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ORIGINAL ARTICLE

Comparative Clinical Outcomes of Patients with Low and Preserved Left Ventricular Ejection Fraction Undergoing Off-Pump Coronary Artery Bypass Surgery – A Single-Center Study

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ABSTRACT

Background: *Left ventricular dysfunction is a major risk factor influencing outcomes after coronary artery bypass grafting (CABG). Off-pump CABG (OPCABG) has been proposed as a safer alternative for patients with reduced ejection fraction by avoiding cardiopulmonary bypass-related complications. This study aimed to compare intraoperative and early postoperative outcomes between patients with reduced and preserved left ventricular ejection fraction (LVEF).* ***Methods & Materials:*** *This comparative observational study was conducted in the Department of Cardiac surgery, United Hospital, Dhaka, Bangladesh, from July 2024 to December 2024. A total of 100 patients undergoing OPCABG were included: Group A (LVEF ≤35%, n=50) and Group B (LVEF >35%, n=50).* ***Results:*** *Patients with reduced LVEF were slightly older (61.8 ± 8.2 vs. 58.4 ± 7.9 years; p=0.041) and had more prior myocardial infarctions (64% vs. 44%; p=0.047). Group A received fewer grafts (2.7 ± 0.8 vs. 3.1 ± 0.7; p=0.008) and required longer operative time (220 ± 35 vs. 205 ± 30 min; p=0.03). The need for intra-aortic balloon pump (16% vs. 4%; p=0.046), prolonged inotropic support (42% vs. 20%; p=0.018), ICU stay (3.8 ± 1.6 vs. 2.9 ± 1.1 days; p=0.004), and hospital stay (9.2 ± 2.5 vs. 7.8 ± 2.0 days; p=0.006) were higher in Group A. LVEF improved significantly in both groups, with greater recovery in Group A (Δ% +8.4 ± 4.1 vs. +4.8 ± 3.9; p=0.002).* ***Conclusion:*** *OPCABG is safe and effective even in patients with severe left ventricular dysfunction, resulting in significant improvement in ventricular function and acceptable early morbidity and mortality rates.*

Keywords: *Off-pump coronary artery bypass grafting, left ventricular ejection fraction, myocardial dysfunction, cardiac surgery outcomes.*

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INTRODUCTION

Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide. Surgical revascularization through coronary artery bypass grafting (CABG) continues to be the mainstay of treatment for patients with multivessel disease or those unsuitable for percutaneous coronary intervention [1]. Over the past few decades, advances in surgical techniques have led to the development of off-pump coronary artery bypass grafting (OPCABG), which is performed on a beating heart without the use of cardiopulmonary bypass [2]. This technique aims to minimize the adverse effects of extracorporeal circulation, such as systemic inflammatory response, coagulation disturbances, and organ dysfunction, thereby improving postoperative recovery [3].

Left ventricular ejection fraction (LVEF) is a crucial prognostic indicator in patients undergoing CABG. It reflects the global systolic function of the heart and serves as an essential parameter in risk stratification and surgical decision-making [4]. Patients with reduced LVEF (≤35%) are often considered high-risk surgical candidates due to their compromised myocardial function and increased susceptibility to perioperative complications, including low cardiac output syndrome, arrhythmias, and postoperative mortality [5]. In contrast, patients with preserved LVEF (>35%) generally have better hemodynamic stability and favorable postoperative outcomes [6].

Despite these challenges, several studies have shown that OPCABG can be performed safely and effectively even in

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patients with poor ventricular function [7]. The technique offers potential benefits such as reduced myocardial injury, lower incidence of renal dysfunction, shorter ventilation time, and decreased intensive care unit (ICU) stay. However, the outcomes of OPCABG in patients with severely reduced LVEF compared to those with preserved function remain a topic of clinical interest and debate, particularly in developing countries where patient comorbidities and healthcare resources vary widely [8].

In Bangladesh, ischemic heart disease is a major contributor to cardiovascular morbidity and mortality, yet data comparing surgical outcomes across different levels of left ventricular function remain limited [9]. Understanding the impact of LVEF on perioperative and postoperative outcomes in OPCABG patients is essential for optimizing patient selection, preoperative preparation, and intraoperative management strategies [10].

Therefore, this study was designed to compare the clinical outcomes of patients with LVEF ≤35% and LVEF >35% undergoing off-pump coronary artery bypass grafting at a cardiac care center in Dhaka, Bangladesh. The objectives were to evaluate and compare perioperative parameters such as operative time, number of grafts, postoperative complications, duration of ICU and hospital stay, and early mortality between the two groups.

METHODS & MATERIALS

This comparative observational study was conducted in the Department of Cardiac surgery, United Hospital, Dhaka, Bangladesh, from July 2024 to December 2024. A total of 100 patients undergoing off-pump coronary artery bypass grafting (OPCABG) were enrolled and divided into two groups: Group A (n = 50) with left ventricular ejection fraction (LVEF) ≤ 35%, and Group B (n = 50) with LVEF > 35%.

Inclusion criteria included adult patients (aged 30–80 years) with ischemic heart disease undergoing elective OPCABG, having preoperative echocardiographic assessment of LVEF, and providing informed consent.

Exclusion criteria were patients undergoing on-pump CABG, emergency revascularization, concomitant valvular or congenital heart surgery, severe renal or hepatic dysfunction, or incomplete perioperative data.

Detailed clinical evaluation, demographic characteristics, and comorbid conditions such as diabetes mellitus, hypertension, and dyslipidemia were recorded. Preoperative, intraoperative, and postoperative parameters were assessed, including number of grafts, operative time, duration of mechanical ventilation, ICU stay, hospital stay, and early postoperative complications such as arrhythmia, low cardiac output syndrome, myocardial infarction, renal dysfunction, and mortality.

Echocardiography was performed preoperatively and one month after discharge to evaluate changes in LVEF. All data were collected using a predesigned structured form and analyzed with Statistical Package for Social Sciences (SPSS) version 25.0. Quantitative variables were expressed as mean ± standard deviation (SD) and compared using the independent samples t-test. Categorical variables were presented as frequency and percentage and analyzed using the Chi-square test or Fisher's exact test as appropriate. A p-value < 0.05 was considered statistically significant.

RESULTS

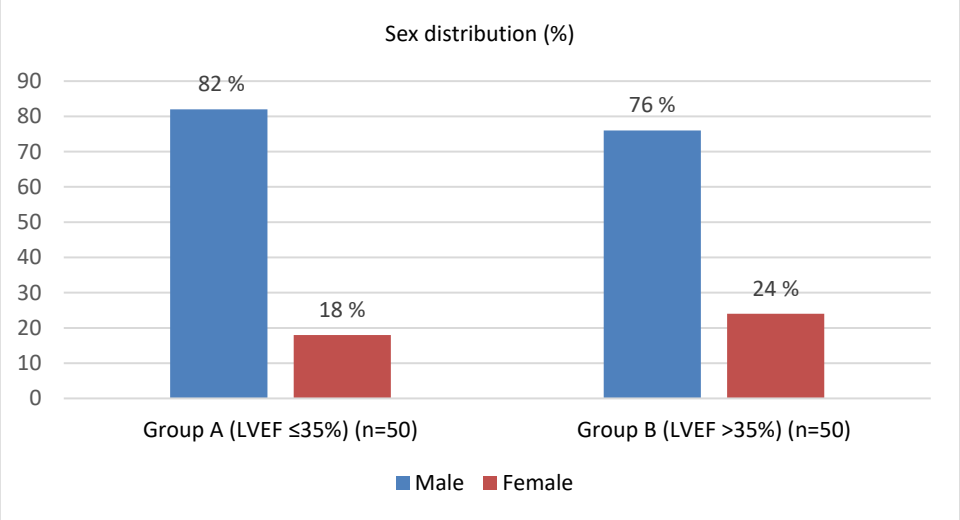

Figure – 1: Sex Distribution of our Study Participants (*n* = 100)

Figure - 1 illustrates the gender distribution among the study participants. Out of the total 100 patients undergoing off-pump coronary artery bypass grafting (OPCABG), a clear male predominance was observed in both groups. In the reduced LVEF group (Group A), 82% were male and 18% were female, while in the preserved LVEF group (Group B), 76% were male and 24% were female. Although males constituted the majority in both categories, the difference in gender distribution between the two groups was not statistically significant (p = 0.47).

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Table – I: Baseline Demographic and Clinical Characteristics (*n* = 100)

Variables	Group A (LVEF ≤35%) (n=50)		Group B (LVEF >35%) (n=50)		p-value
	n	%	n	%	
Mean age (years)	61.8 ± 8.2		58.4 ± 7.9		0.041
Diabetes mellitus	33	66	27	54	0.22
Hypertension	36	72	35	70	0.84
Dyslipidemia	29	58	31	62	0.68
Current smoker	18	36	14	28	0.39
Previous MI	32	64	22	44	0.047
Chronic kidney disease	7	14	3	6	0.19
BMI (kg/m^2)	25.6 ± 3.3		26.2 ± 3.1		0.38
Baseline LVEF (%)	31.0 ± 3.2		47.5 ± 6.4		<0.001

Table - I presents the baseline demographic and clinical characteristics of patients undergoing off-pump coronary artery bypass grafting (OPCABG), divided into two groups based on their preoperative left ventricular ejection fraction (LVEF). The mean age of patients in Group A (LVEF ≤35%) was slightly higher than in Group B (LVEF >35%) (61.8 ± 8.2 vs. 58.4 ± 7.9 years; p = 0.041). The prevalence of comorbidities such as diabetes mellitus, hypertension, and dyslipidemia was comparable between the two groups, with no statistically significant differences. A history of previous myocardial infarction was more frequent in the low LVEF group (64% vs. 44%; p = 0.047). Chronic kidney disease and smoking status were also slightly higher among patients with reduced LVEF, although not statistically significant. The mean body mass index (BMI) was similar in both groups. As expected, baseline LVEF differed significantly between the groups (31.0 ± 3.2% vs. 47.5 ± 6.4%; p < 0.001).

Table – II: Intraoperative Parameters

Variables	Group A (LVEF ≤35%)		Group B (LVEF >35%)		p-value
	n	%	n	%	
Number of grafts (mean ± SD)	2.7 ± 0.8		3.1 ± 0.7		0.008
Surgery duration (min)	220 ± 35		205 ± 30		0.03
Conversion to on-pump	3	6	1	2	0.31
Intraoperative hypotension	14	28	9	18	0.23
Use of IABP	8	16	2	4	0.046
Arrhythmia during surgery	6	12	5	10	0.75
Blood transfusion required	11	22	7	14	0.31

Table - II summarizes the intraoperative findings among patients in both study groups. The mean number of grafts was significantly lower in patients with reduced LVEF compared to those with preserved LVEF (2.7 ± 0.8 vs. 3.1 ± 0.7; p = 0.008), indicating a more conservative surgical approach in the low LVEF group. The average duration of surgery was longer in Group A (220 ± 35 min) than in Group B (205 ± 30 min; p = 0.03), possibly reflecting the technical challenges associated with poor ventricular function. Conversion to on-pump CABG was required in 6% of patients with LVEF ≤ 35% compared to 2% in those with LVEF > 35%, though this difference was not statistically significant (p = 0.31). Intraoperative hypotension and arrhythmias occurred more frequently in Group A (28% and 12%, respectively) than in Group B (18% and 10%), but without significant differences. Notably, intra-aortic balloon pump (IABP) support was used more often in the low LVEF group (16% vs. 4%; p = 0.046), reflecting the greater hemodynamic instability in these patients. The need for blood transfusion was also higher among Group A patients (22% vs. 14%), although not statistically significant.

Table – III: Postoperative Outcomes

Variables	Group A (LVEF ≤35%)		Group B (LVEF >35%)		p-value
	n	%	n	%	
Prolonged inotropic support >24 h	21	42	10	20	0.018
Ventilation >12 h	17	34	9	18	0.08
Re-exploration for bleeding	3	6	2	4	0.65
New-onset atrial fibrillation	9	18	6	12	0.42
Renal dysfunction	7	14	3	6	0.19
Post-op myocardial infarction	5	10	2	4	0.23
Stroke	2	4	1	2	0.56
Sternal wound infection	4	8	3	6	0.69
ICU stay (days)	3.8 ± 1.6		2.9 ± 1.1		0.004
Hospital stay (days)	9.2 ± 2.5		7.8 ± 2.0		0.006

Table III illustrates the comparison of postoperative outcomes between patients with reduced (LVEF ≤35%) and preserved (LVEF >35%) left ventricular function. The requirement for prolonged inotropic support beyond 24 hours was significantly higher in Group A than in Group B (42% vs. 20%; p = 0.018), indicating greater postoperative hemodynamic instability among patients with impaired ventricular function. Similarly, prolonged mechanical ventilation (>12 hours) was more frequent in Group A (34% vs. 18%), though the difference did not reach statistical significance (p = 0.08). Re-exploration for bleeding, new-onset atrial fibrillation, renal dysfunction, postoperative myocardial infarction, stroke, and sternal wound infection occurred slightly more often in the low LVEF group, but these differences were not statistically significant.

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Importantly, patients with reduced LVEF had significantly longer intensive care unit (ICU) stays (3.8 ± 1.6 vs. 2.9 ± 1.1 days; p = 0.004) and total hospital stays (9.2 ± 2.5 vs. 7.8 ± 2.0 days; p = 0.006).

Table – IV: Early Outcomes and Functional Recovery (30 Days)

Variables	Group A (LVEF ≤35%)		Group B (LVEF >35%)		p-value
	n	%	n	%	
30-day mortality	3	6	1	2	0.31
MACCE (composite)	6	12	3	6	0.3
Readmission < 30 days	5	10	2	4	0.25
LVEF at 30 days (%)	39.4 ± 5.1		52.3 ± 5.7		<0.001
Change in LVEF (Δ%)	+8.4 ± 4.1		+4.8 ± 3.9		0.002
Overall satisfactory recovery	42	84	47	94	0.13

Table IV presents the early postoperative outcomes and functional recovery of patients in both study groups. The 30-day mortality was higher in patients with reduced LVEF (6% vs. 2%), though the difference was not statistically significant (p = 0.31). Similarly, the incidence of major adverse cardiac and cerebrovascular events (MACCE) and readmissions within 30 days were slightly higher in Group A (12% vs. 6% and 10% vs. 4%, respectively), without significant differences. Assessment of left ventricular function revealed significant improvements in both groups. The mean LVEF at 30 days, increased to 39.4 ± 5.1% and 52.3 ± 5.7%, respectively (p < 0.001). The mean change in LVEF (Δ%) was significantly higher in patients with reduced baseline LVEF (+8.4 ± 4.1% vs. +4.8 ± 3.9%; p = 0.002), reflecting notable functional recovery. Overall, a higher proportion of patients in Group B achieved satisfactory recovery at 30 days (94% vs. 84%), though this difference did not reach statistical significance (p = 0.13).

DISCUSSION

This prospective comparative study evaluated the clinical outcomes of patients undergoing off-pump coronary artery bypass grafting (OPCABG) with differing preoperative left ventricular ejection fractions (LVEF ≤35% vs. LVEF >35%). The findings demonstrate that although patients with reduced LVEF required more intraoperative support and experienced longer ICU and hospital stays, they showed significant postoperative improvement in LVEF and comparable early mortality and morbidity outcomes to those with preserved ventricular function. These results support the safety and efficacy of OPCABG in patients with compromised ventricular performance.

In our study, patients with LVEF ≤35% were slightly older (mean 61.8 years) and had a higher incidence of previous myocardial infarction (64%) compared to those with LVEF >35% (44%). This aligns with the findings of Xia et al., who observed that patients with severe LV dysfunction undergoing OPCABG were typically older and had higher rates of ischemic cardiomyopathy [11]. The baseline characteristics reflect a common clinical scenario where progressive ischemic damage results in ventricular remodeling and reduced contractile reserve.

Intraoperatively, patients with low LVEF received fewer grafts (2.7 ± 0.8 vs. 3.1 ± 0.7; p = 0.008) and required more intra-aortic balloon pump (IABP) support (16% vs. 4%; p = 0.046). These findings are comparable to Marin-Cuartas et al., who reported that while OPCABG in severe LV dysfunction often necessitated more hemodynamic assistance, the technique minimized the inflammatory and ischemic burden associated with cardiopulmonary bypass [12]. Similarly, He et al., in a meta-analysis found that off-pump surgery significantly reduced myocardial injury, transfusion needs, and inflammatory complications compared to the on-pump approach [13].

The longer operative duration in our low LVEF group (220 ± 35 min vs. 205 ± 30 min; p = 0.03) reflects the technical challenges in maintaining hemodynamic stability in these patients. Comparable results were reported by Sikder et al., in Bangladeshi patients, where off-pump procedures for left main coronary artery disease required longer operative time but offered stable hemodynamic control and reduced postoperative complications [14].

Postoperatively, prolonged inotropic support was more common in Group A (42% vs. 20%; p = 0.018), consistent with Velioglu and Isik, who observed greater inotrope use among patients with poor preoperative ventricular function after OPCABG [15]. However, despite the increased need for support, our patients demonstrated significant improvement in mean LVEF from 31.0% to 39.4% at 30 days (p < 0.001), similar to the findings of Cao et al., who showed that myocardial revascularization leads to favorable ventricular remodeling and recovery of contractility in heart failure patients [16].

The mean ICU stay (3.8 vs. 2.9 days) and hospital stay (9.2 vs. 7.8 days) were longer in patients with reduced LVEF, findings echoed by Abdo et al., who reported that although OPCABG patients with LV dysfunction required extended postoperative care, overall morbidity remained low [17]. Similarly, Taggart et al., in the Arterial Revascularization Trial found no long-term survival disadvantage for OPCABG patients, reinforcing that off-pump procedures provide durable outcomes even in high-risk groups [18].

The 30-day mortality in our study was 6% in the low LVEF group versus 2% in the preserved group, without statistical significance. These results are in line with Zhou et al., who reported similar early mortality between off-pump and on-pump CABG in ischemic cardiomyopathy, suggesting that OPCABG mitigates the perioperative risks typically associated with cardiopulmonary bypass in patients with poor ventricular function [19]. Likewise, Ikeda et al., found that OPCABG in LV dysfunction yielded satisfactory long-term survival and functional improvement, emphasizing its safety profile [20].

Our study also observed a greater mean improvement in LVEF (+8.4% vs. +4.8%; p = 0.002*) among patients with lower baseline ejection fraction, consistent with the functional recovery trends reported by Rao et al., and Matsuhashi et al., who demonstrated that early revascularization restores myocardial perfusion and augments ventricular performance even in depressed LV function [21, 22].

Overall, our findings support the growing body of evidence that OPCABG is a safe and effective revascularization strategy for patients with reduced LVEF. It avoids the deleterious effects of cardiopulmonary bypass, reduces systemic inflammation, and allows faster myocardial recovery, as corroborated by Sun et al., and Kirmani et al [23, 24].

Limitations of the study

This study was limited by its single-center design and relatively small sample size, which may restrict the generalizability of the findings. Larger multicenter studies with longer follow-up periods are needed to validate these results and better assess long-term outcomes in patients undergoing OPCABG with varying degrees of left ventricular dysfunction.

Conclusion

In conclusion, the present study confirms that off-pump CABG provides satisfactory early clinical outcomes even in patients with significant LV dysfunction. While these patients require more intensive perioperative management and longer recovery times, they achieve substantial improvement in cardiac function and comparable short-term survival to those with preserved LVEF. These findings reinforce OPCABG as a valuable surgical option for high-risk patients with impaired ventricular performance, in agreement with global and regional evidence.

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Conflicts of interest

There are no conflicts of interest.

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