

ASSESSMENT OF LEFT VENTRICULAR FUNCTION AFTER CORONARY ARTERY BYPASS GRAFTING

HASHMI KA¹, BASHIR M², KHATTAK MSK¹, JAVAID MAA³, QURESHI AE⁴, KABIR HA^{5*}

¹Department of Cardiology, Nishtar Medical University Multan, Pakistan

²Department of Cardiology, DG Khan Medical College, Pakistan

³Statistical Analyst, Bahauddin Zakariya University (BZU) Multan, Pakistan

⁴Department of Cardiology, Rehmatul-lil-Alameen Institute of Cardiology, PESSI, Lahore, Pakistan

⁵Department of Cardiology, Ch. Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, Pakistan

*Corresponding author's email address: drkash226@gmail.com

(Received, 27th January 2024, Revised 25th April 2024, Published 9th May 2024)

Abstract: Coronary artery bypass grafting (CABG) is a commonly performed surgical intervention for coronary artery disease (CAD), aiming to restore blood flow to the myocardium and improve cardiac function. Left ventricular (LV) systolic function is a crucial determinant of postoperative outcomes in CABG patients, yet the predictors of adverse outcomes remain incompletely understood. **Objective:** This study aimed to evaluate left ventricular function outcomes following CABG and identify predictors of mortality among CABG patients. **Methods:** A prospective cohort study was conducted at, Ch. Pervaiz Elahi Institute Of Cardiology (CPEIC), Multan, Pakistan, from December 2022 to December 2023. The study included 96 patients undergoing CABG surgery. Preoperative data collection encompassed demographic information, medical history, and baseline clinical characteristics. Left ventricular function was assessed using echocardiography preoperatively and postoperatively. Statistical analysis involved descriptive statistics, univariate analysis, and univariate regression. **Results:** The study cohort comprised 96 participants, with a mean age of 56.1 years (± 12.2) and a male predominance (67.7%). Prevalent comorbidities included diabetes mellitus (78.1%) and hypertension (79.2%). LV systolic dysfunction (30.2%) and old ischemic heart disease (72.9%) were common preexisting conditions. Intraoperative variables included perioperative inotropes (5.2%) and emergent surgeries (3.1%). Postoperative complications included reoperation for bleeding (5.2%) and deterioration of LV ejection fraction (34.4%). The mortality rate was 5.2%. Postoperatively, the mean LVEF increased significantly from 32.00% (± 5.219) to 37.00% (± 9.801) in isolated CABG patients. **Conclusion:** This study confirms the significant improvement in LV systolic function following CABG and underscores the high benefit of CABG in patients with reduced EF. However, diabetes mellitus, advanced diastolic dysfunction, and the insertion of IABP were identified as significant predictors of adverse outcomes. Identifying patients with these risk predictors could provide complementary prognostic information and help optimise care, monitoring, and follow-up to improve their expected poor outcomes.

Keywords: Coronary Artery Bypass, Left Ventricular Function, Mortality, Diabetes Mellitus, Intra-Aortic Balloon Pump

Introduction

Coronary artery bypass grafting (CABG) is a widely utilised surgical procedure aimed at restoring blood flow to the myocardium in patients with obstructive coronary artery disease (CAD) (1). In this procedure, conduits are used to bypass blocked or narrowed coronary arteries, thereby alleviating myocardial ischemia and improving cardiac function. (2). An integral aspect of assessing the efficacy and prognosis of CABG is the evaluation of left ventricular function, which plays a crucial role in determining postoperative outcomes and overall cardiac health. (3). Left ventricular function refers to the ability of the left ventricle to contract and pump blood effectively to meet the metabolic demands of the body. (4). It is commonly assessed using ejection fraction (EF) and diastolic function. EF represents the percentage of blood ejected from the left ventricle during each contraction, serving as a measure of systolic function and myocardial contractility (5). Diastolic function, on the other hand, pertains to the relaxation and filling of the left ventricle during diastole, influencing ventricular compliance and filling pressures (6).

Numerous international studies have investigated the impact of left ventricular function on outcomes following CABG. Research by Marazzato J et al. (2021) demonstrated a clear association between preoperative EF and long-term survival post-CABG, with lower EF correlating with increased mortality rates (7). Similarly, investigations by Anantha et al. (2020) highlighted the significance of diastolic dysfunction as an independent predictor of adverse cardiac events following CABG, emphasizing the importance of comprehensive left ventricular assessment in preoperative risk stratification (8).

In Pakistan, where CAD is increasingly prevalent, the demand for CABG procedures continues to rise. According to data from Head SJ. et al. (2018), CAD accounts for a significant proportion of cardiovascular morbidity and mortality in the country, with CABG being a primary treatment modality for advanced coronary artery disease (9). Moreover, epidemiological reports from institutions such as the Pakistan National Heart Association (PANA) underscore the high prevalence of risk factors for CAD, including diabetes mellitus, hypertension, and obesity,

[Citation: Hashmi, K.A., Bashir, M., Khattak, M.S.K., Javaid, M.A.A., Qureshi, A.E., Kabir, H.A. (2024). Assessment of left ventricular function after coronary artery bypass grafting. *Biol. Clin. Sci. Res. J.*, 2024: 809. doi: <https://doi.org/10.54112/bcsrj.v2024i1.809>]

which may impact left ventricular function and surgical outcomes in CABG patients (10).

Given the critical role of left ventricular function in predicting post-CABG outcomes and the scarcity of comprehensive data in the Pakistani context, there is a compelling rationale to investigate the assessment of left ventricular function and its impact on surgical outcomes in CABG patients within the local population (11). Understanding the nuances of left ventricular function in this setting can guide clinicians in risk stratification, perioperative management, and tailored interventions to optimise patient outcomes.

The primary objective of this study is to evaluate the preoperative and postoperative left ventricular function in patients undergoing CABG and to identify the predictors that adversely lead to poor postoperative outcomes.

By addressing these objectives, we aim to enhance our understanding of left ventricular function dynamics following CABG and its implications for patient care and outcomes in the Pakistani population.

Our study has important implications for healthcare policy and clinical practice in Pakistan. Our findings can help inform risk stratification strategies, improve preoperative optimization protocols, and enhance postoperative care pathways for CABG patients nationwide. Additionally, our study can serve as a basis for targeted interventions aimed at reducing the burden of CAD and improving surgical outcomes in Pakistan.

Methodology

This study adopts a prospective cohort study design to evaluate the outcomes of left ventricular function subsequent to coronary artery bypass grafting (CABG) in patients diagnosed with coronary artery disease (CAD). Conducted at the, Ch. Pervaiz Elahi Institute Of Cardiology (CPEIC), Multan, Pakistan, the study spanned from December 2022 to December 2023.

The sample size for this investigation was estimated at 96 participants. Calculated based on the anticipated effect size, significance level, and study power, this sample size ensures adequate statistical power to detect clinically significant differences in left ventricular function outcomes post-CABG.

Inclusion criteria encompassed patients diagnosed with coronary artery disease, with a left ventricular ejection fraction (LVEF) below 45%, scheduled for elective coronary artery bypass grafting (CABG), aged 18 years or older, and capable of providing informed consent.

Exclusion criteria involved patients with normal LVEF, severe pulmonary hypertension, cardiogenic shock, atrial fibrillation, combined CABG with other valve interventions, and those lacking postoperative echocardiography follow-up. Additionally, patients with very low EF (<20%) were excluded due to unsuitability for surgery as determined by the multidisciplinary team.

Data collection procedures involved gathering preoperative data including demographic details, medical and medication history, and baseline clinical characteristics. Preoperative assessment of left ventricular function was conducted via

echocardiography, evaluating parameters such as ejection fraction (EF) and diastolic function indices.

Postoperatively, left ventricular function was reevaluated at specified intervals using echocardiography, immediately post-op, on postoperative day 1, and postoperative day 7, to assess changes in EF and diastolic function following CABG. These changes served as indicators of the procedure's effectiveness.

The primary outcome of the study was the alteration in left ventricular ejection fraction (EF) from baseline to postoperative follow-up, with secondary outcomes including predictors of poor outcomes within the study population. Descriptive statistics were employed to summarize baseline characteristics and outcomes. Continuous variables were presented as mean \pm standard deviation or median (interquartile range), while categorical variables were expressed as frequencies and percentages. Paired t-tests were utilized to compare preoperative and postoperative left ventricular function, while univariate regression analysis was performed to identify predictors of postoperative left ventricular dysfunction and adverse outcomes. Statistical significance was set at $p < 0.05$, with all analyses conducted using statistical software such as SPSS.

Results

A total of 96 participants were included in this study. Table 1 presents the demographic characteristics and clinical parameters of the study cohort undergoing coronary artery bypass grafting (CABG). The mean age of the participants was 56.1 years, with a standard deviation of 12.2 years, indicating a relatively older population undergoing this cardiac surgical procedure. The majority of the cohort was male, comprising 67.7% of the sample, reflecting a higher prevalence of coronary artery disease and CABG in men compared to women. Diabetes mellitus and hypertension were prevalent comorbidities, affecting 78.1% and 79.2% of the participants, respectively, highlighting the association between these metabolic conditions and cardiovascular disease.

Furthermore, the table delineates various cardiac parameters and intraoperative variables relevant to CABG. Notably, a significant proportion of patients presented with preexisting cardiovascular conditions such as old ischemic heart disease (72.9%) and left ventricular (LV) systolic dysfunction (30.2%), underscoring the complexity of cases requiring surgical intervention. Intraoperative measures such as the use of perioperative inotropes (5.2%) and emergent surgeries (3.1%) reflect the acuity and severity of some cases. Postoperative complications, including reoperation for bleeding (5.2%) and deterioration of LV ejection fraction (34.4%), demonstrate the challenges associated with CABG and the need for vigilant postoperative care. Despite advancements in surgical techniques and perioperative management, mortality remained a concern, with a mortality rate of 5.2% observed in this cohort, emphasizing the importance of risk stratification and optimization strategies in CABG patients.

Figure 1 shows the comparison of left ventricular ejection fraction (LVEF) before and after coronary artery bypass

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grafting (CABG) surgery in isolated CABG patients. The preoperative LVEF for isolated CABG patients was 32.00% on average, with a standard deviation of 5.219%, indicating the baseline left ventricular function before surgery. Postoperatively, there was a notable improvement in LVEF, with the mean value increasing to 37.00% and a standard deviation of 9.801%. This increase in postoperative LVEF suggests a positive response to CABG surgery, with the left ventricular function showing improvement following the procedure.

This p-value of < 0.05 suggests that there is a statistically significant difference in LVEF before and after CABG surgery in this subset of patients. The findings underscore the beneficial impact of CABG on left ventricular function in isolated CABG patients, supporting its role as an effective treatment option for improving cardiac function in individuals with coronary artery disease

Table 1: Demographic and clinical characteristics of study population

Variable	Number	Percentage
Age (Mean ±Standard Deviation)	56.1	±12.2
BMI (Mean ± Standard Deviation)	27.8	±5.9
Male	65	67.7
Diabetes Mellitus	75	78.1
Hypertension	76	79.2
Obesity	44	45.8
Chronic Kidney Disease	16	16.7
Old Ischemic Heart Disease	70	72.9
STEMI presentation	14	14.6
NEHA II/III	69	71.9
Standard Euro SCORE	6	(4–8)
LV significant systolic dysfunction	29	30.2
Dilated RV dimension	7	7.3
Dilated LV diameter	12	12.5
Advanced LV diastolic dysfunction	39	40.6
Left Main Disease	12	12.5
Significant Mitral Regurgitation	25	26
Preoperative RV dysfunction	9	9.4
Perioperative inotropes	5	5.2
Emergent surgery	3	3.1
Perioperative IABP (Intra-Aortic Balloon Pump)	18	18.8
Cross clamp time (Mean ± Standard Deviation)	91.09	±37.5
Bypass time (Mean ± Standard Deviation)	139.41	±71.103
Complication		
Reoperation for bleeding	5	5.2
Postoperative further deterioration of LVEF	33	34.4
Postoperative wound infection	18	18.8
Postoperative AKI (Acute Kidney Injury)	4	4.2

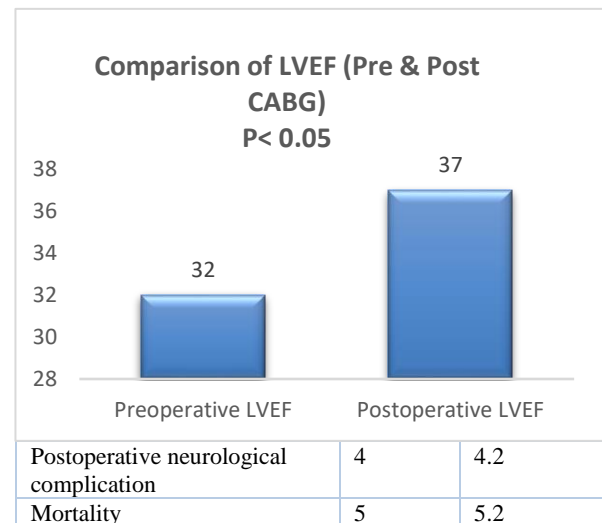


Table 2 presents the univariate analysis results for mortality predictors among the study cohort undergoing coronary artery bypass grafting (CABG).

Figure 1: Comparison of LVEF before and after the CABG

Firstly, diastolic dysfunction II/III, identified in 4.2% of the patients, demonstrated a statistically significant association with mortality, with a univariate p-value of 0.006.

Secondly, diabetes mellitus (DM) was present in 3.1% of the study cohort and exhibited a significant association with mortality, as indicated by a univariate p-value of 0.001.

Lastly, the use of intra-aortic balloon pump (IABP) was noted in 3.1% of the patients and also showed a statistically significant association with mortality, with a univariate p-value of 0.02.

This suggests that patients with DM, IABP and more severe diastolic dysfunction were likely to experience mortality following CABG surgery

Table 2: Univariate analysis for the predictor of mortality

Variable	Mortality	Univariate p-value
Diastolic dysfunction II/III	4 (4.2%)	0.006
DM	3 (3.1%)	0.001
IABP	3 (3.1%)	0.02

Discussion

In our study, we investigated the demographic and clinical characteristics of a cohort of 96 patients undergoing coronary artery bypass grafting (CABG), along with evaluating left ventricular function outcomes and identifying predictors of mortality. The mean age of our study participants was 56.1 years, and the majority were male, consistent with previous studies indicating a higher prevalence of coronary artery disease and CABG in men. Notably, comorbidities such as diabetes mellitus (78.1%) and hypertension (79.2%) were prevalent in our cohort,

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reflecting the association between metabolic conditions and cardiovascular disease, which is consistent with existing literature (12, 13).

Among the cardiac parameters assessed, a significant proportion of patients presented with preexisting cardiovascular conditions, including old ischemic heart disease (72.9%) and left ventricular (LV) systolic dysfunction (30.2%). These findings underscore the complexity of cases undergoing CABG surgery and the challenges associated with managing patients with advanced cardiovascular disease. Additionally, intraoperative measures such as the use of perioperative inotropes (5.2%) and emergent surgeries (3.1%) highlight the acuity and severity of some cases, which is consistent with the literature on CABG outcomes (Agha et al., 2018). Our study also evaluated postoperative complications, including reoperation for bleeding (5.2%) and deterioration of LV ejection fraction (34.4%), demonstrating the challenges associated with CABG and the need for vigilant postoperative care. Furthermore, mortality remained a concern, with a mortality rate of 5.2% observed in our cohort, emphasizing the importance of risk stratification and optimization strategies in CABG patients, which aligns with previous research findings (14).

In terms of left ventricular function outcomes, our study revealed a significant improvement in LVEF following CABG surgery, with isolated CABG patients experiencing a mean increase from 32.00% to 37.00%. This improvement in LVEF supports the efficacy of CABG in enhancing cardiac function and myocardial perfusion, consistent with the findings of previous studies (14, 15).

Our findings are consistent with previous studies that have demonstrated the beneficial impact of CABG on left ventricular function and overall outcomes in patients with coronary artery disease. Research by Bianco et al. (2020) and Howlett JG et al. (2019) has shown similar improvements in LVEF following CABG surgery, underscoring the robustness of our results (16, 17).

Furthermore, our analysis identified specific predictors of mortality, including diastolic dysfunction II/III, diabetes mellitus (DM), and the use of intra-aortic balloon pump (IABP). The increased mortality risk associated with IABP use highlights the need for careful consideration and judicious patient selection when opting for this intervention during CABG. While IABP can provide temporary circulatory support in high-risk patients, clinicians must weigh the potential benefits against the inherent risks and complications associated with its use. Moreover, proactive measures to mitigate these risks, such as vigilant monitoring for complications and prompt intervention in case of adverse events, are imperative to optimize patient outcomes and minimize mortality in CABG patients requiring IABP support. These findings are consistent with existing literature highlighting the prognostic significance of these variables in CABG patients (18, 19).

Overall, our study contributes to the growing body of evidence on CABG outcomes and provides valuable insights into risk stratification and management strategies for improving outcomes in this patient population.

However, several limitations should be acknowledged. Firstly, the single-center nature of the study may limit the

generalizability of our findings to other settings. Additionally, the relatively small sample size may have limited the statistical power to detect smaller effects and associations. Furthermore, the exclusion of certain patient subgroups, such as those with severe pulmonary hypertension or cardiogenic shock, may have introduced selection bias into the study population.

Conclusion

The study results have demonstrated that coronary artery bypass grafting (CABG) can lead to a significant enhancement in the left ventricular (LV) systolic function, which makes it highly beneficial for patients with reduced ejection fraction (EF). However, the study also highlights that patients with diabetes mellitus, high-grade diastolic dysfunction, and insertion of intra-aortic balloon pump (IABP) are at a higher risk of negative outcomes. By identifying these risk factors, medical professionals can provide complementary prognostic information and optimize patient care, monitoring, and follow-up to enhance their outcomes. Further research in other tertiary centers is required to provide multicenter results and generalize the conclusions to the larger population.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate.

Approved by the department concerned. (2022-06-12-CHPIC/005)

Consent for publication.

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

KASHIF ALI HASHMI (Professor)

Coordination of collaborative efforts. Study Design, Review of Literature. Conception of Study, Development of Research Methodology Design, Review of manuscript, and Final approval of manuscript.

MAJID BASHIR (Assistant Professor)

Conception of Study, Final approval of manuscript. Manuscript revisions, critical input.

MUHAMMAD SHEHZAD KHAN KHATTAK (PG)

Manuscript drafting, drafting article.

MUHAMMAD SHEHZAD KHAN KHATTAK (PG)

Coordination of collaborative efforts.

MIAN ADNAN ASLAM JAVAID (Research Scholar)

Data entry and Data analysis, Study Design

AZMAT EHSAN QURESHI (Associate Professor)

[Citation: Hashmi, K.A., Bashir, M., Khattak, M.S.K., Javaid, M.A.A., Qureshi, A.E., Kabir, H.A. (2024). Assessment of left ventricular function after coronary artery bypass grafting. *Biol. Clin. Sci. Res. J.*, 2024: 809. doi: <https://doi.org/10.54112/bcsrj.v2024i1.809>]

Manuscript revisions, critical input. Coordination of collaborative efforts

HAFIZ ABDUL KABIR (Assistant Professor)

Coordination of collaborative efforts. Study Design, Review of Literature. Conception of Study, Development of Research Methodology Design, Review of manuscript, and Final approval of manuscript.

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