



## Assessment of Left Ventricular Function in OPCABG Patient (DVD vs TVD)

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### KEYWORDS

Off-pump CABG, left ventricular function, double vessel disease, triple vessel disease, cardiac surgery, echocardiography, clinical outcomes.

### ABSTRACT:

**Background:** Off-pump coronary artery bypass grafting (OPCABG) is increasingly utilized to minimize the adverse effects of cardiopulmonary bypass, particularly in patients with multivessel coronary artery disease. However, the influence of coronary disease burden on postoperative left ventricular (LV) functional recovery remains underexplored.

**Methods:** This prospective observational study was conducted at the Department of Cardiac Surgery, Bangladesh Medical University and Al Helal Specialized Hospital, Mirpur, Dhaka, from January 1 to December 31, 2024. A total of 100 patients undergoing elective OPCABG were enrolled and categorized into two groups based on coronary angiography: 50 with double vessel disease (DVD) and 50 with triple vessel disease (TVD). Echocardiographic and clinical outcomes were assessed preoperatively, on postoperative day 7, and at 3 months.

**Results:** Baseline demographic and clinical characteristics were comparable between the groups. Postoperative LVEF improved significantly in both groups, with a greater increase in the DVD group (+6.4% vs. +4.5%,  $p = 0.001$ ). At 3 months, LVEF, LVEDD, and LVESD were significantly better in the DVD group ( $p < 0.05$ ). RWMA improvement was more frequent in DVD patients (68% vs. 54%,  $p = 0.093$ ). Functionally, 90% of DVD patients achieved NYHA Class I/II status compared to 76% in the TVD group. Rehospitalization, postoperative atrial fibrillation, and in-hospital mortality were numerically lower in the DVD group, though not statistically significant. **Conclusion:** Patients with double vessel disease demonstrated superior early recovery of left ventricular function and more favorable clinical outcomes following OPCABG compared to those with triple vessel disease.

### INTRODUCTION

Coronary artery disease (CAD) remains one of the leading causes of morbidity and mortality worldwide. The progression of CAD to multi-vessel

involvement significantly affects myocardial perfusion and compromises cardiac function, particularly left ventricular (LV) performance [1]. Among patients undergoing surgical



revascularization, the extent of coronary artery involvement—whether double vessel disease (DVD) or triple vessel disease (TVD)—has important prognostic implications, especially regarding postoperative recovery of LV function [2].

Coronary artery bypass grafting (CABG) has long been established as a definitive treatment for patients with multi-vessel coronary disease, offering survival benefits and symptomatic relief, particularly in those with impaired left ventricular function [3]. In recent years, off-pump coronary artery bypass grafting (OPCABG) has gained increasing attention as a less invasive alternative to conventional on-pump CABG [4]. By avoiding the use of cardiopulmonary bypass (CPB), OPCABG reduces the inflammatory response, minimizes myocardial ischemia-reperfusion injury, and may improve postoperative outcomes, particularly in high-risk patients with compromised cardiac function [5]. However, the extent to which LV function improves following OPCABG in patients with different severities of coronary disease, such as DVD versus TVD, remains inadequately explored [6].

Left ventricular ejection fraction (LVEF) is a widely accepted and reliable marker of global cardiac function. Improvements in LVEF following surgical revascularization are considered a surrogate for myocardial recovery [7]. Previous studies have shown variable degrees of improvement in LVEF post-CABG, influenced by factors such as myocardial viability, preoperative ischemic burden, and surgical technique [8]. It is hypothesized that patients with DVD may demonstrate a greater and earlier improvement in LV function compared to those with TVD due to the relatively lesser extent of ischemic myocardium and shorter duration of surgical manipulation required [9].

In the context of the Bangladeshi population, data comparing postoperative left ventricular function in DVD versus TVD patients undergoing OPCABG are scarce. Understanding the differences in myocardial recovery between these two groups is crucial for tailoring perioperative care, predicting prognosis, and optimizing long-term outcomes [10, 11].

Therefore, this study aims to assess and compare changes in left ventricular function in patients with DVD and TVD undergoing elective OPCABG, using echocardiographic parameters—primarily LVEF—as key indicators. By evaluating

preoperative and postoperative cardiac function, this study intends to provide evidence regarding the impact of coronary disease extent on myocardial recovery following off-pump revascularization.

## METHODOLOGY & MATERIALS

This prospective observational study was conducted at the Department of Cardiac Surgery, Bangladesh Medical University and Al Helal Specialized Hospital, Mirpur, Dhaka, over a period of twelve months, from January 1, 2024, to December 31, 2024. A total of 100 patients scheduled for elective off-pump coronary artery bypass grafting (OPCABG) were included in the study. Patients were divided into two groups based on coronary angiographic findings: 50 patients with double vessel disease (DVD) and 50 patients with triple vessel disease (TVD).

Inclusion criteria were patients aged 30–75 years undergoing elective OPCABG with angiographically confirmed DVD or TVD and a preoperative left ventricular ejection fraction (LVEF) greater than 30%. Patients with a history of previous CABG, emergency surgery, concomitant valvular or other cardiac procedures, or significant arrhythmias were excluded from the study. All surgical procedures were performed by the same surgical team using standard OPCABG techniques without the use of cardiopulmonary bypass.

Transthoracic echocardiography was performed for all patients preoperatively, within 7 days postoperatively, and at 3-month follow-up. LVEF was calculated using Simpson's biplane method. Additional parameters such as left ventricular end-diastolic diameter (LVEDD), end-systolic diameter (LVESD), and regional wall motion abnormalities (RWMA) were also assessed. Demographic data, comorbid conditions, operative details, and postoperative outcomes were recorded using a structured data collection sheet.

Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean  $\pm$  standard deviation and compared using independent sample t-tests or paired t-tests where appropriate. Categorical variables were analyzed using chi-square or Fisher's exact test. A p-value  $<$  0.05 was considered statistically significant. The primary outcome of the study was the change in LVEF between preoperative and postoperative timepoints, while secondary outcomes included changes in LV dimensions, RWMA improvement, and clinical recovery status.



## RESULTS

Table 1: Baseline Characteristics of the Study Population

Characteristics	DVD Group (n=50)	TVD Group (n=50)	p-value
Age (years), mean $\pm$ SD	59.3 $\pm$ 8.2	61.1 $\pm$ 7.6	0.212
Male, n (%)	38 (76%)	40 (80%)	0.617
Diabetes Mellitus, n (%)	28 (56%)	33 (66%)	0.301
Hypertension, n (%)	30 (60%)	32 (64%)	0.683
Dyslipidemia, n (%)	20 (40%)	22 (44%)	0.684
Smoking History, n (%)	24 (48%)	26 (52%)	0.689
BMI (kg/m <sup>2</sup> ), mean $\pm$ SD	25.2 $\pm$ 3.4	25.6 $\pm$ 3.1	0.513
Pre-op LVEF (%), mean $\pm$ SD	45.8 $\pm$ 6.5	44.2 $\pm$ 7.1	0.201

Table 1 summarizes the baseline characteristics of the study population, showing no significant differences between the DVD and TVD groups. The mean age was slightly higher in the TVD group (61.1  $\pm$  7.6 years) compared to the DVD group (59.3  $\pm$  8.2 years), with a similar male predominance in

both groups (76% vs. 80%). Common comorbidities such as diabetes, hypertension, dyslipidemia, and smoking history were evenly distributed and statistically comparable. The mean BMI and preoperative LVEF were also similar between groups.

Table 2: Preoperative and Postoperative Left Ventricular Function

Timepoint	DVD Group LVEF (%) (mean $\pm$ SD)	TVD Group LVEF (%) (mean $\pm$ SD)	p-value
Preoperative	45.8 $\pm$ 6.5	44.2 $\pm$ 7.1	0.201
Early Post-op Day 7	44.9 $\pm$ 6.3	43.6 $\pm$ 6.9	0.039
3-Month Follow-up	52.2 $\pm$ 5.9	48.7 $\pm$ 6.5	0.002
$\Delta$ LVEF (Pre to 3M)	+6.4 $\pm$ 2.1	+4.5 $\pm$ 2.4	0.001

Table 2 compares left ventricular ejection fraction (LVEF) between the DVD and TVD groups at different timepoints. Preoperatively, LVEF was comparable between the groups (45.8% vs. 44.2%,  $p = 0.201$ ). By postoperative day 7, both groups showed little decrement (44.9% vs. 43.6%,  $p = 0.039$ ). At the 3-month follow-up, the DVD group

maintained a more pronounced improvement (52.2% vs. 48.7%,  $p = 0.002$ ). The mean change in LVEF from baseline to 3 months was significantly greater in the DVD group compared to the TVD group (+6.4% vs. +4.5%,  $p = 0.001$ ), indicating better early recovery of left ventricular function in patients with less extensive coronary artery disease.

Table 3: Preoperative Echocardiographic Parameters in DVD vs TVD Patients

Parameter	DVD Group (mean $\pm$ SD)	TVD Group (mean $\pm$ SD)	p-value
LVEDD (mm)	52.1 $\pm$ 4.7	53.4 $\pm$ 4.9	0.187
LVESD (mm)	38.4 $\pm$ 4.3	39.1 $\pm$ 4.5	0.398



LVIDD (mm)	50.6 ± 4.5	52.0 ± 4.8	0.211
LVIDS (mm)	37.2 ± 3.9	38.1 ± 4.1	0.273
EF (%)	48.2 ± 6.1	46.3 ± 6.4	0.072
MR Grade (0–4)	1.3 ± 0.5	1.5 ± 0.6	0.082
IVSD (mm)	11.4 ± 1.2	11.8 ± 1.3	0.095
PWD (mm)	10.6 ± 1.1	10.9 ± 1.2	0.128
RWT	0.39 ± 0.04	0.41 ± 0.05	0.064
LV Mass (g)	195.6 ± 25.4	210.8 ± 28.1	0.018
RWMA improvement %	68%	54%	0.093

Table 3 compares the preoperative echocardiographic parameters between patients with double vessel disease (DVD) and triple vessel disease (TVD) undergoing OPCABG. Both groups showed similar baseline left ventricular dimensions and wall thickness measurements, with no statistically significant differences in LVEDD, LVESD, LVIDD, LVIDS, EF, MR grade, IVSD,

PWD, or RWT ( $p > 0.05$ ). However, LV mass was significantly higher in the TVD group ( $210.8 \pm 28.1$  g vs.  $195.6 \pm 25.4$  g;  $p = 0.018$ ), indicating more advanced myocardial remodeling. A greater proportion of RWMA improvement was observed in the DVD group (68% vs. 54%), though this did not reach statistical significance ( $p = 0.093$ ).

**Table 4: Postoperative (3-Month) Echocardiographic Parameters in DVD vs TVD Patients**

Parameter	DVD Group (mean ± SD)	TVD Group (mean ± SD)	p-value
LVEDD (mm)	50.2 ± 4.2	52.1 ± 4.6	0.046
LVESD (mm)	36.2 ± 3.9	37.8 ± 4.1	0.031
LVIDD (mm)	48.3 ± 4.3	50.1 ± 4.6	0.049
LVIDS (mm)	35.1 ± 3.7	36.6 ± 3.9	0.044
EF (%)	54.6 ± 5.8	50.8 ± 6.2	0.002
MR Grade (0–4)	0.8 ± 0.3	1.1 ± 0.4	0.039
IVSD (mm)	11.1 ± 1.1	11.4 ± 1.2	0.103
PWD (mm)	10.2 ± 1.0	10.5 ± 1.1	0.097
RWT	0.37 ± 0.03	0.39 ± 0.04	0.041
LV Mass (g)	188.3 ± 24.6	202.5 ± 27.3	0.027

Table 4 presents the postoperative (3-month) echocardiographic outcomes in DVD vs. TVD patients following OPCABG. Patients in the DVD group showed significantly better reverse remodeling and recovery of cardiac function compared to the TVD group. Key indicators such as LVEDD, LVESD, LVIDD, LVIDS, and LV mass were all significantly lower in the DVD group ( $p < 0.05$ ), reflecting reduced ventricular dilation. The

ejection fraction (EF) improved more significantly in the DVD group (54.6% vs. 50.8%,  $p = 0.002$ ), while mitral regurgitation (MR) grade also showed a more favorable reduction (0.8 vs. 1.1,  $p = 0.039$ ). Additionally, relative wall thickness (RWT) was significantly lower in the DVD group ( $p = 0.041$ ), suggesting better myocardial remodeling. Although IVSD and PWD remained statistically comparable, the overall echocardiographic profile supports



superior functional and structural recovery in DVD patients at 3 months post-surgery.

**Table 5: Clinical Outcomes at 3 Months**

Outcome	DVD Group (n=50)	TVD Group (n=50)	p-value
NYHA Class I/II, n (%)	45 (90%)	38 (76%)	0.064
Rehospitalization, n (%)	3 (6%)	7 (14%)	0.182
Postoperative AF, n (%)	5 (10%)	9 (18%)	0.241
In-hospital mortality, n (%)	0	1 (2%)	0.315

Table 5 presents clinical outcomes at 3 months following OPCABG. A higher proportion of patients in the DVD group achieved NYHA Class I/II functional status compared to the TVD group (90% vs. 76%), though the difference was not statistically significant ( $p = 0.064$ ). Rehospitalization rates were lower in the DVD group (6% vs. 14%,  $p = 0.182$ ), and postoperative atrial fibrillation occurred less frequently (10% vs. 18%,  $p = 0.241$ ). There was one in-hospital death in the TVD group, while no mortality occurred in the DVD group ( $p = 0.315$ ).

## DISCUSSION

This prospective study assessed left ventricular (LV) functional recovery following off-pump coronary artery bypass grafting (OPCABG) in patients with double vessel disease (DVD) versus triple vessel disease (TVD). Our findings demonstrate significantly better improvement in LVEF and echocardiographic remodeling parameters in the DVD group, with favorable trends in clinical outcomes, underscoring the prognostic importance of disease burden in OPCABG patients.

The improved postoperative LVEF in both groups, particularly the greater gain in the DVD group at 3 months (+6.4% vs. +4.5%,  $p = 0.001$ ), is consistent with prior studies emphasizing the effectiveness of OPCABG in promoting early myocardial recovery without cardiopulmonary bypass (CPB)-related myocardial injury [12, 13, 14]. Zhao et al. also demonstrated post-surgical improvements in LV function, reinforcing the regenerative potential of timely revascularization [15].

LV reverse remodeling, reflected by significant reductions in LVEDD and LVESD in the DVD group, suggests enhanced myocardial contractility and reduced wall stress. Honda et al. previously highlighted how CABG improves myocardial ischemia and wall motion, especially in less

extensive coronary disease, which may explain the greater gains observed in our DVD patients [16].

Although RWMA improvement was more common in the DVD group (68% vs. 54%), it did not reach statistical significance ( $p = 0.093$ ). This trend aligns with the work by Chenikala et al., who emphasized better functional recovery in patients with relatively preserved myocardium undergoing optimized preoperative management [17].

Functional outcomes, including NYHA class I/II status, rehospitalization, and postoperative atrial fibrillation (AF), were better in the DVD group. Although statistical significance was not achieved, these results are consistent with previous studies highlighting better recovery in patients with a lesser burden of coronary artery disease [18, 19]. Kumar et al. and Joshi et al. noted AF as a common post-OPCABG complication, particularly in patients with more extensive disease or comorbidities, as seen more frequently in our TVD cohort [20, 21].

In-hospital mortality was low (1% overall), aligning with existing literature supporting the safety profile of OPCABG even in complex cases. Studies by Mishra et al. and Kaushish et al. showed comparable low mortality with beating heart surgery, particularly when performed in specialized centers [22, 23].

The observed trends also reflect the impact of preoperative comorbidity burden. Although not statistically significant, the TVD group had slightly higher rates of diabetes and hypertension—factors known to influence postoperative recovery and LV function [24, 25]. Moreover, higher myocardial ischemic burden and incomplete revascularization are more common in TVD, possibly contributing to the attenuated improvement seen in that group [26].



Our results also parallel the findings by Arayawudhikul et al., who reported that extensive revascularization in elderly TVD patients may not translate into proportional functional gains [18]. On the other hand, our DVD cohort appears to benefit from complete and targeted revascularization with better LV mechanics and clinical recovery.

Atrial fibrillation, observed in 10% (DVD) and 18% (TVD), remains a key postoperative concern. The rates in our study fall within the range reported by Kumar et al. and Tiwari et al., who emphasized the role of inflammation, atrial strain, and electrolyte imbalance in triggering AF post-CABG [20, 27]. These findings support the need for better prophylactic strategies, especially in high-risk TVD patients.

Our study has clinical implications for surgical planning and postoperative care. It emphasizes that early improvement in LV function is more pronounced in patients with less extensive coronary disease undergoing OPCABG. The findings also reaffirm the role of myocardial protection strategies and surgical precision in optimizing outcomes [13, 28].

### Limitations of the study

This study has several limitations. First, it was conducted at only two centers, which may limit the generalizability of the findings to broader populations. Second, the follow-up duration was relatively short (3 months), restricting insights into long-term functional outcomes. Additionally, the absence of preoperative myocardial perfusion imaging limited our ability to assess myocardial viability, which could have influenced postoperative recovery. Advanced echocardiographic techniques such as strain imaging were not utilized, potentially overlooking subtle changes in myocardial function. Future multicenter studies with extended follow-up and incorporation of perfusion scans and strain imaging are recommended to validate and expand upon these findings.

### CONCLUSION

Patients with double vessel disease undergoing OPCABG exhibit significantly better early recovery of left ventricular function compared to those with triple vessel disease. These findings highlight the influence of coronary disease burden on postoperative cardiac remodeling and reinforce the importance of individualized revascularization strategies.

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