	0.215[2]

Three	36 (72%)	39 (78%)	
Four	7 (14%)	9 (18%)	
Dobutamine ECHO			
Mild	13 (26%)	50 (100%)	<0.001*2
Moderate	37 (74%)	0 (0%)	

1Student t test.
2Chi square test.
*Statistically significant as *P<0.05*.
Abbreviations: FS, fractional shortening; LA, left atrium; LVEDD, left ventricular end diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end systolic diameter; MR, mitral Regurge; SPAP, presystolic pulmonary artery pressure; SWMA, segmental wall-motion abnormalities.

Table 3: Intraoperative data (n=50)

	Group I (*n*=50)	Group II (*n*=50)	*P* value
CPB time $_{(min)}$	115 (65–165)	70 (45–95)	<0.001*1
Aortic cross clamp time $_{(min)}$	88.5 (50–130)	47.5 (28–70)	<0.001*1
Intra-aortic balloon pump use	3 (6%)	2 (4%)	0.6462
Use of inotropic drugs	46 (92%)	41 (82%)	0.1372
No. grafts			
One	0 (0%)	0 (0%)	0.2112
Two	12 (24%)	6 (12%)	
Three	31 (62%)	34 (68%)	
Four	7 (14%)	10 (20%)	

1Man Whitney U test.
2Chi square test.
*Statistically significant as *P<0.05*.
Abbreviations: CPB, cardiopulmonary bypass.

Table 4: Post-operative assessment (n=50)

	Group I (*n*=50)	Group II (*n*=50)	*P* value
Blood loss, $_{mL}$	350 (100–1350)	300 (100–1400)	0.1731
Re-explorations	2 (4%)	1 (2%)	1.002
Neurological complications	1 (2%)	1 (2%)	1.002
Renal complications	0 (0%)	1 (2%)	1.002
GIT complications	0 (0%)	0 (0%)	1.002
Respiratory complications	3 (6%)	1 (2%)	0.8722
Ventilation Time (hours)	10 (5–40)	8 (5–36)	0.009*1
Inotropic support	45 (90%)	39 (78%)	0.1022
Use of intra-aortic balloon pump	1 (2%)	0 (0%)	1.002
Arrhythmia	11 (11%)	7 (14%)	0.6722
MI	2 (4%)	3 (6%)	1.002
ICU stay(days)	5 (2–11)	3 (2–5)	<0.001*1
Mortality	2 (4%)	1 (2%)	0.8722
Total hospital stay (days)	9 (6–20)	8 (5–18)	<0.001*1

1Man Whitney U test.
2Chi square test.
*Statistically significant as *P<0.05*.
Abbreviations: ICU, intensive care unit; MI, myocardial infarction.

Table 5: One week after surgery assessment (n=50)

	Group I (*n*=50)	Group II (*n*=50)	*P* value
NYHA Classification			
I	13 (26%)	15 (30%)	0.425[1]
II	27 (54%)	26 (54%)	
III	10 (20%)	9 (18%)	
Pericardial effusion	0 (0%)	2 (4%)	0.109[1]
LVESD, $_{cm}$	5.1±0.55	4.9± 0.49	0.637[1]
LVEDD, $_{cm}$	5.9±0.51	5.7±0.46	0.608[1]
LVEF $_{(\%)}$	45.4±2.1	47.1±2.5	0.109[2]
SPAP $_{(mmHg)}$	25.6±5.2	26.2±6.4	0.597[1]
New SWMA	4 (8%)	7 (14%)	0.062[1]
Wound infection	3 (6%)	2 (4%)	1.00[1]

1Chi square test.
2Man Whitney U test.
*Statistically significant as *P<0.05*.
Abbreviations: LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; SWMA, segmental wall-motion abnormalities.

Table 6: Six months follow-up results (n=50)

	Group I (*n*=50) [n (%)]	Group II (*n*=50) [n (%)]	*P* value
NYHA Classification			
I	25 (50)	12 (24)	0.008*[,1]
II	15 (30)	20 (40)	
III	10 (20)	15 (30)	
IV	0	3 (6)	
LVESD, cm	4.8±0.43	4.7± 0.21	0.308[2]
LVEDD, cm	5.7±0.33	5.5± 0.19	0.148[2]
LVEF $_{(\%)}$	49.7±3.2	48.2±1.9	0.382[2]
LA, cm	3.95±0.34	4.0±0.8	0.208[2]
SPAP $_{(mmHg)}$	21.7±2.1	22.4±3.8	0.252[1]
Degree of MR			
No	35 (70)	5 (10)	<0.001*[2]
Trivial	5 (10)	18 (36)	
Mild	7 (14)	17 (34)	
Moderate	3 (6)	9 (18)	
Severe	0	1 (2)	

1Chi square test.
2Student t test.
*Statistically significant as *P<0.05*.
Abbreviations: LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; SWMA, segmental wall-motion abnormalities.

DISCUSSION

IMR is a consequence of coronary artery disease (CAD) that has normal chordal and leaflet anatomy. IMR is related to higher mortality and the chance of developing heart failure, independent of the therapy used. Approximately half of individuals after a myocardial infarction acquire IMR, and up to 17% have moderate or severe IMR[6].

The lack of evidence contributes to the debate about the best therapy for mild IMR. Proponents of the combined MV operation and CABG emphasize that 40% of patients continue to have moderate mitral regurgitation (MR) after standalone CABG and that persistent or worsening MR may lead to poor results[7].

It is unclear, however, if the reduced incidence of MR after the combination surgery has any clinical significance. Some studies revealed a functional

advantage from the simultaneous MV operation, whereas others reported no clinical or survival benefit from adding MV surgery to CABG[8].

Considering the lack of consensus on the optimal treatment method for moderate IMR, we conducted the present study. It aims to determine whether a concomitant MV surgery during CABG improves clinical outcomes in moderate IMR patients.

In this study, we comparatively-studied the course of un-repaired moderate mitral regurgitation after CABG alone, versus CABG with MV procedure, in order to assess the impact of un-repaired moderate ischemic mitral regurgitation on the immediate and early outcome of CAD patients undergoing standard CABG using CPB. This study population encompassed 100 CAD patients complicated by moderate IMR who underwent CABG with (group I, no 50) or without mitral valve repair (group II, no 50).

In the current study, Dobutamine Echo was applied to all patients in both groups. In group (B) degree of MR was improved from moderate to mild, while in group (A) only in 13 (26%) patients MR was improved by dobutamine to mild, and in 37 patients MR was moderate by dobutamine.

In our study, operative data analysis including CBP and aortic cross clamp time revealed a significant difference when comparing the two groups. Group I had a significantly longer duration of CBP and aortic class time than group II with statistically significant differences ($P<0.05$). Also, group I had a higher percentage of use of intraaortic balloon pump (three patients in group I and two patients in group II) and inotropic drugs than group II, but with statistically insignificant differences as *P* greater than 0.05.

This is in agreement with Sameer and others study in which group I (CABG+MVR) showed a mean pump time of 123±8 min, while it was 90.5±4.5 min in group II (CABG only)[9]. Furthermore, the aortic cross-clamp and cardiopulmonary bypass times were comparable with that reported in other studies[10,11].

In this study, among group I, the severity of NYHA classification distribution showed a statistically significant decrease (*P<0.001*). Mean LVESD and LVEDD showed a significant reduction, while the mean of LVEF showed a significant increase as the preoperative LVEF% of 44.89±3.20 stepped up to 45.4%±2.1 and 49±3.2% on discharge and after 6 months follow-up, respectively.

Also, the severity of MR significantly decreased (*P<0.001*). Among group II, the severity of NYHA classification distribution showed a statistically significant decrease. Also, the mean LVESD and LVEDD showed a significant reduction, while the mean of LVEF showed significant increase as the preoperative LVEF% of 45.92±2.61 stepped up to 47.1±2.2.5% and 48.2±1.9 on discharge and after 6 months follow-up, respectively. Also, the severity of MR significantly decreased. It is worth mentioning that the differences between the two groups showed no statistical significance in the immediate PO period, and significance after 6 months follow-up.

It is evident from the previous display of our study results, CABG alone did, to some extent, improve IMR over 6 months of follow-up. Although the overall postoperative clinical parameters demonstrated statistically significant values in both groups, CABG combined with mitral valve procedure achieved more improvement in the clinical follow-up parameters (EF %, MR echo-grade and mean NYHA class) when compared with preoperative patient condition.

In the same line with our study, Chan and others. found that the addition of MVR by annuloplasty to CABG reduced MR severity, LV volumes, and BNP levels, and these translated into an improvement in functional capacity and symptoms at 1 year. However, the addition of MVR to CABG required longer operation times, including time on cardiopulmonary bypass, increased blood transfusion, and intubation times, and resulted in a longer hospital stay. There was also a trend toward higher complication rates in the CABG plus MVR group, although the differences were not significant. The results support the addition of MVR to CABG in patients with moderate ischemic MR undergoing CABG, but the benefits of the combined procedure must be balanced against possible increased risk of morbidity in the perioperative period[12,13].

Finally, the principle finding of this study is that intervention on the mitral valve likely improved short-term survival benefits over CABG alone.

CONCLUSION & RECOMMENDATIONS

Our study concluded that there is good evidence to suggest that moderate mitral regurgitation in patients undergoing isolated CABG adversely NYHA functional class and mitral regurgitation does not reliably improve after CABG alone.

Accordingly, we recommend further studies to be carried out on a larger sample size to emphasize our conclusion. Also, the duplication of this study but with increasing the follow-up period. Finally we recommend carrying out survival analysis studies.

CONFLICT OF INTEREST

There are no conflicts of interest.

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