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Outcome of Severe Left Ventricle Systolic Dysfunction Patients After Coronary Artery Bypass Grafting

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ABSTRACT

Coronary artery bypass grafting (CABG) has historically been regarded as a high-risk intervention. **Objective:** To evaluate the short-term outcomes of severe left ventricular (LV) systolic dysfunction in patients after CABG. **Methods:** This prospective observational cohort study was done at the Department of Cardiac Surgery, Pervaiz Elahi Institute of Cardiology, Bahawalpur, Pakistan, from August 2022 to September 2024. Patients aged 30–75 years, with confirmed coronary artery disease requiring CABG and ejection fraction (EF) ≤30%, were analyzed. Preoperative variables included demographic information, comorbidities, cardiac function parameters and angiographic findings. Postoperative complications and 90-day mortality were noted. **Results:** In a total of 78 patients, 53 (68%) were male.The mean age was 55.2 ± 9.3 years. The mean baseline EF was 25.4 ± 4.6%.The mean bypass and cross-clamp times were 90.3±16.8 minutes and 51.4 ± 11.6 minutes, respectively.The most common post-surgery complications were arrhythmias, neurological disorders, wound infection, and acute kidney injury, noted in 12 (15.4%), 6 (7.7%), 5 (6.4%), and 3 (3.8%) patients, respectively. At 90 days postoperatively, mortality was reported in 6 (8.7%) patients. Predictors of 90-day mortality included preoperative EF <25% (OR=3.2, 95% CI:1.2–8.5, p=0.014), age ≥65 years (OR=2.8, 95% CI:1.1–7.0, p=0.021), and left main disease (OR=3.6, 95% CI:1.4–9.1, p=0.008). **Conclusions:** In terms of short-term outcomes, CABG in patients with severe LV systolic dysfunction is associated with significant improvements in functional status and EF. Key predictors of mortality included preoperative EF <25%, advanced age (≥65 years), and left main disease, highlighting the need for careful preoperative risk stratification.

INTRODUCTION

Coronary artery disease (CAD) is known to be an important cause of morbidity and mortality worldwide [1]. Ischemic heart disease (IHD) is estimated to affect around 126 million people globally, with a significant proportion experiencing left ventricular (LV) systolic dysfunction (LVSD) [2]. In 2022, it was estimated that there were 315 million CAD cases globally [3]. CAD prevalence is anticipated to be increasing with advanced disease due to delayed access to care in Pakistan [4]. A recent study estimated the prevalence of CAD among adults aged 30-75 years as 34.9%, which seems very high [5]. It has been noticed that around 30% of cases who undergo coronary artery bypass grafting (CABG) have LV dysfunction (LVD), yet their outcomes remain poorly characterized [6]. CABG is a good revascularization strategy in CAD, exhibiting good efficacy in terms of improvement in survival and symptoms, particularly in multi-vessel disease [7, 8]. The outcomes of CABG in patients with severe LVSD remain less clear, especially in resource-limited settings like Pakistan. CABG has historically been nominated as a high-risk intervention for patients with severe LVD (ejection fraction ≤30%) due to the heightened risk of perioperative complications, including arrhythmias, low cardiac output syndrome, and mortality [9, 10]. Despite these risks, data from high-income countries have demonstrated that CABG can offer significant survival and symptomatic benefits if patients are carefully selected [11]. Evidence from trials such as the STICH trial further reinforced the role of surgical revascularization in improving outcomes for these patients [12]. However, in developing countries, barriers such as

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delayed diagnosis, limited access to advanced diagnostic tools (e.g., viability imaging), and lack of surgical expertise in managing complex cases complicate the application of these findings. Contemporary local data has shown a mortality rate of 5% with CABG, while severe LVD is significantly associated with ICU stay and post-operative complications in these patients [13]. This study aims to bridge the gap in evidence and provide insights into the short-term outcomes of CABG in this high-risk cohort, which may inform future policy and clinical decision-making.

This study aims to evaluate the short-term outcomes (post-operative complications, NYHA classification improvement, ejection fraction, and mortality) of severe LVSD in patients after CABG.

METHODS

This prospective observational cohort study was conducted at the Department of Cardiac Surgery, Pervaiz Elahi Institute of Cardiology, Quaid-e-Azam Medical College, Bahawalpur, Pakistan, from August 2022 to September 2024. Ethical approval was obtained from the institutional review board (letter number: 43/IERB/QAMC Bahawalpur). Considering the prevalence of CAD as 9.5% [14], with a 95% confidence level and 8% margin of error, the sample size was calculated to be 68. With the expected loss of follow-up, an additional 15% sample was added, so the final calculated sample size was 78. Non-probability, consecutive sampling technique was adopted. Inclusion criteria were patients of either gender, aged 30–75 years, with confirmed CAD requiring CABG. Patients with concomitant valve surgery, significant congenital or structural heart disease, recent myocardial infarction (<4 weeks), or malignancy were excluded. Severe LVD was defined as an ejection fraction (EF) ≤ 30% [15], assessed via transthoracic echocardiography. Informed consent was obtained from all participants. Preoperative variables included documentation of demographic information, comorbidities, cardiac function parameters, and angiographic findings. Intraoperative data included the surgical technique (on-pump vs. off-pump), cardiopulmonary bypass (CPB), and cross-clamp (IACC) times, number and type of grafts used, and the use of an intra-aortic balloon pump IABP. Postoperative data encompassed complications such as arrhythmias, stroke, acute kidney injury, wound infections, and re-exploration for bleeding. Short-term outcomes were evaluated at 90 days postoperatively. The primary outcomes were all-cause mortality, improvement in functional status (New York Heart Association (NYHA) class), and readmission rates. Secondary outcomes included postoperative complications, and changes in EF. A special proforma was designed to record study data. Data were analyzed using IBM-SPSS Statistics, version 26.0. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. An independent t-test was applied to compare continuous variables, and chi-square or Fisher's exact tests were used for categorical variables. Multivariable logistic regression analysis was performed to identify independent predictors of mortality by estimating odds ratios (ORs) with 95% confidence intervals (CIs) and corresponding p-values. A p-value of <0.05 was considered statistically significant.

RESULTS

In a total of 78 patients, 53 (68%) were male. The mean age was 55.2 ± 9.3 years, while 40 (51.3%) patients were aged 45–64 years. The mean BMI was 27.4 ± 3.6 kg/m2. Common comorbidities included hypertension 61 (78.2%), and diabetes mellitus 51 (65.4%). The mean baseline ejection fraction was 25.4 ± 4.6%. Angiographic findings revealed triple-vessel disease in 65 (83.3%) and left main coronary artery disease in 20 (25.6%) patients.Myocardial viability was confirmed in 72 (92.3%) cases.The baseline characteristics of patients are shown in Table 1.

Table 1: Baseline Characteristics (n=78)

Characteristics		Frequency (%)
Gender	Male	53
	Female	25
Age (Years)	18-44	12 (15.4%)
	45-64	40 (51.3%)
	≥65	26 (33.3%)
Body Mass Index (kg/m^2)	Below 18.5	5 (6.4%)
	18.5 to 24.9	18 (23.1%)
	25.0 to 29.9	35 (44.9%)
	Equal Or Above 30	20 (25.6%)
Comorbidities	Diabetes Mellitus	51 (65.4%)
	Hypertension	61 (78.2%)
	Chronic Kidney Disease	14 (18.0%)
NYHA Class	II	12 (15.4%)
	III	44 (56.4%)
	IV	22 (28.2%)
Angiographic Findings	Triple-Vessel Disease	65 (83.3%)
	Left Main Disease	20 (25.6%)
	Viable Myocardium	72 (92.3%)

On-pump CABG was performed in 66 (84.6%) patients. The mean CPB and cross-clamp times were 90.3 ± 16.8 minutes and 51.4±11.6 minutes, respectively.The mean number of grafts per patient was 3.1 ± 0.8. The IABP was used in 13 (16.7%) patients.No mortality was reported intra-operatively.The most common post-surgery complications were arrhythmias, neurological disorders, wound infection, and acute kidney injury, noted in 12 (15.4%), 6 (7.7%), 5 (6.4%), and 3 (3.8%) patients, respectively. Re-exploration for bleeding was performed in 3 (3.8%) patients. Readmission was reported in 10 patients

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during the 90-day post-surgery evaluation period. The most common reasons for readmission were heart failure exacerbation 4 (40.0%), surgical wound infections 3 (30.0%), arrhythmias 2 (20.0%), and pneumonia 1 (10.0%). At 90 days postoperatively, 69 patients completed follow-up. Mortality was reported in 6 (8.7%) patients. Among survivors, 52 (75.4%) showed improvement in NYHA functional class ($p<0.001$). The detailed comparison of the NYHA classification baseline and after 90 days' post-surgery is shown in Figure 1.

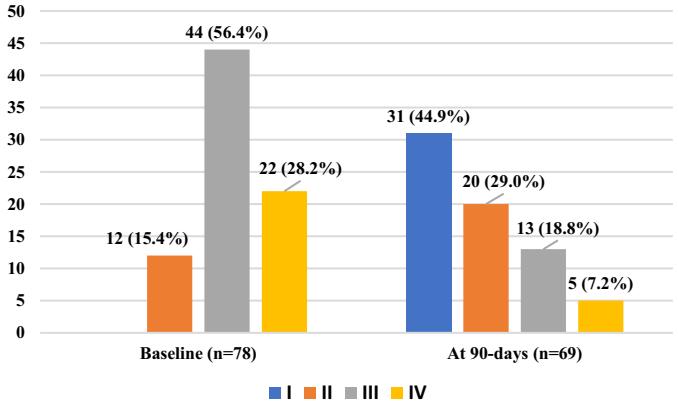

Figure 1: Comparison of Baseline and Post-Surgery 90 Days NYHA Classification

A significant improvement in EF was observed, increasing from a baseline mean of 25.4 ± 4.6% to 35.7 ± 5.2% at 90 days ($p<0.001$), as shown in Figure 2.

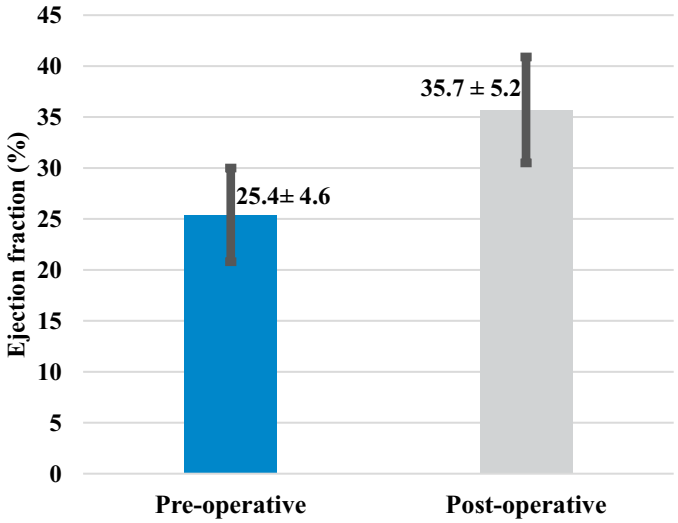

Figure 2: Comparison of Baseline and Post-Operative 90 Days Ejection Fraction (%)

Predictors of 90-day mortality included preoperative EF <25% (OR 3.2, 95% CI: 1.2–8.5, $p=0.014$), age ≥65 years (OR 2.8, 95% CI: 1.1–7.0, $p=0.021$), and left main disease (OR 3.6, 95% CI: 1.4–9.1, $p=0.008$), as shown in Table 2.

Table 2: Multivariable Logistic Regression for Predictors of Mortality at 90 Days

Predictors	Odds ratio (95% CI)	p-Value
Pre-Operative Ejection Fraction <25%	3.2 (1.2-8.5)	0.014
Age ≥65 Years	2.8 (1.1-7.0)	0.021
Left Main Disease	3.6 (1.4-9.1)	0.008

DISCUSSION

The findings of this study indicated that CABG significantly improved functional status, as demonstrated by improvements in NYHA classification and EF at 90 days postoperatively.Hillis *et al.*, demonstrated that patients with EF ≤ 35% undergoing CABG achieved significant survival benefits and functional improvement, with a 3-year survival rate of 81% [16]. Koene *et al.*, found that patients with low preoperative EF (<50%) experienced significant postoperative EF improvement after CABG, with greater gains observed in those with lower baseline EF [17].Current findings align with the published literature, demonstrating substantial EF recovery in a population with severe LVD, reaffirming the physiological benefits of revascularization.While the overall trends in EF improvement and functional recovery after CABG in this study are comparable to international data, the relatively higher complication rates in this study are noteworthy. These rates were a bit higher than those reported in studies from high-resource settings, such as Koene *et al.*, where complication rates were significantly lower [17].This disparity may reflect differences in perioperative care, infection control practices, and patient comorbidity burden.The readmission rate of 14.5% within 90 days, primarily due to heart failure exacerbation and wound infections, underscores the need for improved postoperative management.Despite functional improvements, the observed mortality rate of 8.7% within 90 days highlights the high-risk nature of this population. The observed 90-day mortality rate (8.7%) was higher than rates reported in some high-resource settings, where mortality is often below 5% [18, 19].This study's population had a high prevalence of diabetes mellitus (65.4%) and hypertension (78.2%), which are known contributors to worse surgical outcomes [20].Resource constraints in South Punjab, such as limited access to advanced diagnostic imaging and perioperative care, may have influenced outcomes.Studies by Yang *et al.* and Sun *et al.* highlighted the role of adjunct procedures like surgical ventricular reconstruction (SVR) and advanced imaging in improving CABG outcomes, but these were not feasible in our setting [21, 22]. Preoperative EF < 25%, age ≥65 years, and left main disease were significant predictors of 90-day mortality in our cohort.Nardi *et al.*, identified reduced preoperative EF and advanced age as independent predictors of perioperative and long-term mortality [23].

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Left main disease, associated with a higher ischemic burden and hemodynamic instability, has also been consistently linked to poorer outcomes in prior studies [24, 25].The findings of this study also align with findings from the STICH trial, which underscored the importance of myocardial viability assessment in predicting CABG success [12].However, in our cohort, viability was assessed using basic imaging rather than advanced modalities like cardiac MRI, potentially impacting patient selection and risk stratification.The identification of key predictors of mortality, including preoperative EF <25%, advanced age, and left main disease, underscores the need for rigorous preoperative risk stratification.This can guide surgical decision-making and patient counseling, ensuring appropriate resource allocation for high-risk cases. Patients with borderline EF or significant comorbidities may benefit from adjunct therapies, such as preoperative optimization with mechanical circulatory support or intraoperative strategies to minimize ischemic burden [26].The high rates of postoperative complications observed in this study emphasize the importance of strengthening perioperative care protocols.Targeted interventions, such as enhanced infection control measures, standardized perioperative anticoagulation protocols, and improved post-extubation care, could help mitigate these complications.Early detection and management of arrhythmias, along with structured cardiac rehabilitation programs, may further reduce morbidity and readmissions.Investment in staff training, perioperative hemodynamic monitoring, and postoperative critical care resources could also improve outcomes in resource-limited settings.These findings suggest a need for multidisciplinary collaboration, involving cardiologists, surgeons, and intensivists, to optimize outcomes for these patients [27].These findings suggest a need for multidisciplinary collaboration, involving cardiologists, surgeons, and intensivists, to optimize outcomes for these patients.By focusing on a high-risk population in South Punjab, Pakistan, the present findings address a critical gap in the literature and provide evidence to guide clinical practice in similar settings.This study highlights the potential for significant functional recovery and survival benefits, even in resource-constrained environments, when CABG is performed with careful patient selection and perioperative care.

CONCLUSIONS

It was concluded that in terms of short-term outcomes, CABG in patients with severe LVSD is associated with significant improvements in functional status and EF. Key predictors of mortality included preoperative EF <25%, advanced age (≥65 years), and left main disease, highlighting the need for careful preoperative risk stratification. These findings emphasize the importance of optimizing perioperative management strategies to improve short-term outcomes in this high-risk population. While complications and readmissions remain a challenge in resource-limited settings, the observed benefits highlight the value of CABG as a viable treatment option for this high-risk population.

Authors Contribution

Conceptualization: MM[1], HA
Methodology: MM1, HA, MM[2]
Formal analysis: HA, MM[2]
Writing review and editing: Mm[2]

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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