

Research Article

Effect on Left Ventricular Ejection Fraction After off Pump Coronary Artery Bypass Grafting of Triple Vessels Ischemic Heart Disease with Viable Myocardial Tissues

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Abstract

Background: Patients with triple-vessel ischemic heart disease and reduced left ventricular ejection fraction (LVEF) present a high-risk surgical population. Off-pump coronary artery bypass grafting (OPCAB) has been proposed as a safe revascularization strategy with potential for functional recovery. This study aimed to evaluate changes in LVEF and perioperative outcomes following OPCAB in patients stratified by baseline LVEF. **Methods:** This descriptive cross-sectional study was conducted in the Department of Cardiac Surgery, Bangladesh Medical University, Dhaka, from September 2024 to August 2025. A total of 120 patients with angiographically confirmed triple-vessel ischemic heart disease and viable myocardium assessed by Dobutamine stress echocardiography underwent OPCAB. Patients were divided into four groups according to baseline LVEF: Group A (20–30%), Group B (31–40%), Group C (41–50%) and Group D (>51%). LVEF was measured by transthoracic echocardiography preoperatively, on the 7th postoperative day, at 1 month and at 3 months. **Results:** The mean age of the study population was 55.8 ± 7.0 years, with males comprising 68%. Progressive improvement in LVEF was observed in all groups. Group A showed the largest relative gain ($25 \pm 3\%$ to $36 \pm 5\%$ at 3 months), with 83% achieving $\geq 5\%$ improvement and 50% achieving $\geq 10\%$. Overall, 64% of patients improved by $\geq 5\%$ and 28% by $\geq 10\%$. Perioperative mortality was low (0.8%), while postoperative myocardial infarction (3.3%), arrhythmias (11.7%), prolonged ICU stay (18.3%) and wound infection (3.3%) were observed, particularly among patients with lower baseline EF. **Conclusion:** OPCAB in patients with triple-vessel ischemic heart disease and viable myocardium is associated with significant improvement in LVEF, particularly in those with lower baseline EF and carries a low incidence of perioperative complications.

Keywords

Off-pump Coronary Artery Bypass Grafting, Left Ventricular Ejection Fraction, Ischemic Heart Disease, Myocardial Viability

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1. Introduction

Ischemic heart disease (IHD) remains a leading cause of morbidity and mortality worldwide, with triple-vessel coronary artery disease representing a severe subset associated with significant left ventricular dysfunction and poor long-term outcomes [1]. In patients with compromised myocardial function, timely revascularization is essential to improve survival, restore myocardial perfusion and prevent further adverse remodeling [2]. Coronary artery bypass grafting (CABG) is widely recognized as the standard of care for patients with multivessel coronary artery disease, particularly in those with left ventricular systolic dysfunction and viable myocardium [3].

Off-pump coronary artery bypass grafting (OPCAB) has emerged as an alternative to conventional on-pump surgery, avoiding cardiopulmonary bypass and minimizing the systemic inflammatory response [4]. This technique is associated with reduced perioperative morbidity, including lower rates of myocardial injury, arrhythmia and neurocognitive complications, while maintaining comparable long-term graft patency [5]. Preservation of left ventricular function is a key determinant of postoperative outcomes and assessing the impact of OPCAB on ejection fraction (EF) is critical in guiding clinical management and prognostication [6].

Myocardial viability refers to the presence of dysfunctional but salvageable myocardium in regions affected by chronic ischemia. Identifying viable myocardium before revascularization allows clinicians to predict functional recovery after CABG [7]. Several imaging modalities, including viable myocardium assessed by dobutamine stress echocardiography, single-photon emission computed tomography, and cardiac magnetic resonance imaging, are commonly employed to evaluate myocardial viability [8]. Patients with viable myocardium often demonstrate significant improvement in left ventricular ejection fraction and functional status following successful revascularization, highlighting the importance of preoperative assessment [9].

Although numerous studies have evaluated the benefits of CABG in multivessel disease, data specifically addressing the effect of off-pump surgery on left ventricular systolic function in patients with triple-vessel disease and viable myocardium remain limited [10, 11]. Understanding the degree and timing of left ventricular functional recovery after OPCAB is crucial for patient selection, perioperative planning and optimizing long-term outcomes [12]. Furthermore, stratification based on baseline EF may provide insights into which patient groups derive the greatest benefit from surgical intervention.

The present study aims to evaluate the impact of off-pump coronary artery bypass grafting on left ventricular ejection fraction in patients with triple-vessel ischemic heart disease

and viable myocardium.

2. Methodology & Materials

This descriptive cross-sectional study was conducted in the Department of Cardiac Surgery, Bangladesh Medical University, Dhaka, from September 2024 to August 2025. A total of 120 patients with angiographically confirmed triple-vessel ischemic heart disease and viable myocardium assessed by Dobutamine stress echocardiography underwent OPCAB. Patients were divided into four groups based on baseline left ventricular ejection fraction (LVEF): Group A (20–30%, n=30), Group B (31–40%, n=30), Group C (41–50%, n=30) and Group D (>51%, n=30). LVEF was measured by color Doppler transthoracic echocardiography at four time points: preoperative, 7th postoperative day, 1 month and 3 months.

Adult patients aged 18 years or older with angiographically confirmed triple-vessel coronary artery disease, documented myocardial viability and scheduled for elective off-pump coronary artery bypass grafting (OPCAB) were included in the study. Patients were excluded if they had experienced a recent acute myocardial infarction within the past seven days, required emergency surgery, or were undergoing concomitant valve or other major cardiac procedures. Those with severe non-cardiac comorbidities or a poor echocardiographic window preventing reliable assessment of left ventricular function were also excluded.

Baseline demographic data (age, gender) and clinical variables were recorded. LVEF changes over time were analyzed to assess surgical effectiveness. Continuous variables were expressed as mean $\pm$ SD and categorical variables as frequency and percentage. Paired t-tests or Wilcoxon signed-rank tests were used to compare pre- and post-operative LVEF within groups, while one-way ANOVA or Kruskal–Wallis tests were applied for between-group comparisons. Repeated measures analysis assessed LVEF trends over time. Odds ratios for clinically significant EF improvement ($\geq 5\%$) were calculated. All analyses were performed using SPSS version 25 and a p-value < 0.05 was considered statistically significant.

3. Results

Table 1 shows the demographic characteristics of patients by baseline LVEF group. The mean age of participants ranged from 54 ± 7 to 58 ± 8 years across groups, with an overall mean of 55.8 ± 7.0 years. Males predominated in all groups, accounting for 68% of the total study population, while females comprised 32%.

Table 1. Demographic Characteristics of Patients by LVEF Group (n = 120).

Characteristic	Group A (n=30)	Group B (n=30)	Group C (n=30)	Group D (n=30)	Total (n=120)
Age (years)					
Mean $\pm$ SD	58 $\pm$ 8	56 $\pm$ 7	55 $\pm$ 6	54 $\pm$ 7	55.8 $\pm$ 7.0
Gender					
Male, n (%)	22 (73%)	21 (70%)	20 (67%)	19 (63%)	82 (68%)
Female, n (%)	8 (27%)	9 (30%)	10 (33%)	11 (37%)	38 (32%)

Comparisons were made using ANOVA and Chi-square test where appropriate.

Table 2. LVEF Improvement After OPCAB.

Group	Baseline EF (%)	7th POD EF (%)	1 Month EF (%)	3 Month EF (%)	OR (Improvement $\geq$ 5%)
A	25 $\pm$ 3	30 $\pm$ 4	33 $\pm$ 5	36 $\pm$ 5	2.5
B	36 $\pm$ 3	40 $\pm$ 4	43 $\pm$ 4	46 $\pm$ 5	2
C	45 $\pm$ 3	48 $\pm$ 4	50 $\pm$ 4	52 $\pm$ 4	1.5
D	55 $\pm$ 3	57 $\pm$ 4	58 $\pm$ 4	60 $\pm$ 4	1.2

Note: OR = odds ratio of achieving $\geq$ 5% EF improvement at 3 months.

Comparisons of mean LVEF values over time were performed using Repeated Measures ANOVA.

Table 2 presents the changes in left ventricular ejection fraction (LVEF) following off-pump coronary artery bypass grafting (OPCAB) across the four baseline EF groups. All groups demonstrated progressive improvement in LVEF over time, from baseline to the 3rd postoperative month. Group A

(EF 20–30%) showed the greatest relative improvement, with mean LVEF increasing from 25 $\pm$ 3% preoperatively to 36 $\pm$ 5% at 3 months, corresponding to an odds ratio of 2.5 for achieving $\geq$ 5% improvement.

Table 3. Proportion of Patients with Clinically Significant EF Improvement.

Group	Patients with $\geq$ 5% Improvement	%	Patients with $\geq$ 10% Improvement	%
A	25	83	15	50
B	22	73	10	33
C	18	60	6	20
D	12	40	3	10
Total	77	64	34	28

Comparisons for categorical variables were performed using the Chi-square test.

Table 3 shows the proportion of patients achieving clinically significant improvement in left ventricular ejection fraction (LVEF) after OPCAB. Overall, 64% of patients (77/120) demonstrated an increase of $\geq$ 5%, while 28% (34/120) improved by $\geq$ 10%. The greatest improvement was

observed in Group A (EF 20–30%), where 83% of patients improved by $\geq$ 5% and 50% by $\geq$ 10%. The proportion of patients achieving significant improvement decreased progressively with higher baseline EF, with only 40% of Group D (EF >51%) improving $\geq$ 5% and 10% improving $\geq$ 10%.

Table 4. Perioperative Outcomes.

Outcome	Group A	Group B	Group C	Group D	Total
Mortality (n, %)	1 (3%)	0 (0%)	0 (0%)	0 (0%)	1 (0.8%)
Post-op MI (n, %)	2 (7%)	1 (3%)	1 (3%)	0 (0%)	4 (3.3%)
Arrhythmia (n, %)	5 (17%)	4 (13%)	3 (10%)	2 (7%)	14 (11.7%)
ICU Stay >3 days (n, %)	8 (27%)	6 (20%)	5 (17%)	3 (10%)	22 (18.3%)
Wound Infection (n, %)	2 (7%)	1 (3%)	1 (3%)	0 (0%)	4 (3.3%)

Comparisons for categorical perioperative outcomes were performed using the Chi-square test.

Table 4 summarizes the perioperative outcomes following off-pump coronary artery bypass grafting. Overall mortality was low (0.8%), with a single death occurring in Group A. Postoperative myocardial infarction occurred in 3.3% of patients, predominantly in Groups A and B. Arrhythmias were observed in 11.7% of patients, with higher incidence in those with lower baseline EF. Prolonged ICU stay (>3 days) was required in 18.3% of patients, again more common in patients with reduced preoperative EF. Wound infections were infrequent, occurring in 3.3% of the total population.

4. Discussion

This study evaluated the effect of off-pump coronary artery bypass grafting (OPCAB) on left ventricular ejection fraction (LVEF) in patients with triple-vessel ischemic heart disease and viable myocardium. Our results demonstrate significant improvement in LVEF following surgery, particularly among patients with lower baseline EF, with overall low perioperative morbidity and mortality.

The observation that patients with lower preoperative EF experienced greater relative improvement aligns with previous studies. Rajbhandari et al., reported that patients with impaired LV function achieved marked recovery of EF after CABG, with benefits most evident in those starting with severely depressed function [13]. Similarly, Inamdar et al., noted favorable outcomes of CABG in low-EF patients, emphasizing the role of revascularization in reversing ischemic dysfunction [14]. Our finding that 83% of patients in the lowest EF group achieved $\geq 5\%$ improvement further supports these results.

Myocardial viability is a critical determinant of recovery. Zhang et al., demonstrated that viability assessment using cardiac magnetic resonance could predict EF improvement after CABG [15]. In the present study, all patients had documented viable myocardium, which likely contributed to the favorable outcomes. Aasim et al., also highlighted the importance of viability, reporting improved survival and ventricular recovery in patients with viable myocardium undergoing CABG [16].

Comparisons with alternative revascularization strategies

are noteworthy. Shah et al., showed better survival with CABG compared to PCI in patients with EF <30%, underscoring the superiority of surgical revascularization in this high-risk group [17]. In our series, mortality was low (0.8%), suggesting that OPCAB provides safe and effective revascularization even in patients with advanced dysfunction.

The technique of revascularization also influences outcomes. Chikwe et al., demonstrated durable long-term results after OPCAB when performed by experienced surgeons [18]. Similarly, Rustenbach et al., found that off-pump CABG provided outcomes comparable to on-pump CABG in patients with heart failure and reduced EF [19]. Our findings mirror these observations, with perioperative complication rates remaining acceptable and most adverse events confined to patients with lower baseline EF.

Perioperative morbidity in our study, including arrhythmias (11.7%) and prolonged ICU stay (18.3%), was consistent with prior reports. Timorian et al., showed that techniques like coronary endarterectomy in CABG patients with diffuse disease could still yield EF improvement, though with slightly higher complication risks [20]. Our study similarly highlights that even higher-risk patients can benefit significantly when viability is preserved.

The choice between on-pump and off-pump remains debated. Xia et al., compared on-pump beating-heart CABG with OPCAB in severe LV dysfunction, showing comparable EF improvement but with reduced hemodynamic stress in the off-pump group [21]. Our results reinforce the safety of OPCAB in this population. Moreover, Salihi et al., confirmed CABG's effectiveness in improving EF among patients with LV dysfunction, supporting its use in this challenging subset [22].

Emerging adjunctive strategies may further optimize outcomes. Kawamura et al., demonstrated the potential role of stem cell therapies in ischemic cardiomyopathy, aiming to enhance myocardial recovery beyond surgical revascularization [23]. While not part of our protocol, such approaches may complement OPCAB in the future.

The present findings add to the body of evidence that complete revascularization in viable myocardium improves both ventricular function and survival. As Arjomandi Rad et

al., highlighted, viability assessment remains pivotal in guiding surgical decisions in ischemic cardiomyopathy [24]. Our study supports this principle, as significant EF recovery was achieved across groups, particularly in those starting with the most impaired function.

5. Limitations of the Study

This study was descriptive and single-centered with a relatively small sample size. Longer-term follow-up is needed to assess durability of EF improvement and survival outcomes. Furthermore, advanced imaging such as CMR viability testing was not uniformly applied, which could have provided deeper mechanistic insights.

6. Conclusion

OPCAB in patients with triple-vessel disease and viable myocardium is associated with significant improvement in LVEF and low perioperative morbidity and mortality. The greatest benefit was observed in patients with the lowest baseline EF, underscoring the importance of timely surgical revascularization in this high-risk group. These findings are consistent with international evidence and support OPCAB as a safe and effective strategy for patients with ischemic heart disease with viable myocardium.

Abbreviations

CABG	Coronary Artery Bypass Grafting
OPCAB	Off-Pump Coronary Artery Bypass Grafting
LVEF	Left Ventricular Ejection Fraction
IHD	Ischemic Heart Disease

Author Contributions

Md. Alauddin: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

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Conflicts of Interest

There are no conflicts of interest.

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