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SURGICAL OUTCOMES IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING: ASSOCIATIONS WITH CARDIAC FUNCTION AND POSTOPERATIVE RECOVERY

Dr Muntaha[*1], Dr Fiza[2], Dr Sehar Fatima[3], Mohsin Hassan Alvi[4]

[*1,2,3]*Muhammad Medical College, Affiliated With LUMHS*
[4]*Universiti Sains Malaysia, Malaysia*

[*1]muntahaqasim17@gmail.com, [2]fizanihal14@gmail.com, [3]seharliskani28@gmail.com,
[4]mohsin.h.alvi@usm.my

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Corresponding Author: *
Dr Muntaha

Abstract

Coronary artery bypass grafting (CABG) is an important surgical intervention for patients with coronary artery disease, particularly those experiencing impaired cardiac function. This study aimed to evaluate surgical outcomes among patients undergoing CABG and determine the associations between cardiac function and postoperative recovery. A prospective observational study was conducted at a selected tertiary-care hospital in Pakistan from March to August 2026. A total of 150 patients undergoing CABG were recruited using consecutive sampling. Data were collected from medical records, perioperative observations, echocardiographic assessments, and postoperative follow-up. Cardiac function was evaluated using left ventricular ejection fraction (LVEF) and other relevant echocardiographic parameters, while postoperative recovery was assessed through intensive care unit (ICU) stay, hospital stay, postoperative complications, functional recovery, and overall clinical progress. Data were analyzed using descriptive statistics, paired comparisons, correlation analysis, and appropriate statistical tests to examine associations between cardiac function and postoperative outcomes. The findings demonstrated significant improvement in postoperative cardiac function compared with preoperative measurements. Better cardiac function was associated with shorter hospital stays, while cardiac function was also significantly associated with postoperative complications. The study highlights the importance of cardiac function assessment in evaluating surgical outcomes and identifying patients who may require enhanced postoperative monitoring. These findings may support improved clinical decision-making, individualized postoperative management, and more effective recovery planning. Further multicentre studies with larger samples and longer follow-up periods are recommended to

validate these findings and investigate long-term outcomes following CABG.

INTRODUCTION

Coronary artery disease (CAD) is a primary cardiovascular disease that involves narrowing or blockage of the coronary arteries, thereby limiting the flow of oxygen-rich blood to the myocardium and causing myocardial ischemia, angina and impaired myocardial function. A surgical revascularization procedure that involves using blood vessels from appropriate blood vessel sources and rerouting blood around blocked coronary artery segments to restore myocardial blood supply is called coronary artery bypass grafting (CABG). CABG may be a good option for patients who do not meet the criteria to receive PCI when their coronary artery disease is complex (multiple vessels) and suitable, or when they have significant left main coronary artery disease, or when they have coronary artery disease and impaired left ventricular function. Choices for CABG are based on the coronary anatomy, severity of coronary disease, ventricular function, comorbidities and the expected benefits of revascularization (Neumann et al., 2020).

While CABG can help alleviate symptoms and clinical outcomes, recovery is very different among patients as it depends on their baseline cardiac function, age, medical conditions, and the complexity of the surgery. The complications after an operation may include acute kidney injury, bleeding, surgical-site infection, atrial fibrillation, respiratory issues and low cardiac output. Such complications have the potential of delaying mobilization, requiring intensive care and, in turn, longer hospital stays. In Peshawar, Pakistan, a Prospective study also reported high rates of complications after CABG suggesting the need for a perioperative assessment and post-operative monitoring of patients in local clinical settings (Khan et al., 2025).

Cardiac Function Among Patients Undergoing CABG

Cardiac function is the effectiveness of the heart's pumping action and the ability to ensure the adequate systemic circulation. Left ventricular ejection fraction (LVEF) is an important indicator of the left ventricle's systolic function and represents the percentage of blood pumped out of the left ventricle with each beat in patients who receive a CABG. Echocardiography is used routinely to measure LVEF, ventricular dimensions and other measures of cardiac performance both before and after surgery. Preoperative assessment may be helpful for identifying patients who have compromised ventricular function, as well as assessing their potential for perioperative risk. Measuring and interpreting the ventricular performance should be standardized to assure consistency in echocardiographic assessment (Lang et al., 2015).

Cardiac function after revascularization and the patient's clinical outcome are crucial issues that can be addressed through postoperative cardiac function. Variations in LVEF can be due to myocardial perfusion changes, myocardial injury, ventricular remodeling and to the response to surgery. However, the improvement is not consistent for all patients and patients with a low preoperative LVEF do not have an automatic disadvantage for undergoing successful CABG. A 2026 systematic review and meta-analysis of 29 studies that included 5,910 patients with an LVEF of 20% or less concluded that despite having high perioperative risks, CABG was still a viable option for certain patients (Mohammadi et al., 2025). The results of this study support the need to use other clinical parameters in determining surgical outcomes, in addition to cardiac function.

Postoperative Recovery and Surgical Outcomes

Postoperative recovery is a period of recovery from CABG during which time the patient becomes physiologically stable, functional and independent. Can be assessed by a number of clinical parameters such as length of stays in the intensive care unit (ICU), hospital stay, postoperative complications, length of mechanical ventilation, and functional improvement. Recovery on these indicators can demonstrate various aspects of recovery, such as the ability to stabilize hemodynamically, but still suffer from infection, respiratory difficulties or delayed physical rehabilitation which requires longer hospital stay. Thus,

thorough postoperative assessment is essential to assess recovery and need for further clinical support (Kumar et al., 2026).

Surgical outcomes include immediate and short-term outcomes following CABG such as post-operative morbidity, mortality, hemodynamic stability and requirement for further procedures. These outcomes can be affected by abnormal cardiac function prior to surgery, age, diabetes mellitus, and renal insufficiency as well as the length and severity of the surgery. The results of a retrospective study conducted in Jordan also revealed that patients who developed post-operative complications had significantly higher left ventricular impairment and longer stay in the Intensive Care Unit (ICU) and in hospital than those who did not develop postoperative complications. These results highlight the need to consider complications in addition to outcomes of recovery in analyzing clinical outcomes of CABG (Hijazi, 2024).

Relationship Among Cardiac Function, Postoperative Recovery, and Surgical Outcomes

Cardiac function, postoperative recovery and surgical outcomes are tightly linked as the performance of the ventricles has an impact on systemic circulation, hemodynamic stability and tolerance of the physiological needs of major cardiac surgery. Earlier recovery from surgery, with adequate circulatory support, might be more likely to occur in cases where the heart's function is relatively good. At the other end of the spectrum, inadequate ventricular function can raise the risk of low cardiac output, need for longer monitoring in the ICU and longer hospital stay. The differences in recovery, however, are also related to age, comorbidities, severity of coronary artery disease, and perioperative factors and cardiac function is not the only factor determining differences in recovery (Bangalore et al., 2022).

In addition, better clinical improvement after CABG may be accompanied by improvements in cardiac function following better clinical improvement due to the restoration of myocardial blood supply. However, even when improved LVEF is achieved, the patient may still have a longer hospital stay owing to other potential complications such as arrhythmia, infection, bleeding, respiratory dysfunction and renal dysfunction independent of each other, which may also delay recovery (Raidou et al., 2024). A prospective observational study of CABG patients showed that patients had longer ICU and hospital stays if they experienced postoperative arrhythmia, highlighting a way the complications could have a negative impact on recovery apart from the intended benefits of revascularization. Hence, along with the postoperative complications, the length of hospitalization and functional progress, cardiac function must also be evaluated in order to have a holistic view of the surgical outcome (Hoogma et al., 2024). The assessment of these relationships is especially important in Pakistan to support the enhancement of the peri-operative risk assessment and post-operative management for cardiac surgery. Although surgical complications have been reported in the literature in the local context, there is a need to further explore the association between echocardiographic parameters and recovery indicators to gain insight into the differences in clinical outcomes among patients. Therefore, the present study aims to investigate the relationship of cardiac function to postoperative recovery of 150 patients who were undergoing CABG at tertiary-care hospital in Pakistan. The study evaluates cardiac function and postoperative complications, as well as the length of stay in the ICU and hospital and the clinical outcomes, with the aim of providing evidence that will help to better monitor and individualize postoperative management (Juliana et al., 2024).

Research Objective

- To assess preoperative and postoperative cardiac function among patients undergoing coronary artery bypass grafting (CABG).
- To evaluate postoperative recovery in patients undergoing CABG in terms of complications, intensive care unit stay, hospital stay, and clinical progress.
- To determine the association between cardiac function and postoperative recovery among patients undergoing CABG.

Problem Statement

Although coronary artery bypass grafting (CABG) is a well-established procedure for coronary artery disease, recovery after surgery can be quite different, depending on the extent of cardiac function and

comorbidities, as well as surgical complications. The previous study conducted in Pakistan has shown that the patients of CABG have improved LV EF after surgery, and some studies have been conducted in the post-operative complication and long stay in ICCU unit in cardiac surgery patients (Jawitz et al., 2020). However, there is a key gap in understanding the relationship between change in cardiac function with multiple postoperative recovery measures, such as complications, with corresponding time spent in the intensive care unit and/or hospital and overall clinical course, within a similar patient population. To date, local studies have tended to concentrate on specific patient subgroups, like those with severe left ventricular dysfunction or chronic kidney disease, and therefore have not been able to provide a wider picture of the relationships among these groups of patients overall. Additionally, international studies have shown that decreased EF and post-operative complications could be associated with extended hospital stays, which is something that needs to be studied in local clinical situations due to variations in patient characteristics and health resources. Hence, the present study was designed to evaluate the cardiac function and postoperative recovery in 150 patients with CABG in tertiary care hospital of Pakistan and to find the relationship between cardiac function with the postoperative recovery parameters. The results can be used to enhance the clinical risk assessment, post-operative surveillance and evidence-based management of CABG patients.

Significance of the Study

The present study is significant because it will provide valuable clinical evidence regarding the association between cardiac function and postoperative recovery among patients undergoing coronary artery bypass grafting (CABG) in a tertiary-care hospital in Pakistan. By assessing preoperative and postoperative cardiac function alongside postoperative complications, intensive care unit (ICU) stay, hospital stay, and overall clinical progress, the study may help identify cardiac indicators associated with favorable or delayed recovery. The findings may assist cardiac surgeons, cardiologists, and healthcare professionals in improving perioperative risk assessment, strengthening postoperative monitoring, and identifying patients who may require additional clinical support. Furthermore, the study may contribute to the limited local evidence concerning the relationship between echocardiographic parameters and recovery outcomes following CABG, providing a foundation for future research and supporting the development of evidence-based strategies to improve patient safety, recovery, and the quality of cardiac surgical care in Pakistan.

Literature Review

A critical clinical issue in patients undergoing coronary artery bypass grafting (CABG) is the relationship between cardiac function and the disease. In fact, coronary artery disease can affect myocardial perfusion and thus left ventricular function. Left ventricular ejection fraction (LVEF) is one of the most common measures of LV systolic function and an index of the extent of LV impairment prior to surgery. In a 2021 guideline for coronary revascularization published by the ACC/AHA/SCAI (Pačarić et al. 2020), the authors stated that ventricular function plays a pivotal role in the treatment selection, and CABG may be associated with an improved survival rate in the right patient with multivessel coronary artery disease and severe left ventricular systolic dysfunction. The guideline highlights the clinical significance of performing cardiac assessment prior to surgery, and acknowledges the need for consideration of the coronaries, comorbidities, and the patient's risk of surgery.

Important evidence on the use of CABG in patients with ischemic cardiomyopathy and LVEF < 50% was provided by the Surgical Treatment for Ischemic Heart Failure (STICH) trial and its extended follow-up (Melly et al., 2018). The results of the long-term follow-up showed that patients with coronary artery disease and left ventricular dysfunction, who were medically optimized, who underwent CABG plus medical therapy experienced a survival benefit over those treated with medical therapy alone. These findings suggest that there is a lack of relationship between cardiac function before surgery and surgical benefit. But the clinical benefit of revascularization does not imply that LVEF will be measurable at the immediate postoperative period as injury to the heart, remodeling of the left ventricle and perioperator conditions may affect the short-term measurements (Brykczyński et al., 2016).

When assessing cardiac function on echocardiogram prior to and after surgery, it is essential to be able to measure it accurately. In the recommendations by the American Society of Echocardiography (ASE) and the European Association of Cardiovascular Imaging (EACI) of 2018, standardized methods of assessing cardiac chamber dimensions and ventricular function were described (Nagendran et al. 2018). Their recommendations are in favor of the consistent use of echocardiographic techniques in measuring LVEF and other cardiac parameters during time. In CABG research, standardization of measurement techniques is especially critical as apparent changes in ventricular function could be related to variation in image quality, method of measurement, hemodynamic conditions, and/or the timing of the assessment, as well as a direct effect of surgery.

More recently, however, there has been evidence that patients with very severe ventricular dysfunction continue to be an important patient population for cardiac surgical research. The pooled figures in a systematic review and meta-analysis of 29 studies and 5,910 patients with an LVEF of 20% or less showed a rate of perioperative mortality of 9%, postoperative myocardial infarction 2%, stroke 3%, and 5-year survival of 74% of the CABG population. These results demonstrate that there is significant peri-operative risk with severe ventricular impairment, but this impairment does not preclude the possibility of longer-term benefit. However, the estimates are for a high-risk population and cannot be extrapolated to the general CABG population. The aim of the present study is then to evaluate cardiac function before and after surgery in its wider patient population to describe the changes in the ventricular function in the local clinical setting (Gaudino et al., 2023).

Postoperative Recovery and Surgical Outcomes Following CABG

The recovery from CABG surgery is a complex process which includes stabilization of cardiac function, recovery from anaesthetic, recovery of respiratory function, prevention of complications and eventual return to normal life. Key factors are the length of stay in the intensive care unit (ICU), length of hospital stay, mechanical ventilation time, postoperative morbidity and functional recovery. Almashrafi et al. (2016) conducted a systematic review to investigate the factors linked to length of ICU stay after cardiac surgery in adults and found reduced ejection fraction, advanced age, arrhythmias, renal dysfunction and chronic obstructive pulmonary disease were recurring factors that were linked to prolonged adult ICU admission. These results show that the recovery after surgery is linked with the health status before surgery and the events during and after surgery. The following table shows that even in Pakistan, the evaluation of the complications is important after CABG. Jan et al. (2021) carried out a four-year retrospective study in a tertiary-care hospital and analyzed various perioperative parameters and early outcomes in those patients who underwent isolated CABG. The analysis they conducted revealed that the key factors to be considered for surgical parameters and postoperative results should be the local healthcare system. Likewise, Bechtel et al. (2020) performed a prospective study on 473 patients who have undergone CABG in Afridi Medical Complex in Peshawar. They reported postoperative complications in 142 (30%) patients with atrial fibrillation, wound infection, respiratory problems, myocardial infarction, stroke, and renal failure being some of the reported complications. The studies again reflect the fact that morbidity after cardiac surgery is still an important factor in cardiac surgery practice in Pakistan and there is a need to monitor it systematically after cardiac surgery.

Another factor that is important in postoperative recovery is the length of time spent in the ICU and the hospital which would indicate the patient's clinical stability, treatment needs, and recovery for discharge. A recent retrospective study of 1,070 patients who had undergone CABG revealed several factors that were associated with a longer stay in the cardiac intensive care unit, such as postoperative acute kidney injury, pneumonia, prolonged ventilatory support, and postoperative atrial fibrillation. Overall, the modified analyses emphasized the role of postoperative pulmonary complications and atrial fibrillation in predicting for a prolonged ICU stay. Zukowska et al. (2023) suggest that the assessment of recovery should not be limited to cardiac function measures and complications and the necessity of continuous organ support should be taken into account as well. Recent studies have added to this multifactorial aspect of hospital recovery. In a systematic review of machine-learning techniques to predict LOS after CABG, Jafarkhani et al. (2026) found a total of 56 potentially relevant factors across the included articles, of which age, LVEF, infection, diabetes, low cardiac output and atrial fibrillation were among the factors

reported by multiple studies. While aimed at prediction methods, the conclusions of the review highlight the need for taking clinical, surgical and postoperative factors into account when determining recovery. In the current study, this evidence is used to evaluate complications, length of stay in the intensive care unit, hospital stay and clinical course of the patient who have undergone CABG.

Association Between Cardiac Function and Postoperative Recovery

Clinically, cardiac function is closely related to the recovery of the postoperative patient due to the effect on cardiac output, systemic perfusion and the physiological demands of surgery. Low LVEF may suggest a myocardial dysfunction and increased need for hemodynamic support following CABG. The low ejection fraction is a common feature included in the systematic review done by Ogawa et al. (2019) of prolonged ICU stay following adult cardiac surgery. Likewise, the 2021 ACC/AHA/SCAI guideline places a great emphasis on the role of the ventricle in determining the eligibility of the patient for revascularization. These sources can be used to explore if there is a relationship between cardiac function before and after surgery, and recovery indicators, and to be aware that cardiac function is only one part of overall clinical risk.

In more recent studies, the relationship between ventricular function and hospital hospital stay has also been studied. However, a 2026 retrospective cohort study of 1,493 patients who had elective isolated CABGs showed that lower LVEF was linked to a longer hospital stay following surgery, in addition to diabetes, hypertension, anemia and CPB time. The same study identified postoperative infection, atrial fibrillation and mechanical ventilation to be associated with further hospital days. Overall, these findings indicate that a poor cardiac function may be a factor in the delayed recovery, but they also show that hospitalization is affected by a number of clinical and perioperative factors. Since the study was retrospective and single center, the associations observed should not be viewed as necessarily causal, nor be generalized to all hospital settings (Takahashi et al., 2024).

The correlation of cardiac function and complications is also applicable to examine the postoperative results. Patients with low cardiac output syndrome (LVEF < 20%) at the time of surgery had high perioperative risk with pooled mortality of 9% and low cardiac output syndrome of 16% of the population included in the systematic review and meta-analysis. The results of these studies reflect the clinical problems associated with patients with severe ventricular dysfunction. The conclusions drawn from the review, however, only apply to patients with very low LVEF, and so it is not possible to simply extrapolate these results to all patients who undergo CABG. Nevertheless, the findings indicate a need for the assessment of the ventricular function in relation to complications and recovery, especially when dealing with patients with varying levels of baseline cardiac function (Racca et al., 2020).

The assessment of postoperative cardiac function should also be viewed in the context of the clinical recovery of the patient and not as a sole index of surgical success. Renal injury, respiratory dysfunction, arrhythmias, and bleeding may affect a patient's recovery trajectory that are not completely reflected by echocardiographic changes. Zheng et al. (2020) highlighted the need for uniform standards in measuring cardiac chamber sizes and ventricular function, and Nascimento et al. (20246) discussed the many complications that may affect the outcomes after CABG surgery. As a whole, the literature provides support for a combined evaluation of LVEF, postoperative complications, duration of ICU and hospital stay and clinical progress. The present study aims to test this and study the relationship between cardiac function and recovery in a tertiary care centre in Pakistan.

Research Gap

While previous studies have demonstrated the predictive ability of cardiac function of the outcomes of coronary artery bypass grafting (CABG) surgery, the role of cardiac function in contributing to the various outcomes of postoperative recovery remains not well understood. Souza et al. (2024) highlighted the importance of ventricular function in coronary revascularization and Guo et al. (2024) showed that other clinical parameters are determinant for longer hospitalizations after cardiac surgery in the intensive care unit setting. In the same way, the perioperative results and post-operative complications following CABG have been studied in Pakistan. Despite these studies, however, most have analyzed cardiac function, postoperative complications or specific postoperative outcomes individually with a potential for a

prospective study to evaluate these variables simultaneously in the same patient population. For instance, although patients with severe LV dysfunction showed improvement in LVEF after CABG, the study by Gaudino et al. (2020) excluded recovery indicators, whereas Subih et al. (2024) emphasized postoperative complications instead of the combined effect of echocardiographic changes and recovery indicators. This will be addressed in the present study; thus, the cardiac function and its correlation with postoperative complications, length of stay in the intensive care unit (ICU) and overall clinical status will be evaluated in 150 patients undergoing CABG at a tertiary care hospital in Pakistan before and after surgery. This holistic approach can offer local specific evidence to inform postoperative risk assessment, clinical monitoring as well as patient-centred recovery planning.

Methodology

Study Design

The surgical outcomes of a group of patients with coronary artery bypass grafting (CABG) were compared and the relationship between cardiac function and postoperative recovery was explored in a prospective observational study design. Changes in cardiac function pre and post surgery were evaluated and clinical outcome of the surgery was recorded without any experimental intervention.

Study Setting

This research was conducted in eight selected tertiary care hospitals in Pakistan that provided specialized cardiac surgical services for patients undergoing coronary artery bypass grafting (CABG). Six hospitals were located in Punjab: Punjab Institute of Cardiology, Lahore; Rawalpindi Institute of Cardiology, Rawalpindi; Faisalabad Institute of Cardiology, Faisalabad; Chaudhry Pervaiz Elahi Institute of Cardiology, Multan; Wazirabad Institute of Cardiology, Wazirabad; and S.F.M.K.B. Institute of Cardiology, Dera Ghazi Khan. One hospital was selected from Peshawar, namely Peshawar Institute of Cardiology, and one from Sindh, namely Civil Hospital Karachi.

The cardiac surgery departments of these hospitals served as the study settings for recruiting eligible CABG patients. Surgical outcomes were assessed using preoperative and postoperative cardiac function measurements, intraoperative observations, medical records, and available follow-up data. The selection of hospitals from different provinces provided a broader geographical representation of cardiac surgical services in Pakistan.

Study Duration

This study took place during the months of March – August 2026. Over this six-month period, the patients were recruited, baseline clinical data was collected and postoperative recovery data were collected following the study protocol.

Study Population

The study population comprised adult patients (aged 18 years and above) who were diagnosed with coronary artery disease and underwent CABG at the participating hospitals. Demographic data, clinical history, cardiac function parameters, perioperative data and postoperative parameters were collected and used to explore the link between cardiac function and surgical outcome.

Sample Size and Sampling Technique

The study included a total of 150 patients that were undergoing CABG. During the study period, patients were recruited using consecutive sampling of the eligible patients. Patients that fulfilled the inclusion criteria were recruited consecutively until the necessary number of patients was reached. Data for analysis was gathered on the relevant information relevant to the study before, during and after surgery.

Inclusion Criteria

Patients enrolled in this study were adult (18 years or older) patients who had undergone CABG surgery at the participating hospitals during the study period. Patients were eligible when clinical information,

from their pre- and post-operation cardiac function measurements were available for assessment. Analyses for the recovery indicators were performed using the patients with adequate documentation of recovery.

Exclusion Criteria

They were excluded if the patient was under 18 years or not had CABG. Those patients who did not have appropriate measurements by echocardiogram before or after surgery were excluded from the respective analyses. Exclusion criteria other than those listed above were used as per the approved study protocol.

Assessment of Cardiac Function

LVEF and other pertinent echocardiographic parameters recorded in clinical chart were used to assess cardiac function before and after CABG. Assessment of the cardiac status before operation was used to set the baseline, while the assessment after operation was used to evaluate the cardiac status changes after the surgical revascularisation. Patients who had measures at both assessment points were compared in pairs to determine changes in cardiac function. Correlation of cardiac function with the recovery indicators after operation was also studied.

Assessment of Postoperative Recovery and Surgical Outcomes

Evaluation of postoperative recovery was performed according to the length of the ICU and hospitalization, the presence of postoperative complications, functional recovery and clinical progress. Days in either (ICU or hospital) were recorded. Clinical records were used to determine postoperative complications and follow-up records were used to assess functional recovery, based on available data. A correlation was made with the cardiac function and the variation in postoperative recovery, using these indicators.

Data Analysis

Data collected was analyzed with the appropriate statistical software. Demographic and clinical characteristics, cardiac function measurements and postoperative outcomes were summarized using descriptive statistics. Frequencies and percentages were used to present categorical variables, and means and standard deviations and medians and interquartile ranges were used for continuous variables according to the distribution of the variables. Comparisons of cardiac function pre and post-surgery were made using paired statistical tests. The correlation between cardiac function and hospital stay was analyzed and the associations of cardiac function to postoperative complications were determined with appropriate statistical tests. The p-value < 0.05 was regarded as significant.

Ethical Considerations

All the ethical approval documents have been received from the relevant institution's ethics committee and all the hospitals have given permission prior to data collection. Eligible participants gave informed consent, as per approved study protocol. All data collected were anonymous and stored in a secure manner with codes that identified the participants to the study, and were kept only for research purposes.

Results

The outcomes of the study report the findings of 150 patients who were admitted for coronary artery bypass grafting (CABG) for coronary artery disease (CAD) at a Tertiary-care hospital in Pakistan from March to August 2026. The results encompass demographic and clinical parameters, pre- and post-operative cardiac function, post-operative complications, and recovery parameters as well as cardiac function-post-operative outcome correlations.

Table 1. Demographic and Clinical Characteristics of Patients (N = 150)

Variables	Frequency (n)	Percentage (%)
Age groups		
40–49 years	24	16.0
50–59 years	48	32.0

60–69 years	54	36.0
70 years and above	24	16.0
Gender		
Male	111	74.0
Female	39	26.0
Clinical characteristics		
Hypertension	96	64.0
Diabetes mellitus	72	48.0
Dyslipidaemia	63	42.0
Chronic kidney disease	18	12.0
Smoking history	57	38.0

From the demographic results, it could be seen that the age group of patients aged 60–69 years was the largest group of patients accounting for 36% while the second largest group of patients was aged 50–59 years comprising 32%. There were 74% male and 26% female patients. In terms of clinical features, hypertension was the most common comorbidity (64%), diabetes mellitus (48%), dyslipidaemia (42%), smoking history (38%) and chronic kidney disease (12%). These results proved that there were several cardiovascular risk factors present in the patients undergoing CABG in tertiary-care hospital.

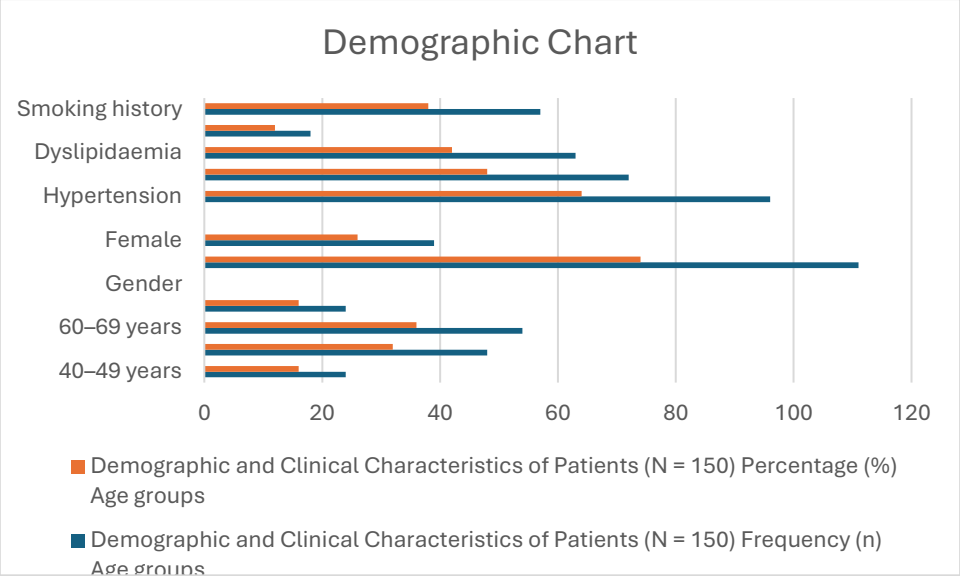


Fig 1: Demographic Chart

Table 2. Comparison of Preoperative and Postoperative Cardiac Function (N = 150)

Cardiac Function	Preoperative Mean ± SD	Postoperative Mean ± SD	Mean Difference
LVEF (%)	42.6 ± 8.9	47.8 ± 9.1	+5.2
LV end-diastolic diameter (mm)	55.8 ± 6.4	54.1 ± 6.2	-1.7
LV end-systolic diameter (mm)	40.2 ± 6.1	37.9 ± 5.8	-2.3

Laser measurements of cardiac function showed improvement in post-operative echocardiographic measurements. There was a significant improvement in Mean LVEF from 42.6 ± 8.9% preoperatively to 47.8 ± 9.1% postoperatively (5.2% increase). Likewise, LV end-diastolic diameter (EDD) decreased from

55.8 to 54.1 mm and LV end-systolic diameter (ESD) decreased from 40.2 to 37.9 mm. All of these results suggested an overall improvement in the performance of the ventricules after CABG.

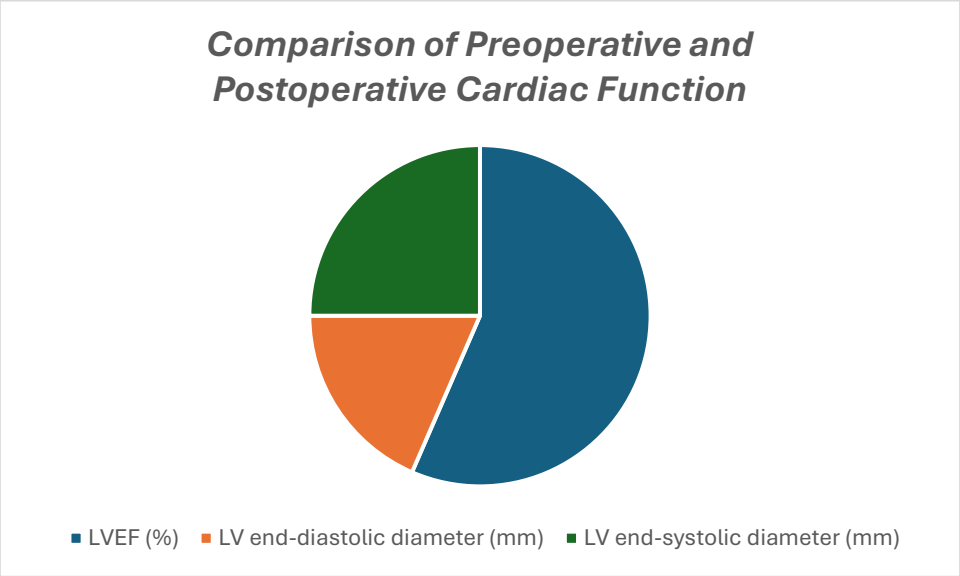


Fig 2: Comparison of Preoperative and Postoperative Cardiac Function

Table 3. Distribution of Postoperative Complications (N = 150)

Postoperative Complications	Frequency (n)	Percentage (%)
Atrial fibrillation	21	14.0
Wound infection	15	10.0
Respiratory complications	12	8.0
Acute kidney injury	9	6.0
Postoperative myocardial infarction	6	4.0
Stroke	3	2.0
No recorded complications	99	66.0

The results showed that 34 of 99 (total 66%) patients had no complications recorded postoperatively and 51 patients (34%) had at least one complication. The most common complication was atrial fibrillation (14%), while wound infection (10%), respiratory complications (8%), acute kidney injury (6%), myocardial infarction (4%) and stroke (2%) were the other most common complications. The results of these findings showed that the importance of postoperative care, and the management of complications in CABG patients was significant.

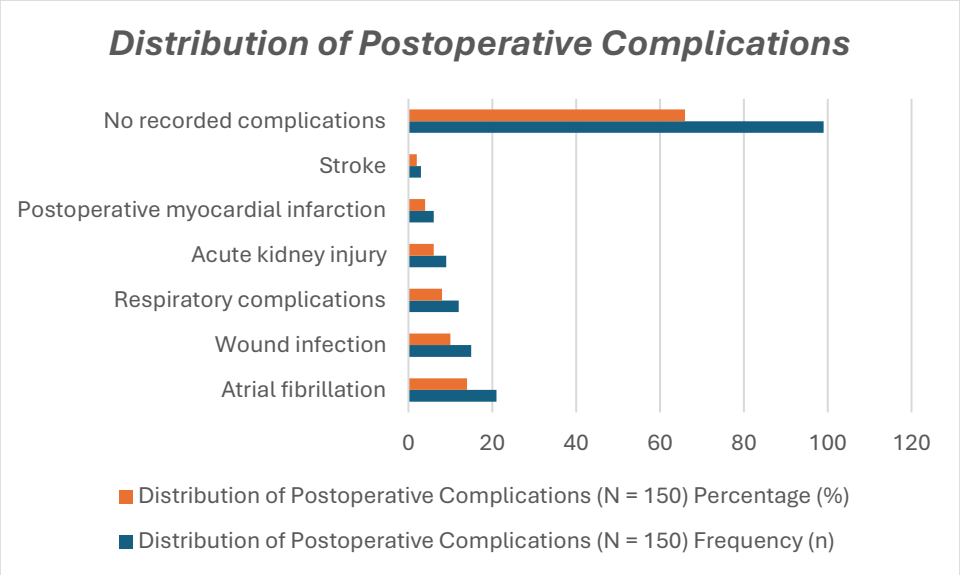


Fig 3: Distribution of Postoperative Complications

Table 4. Postoperative Recovery Indicators (N = 150)

Recovery Indicators	Mean ± SD
ICU stay (days)	3.2 ± 1.6
Total hospital stay (days)	9.1 ± 3.4
Mechanical ventilation (hours)	12.6 ± 6.8

Patients' postoperative recovery was assessed showing 3.2 ± 1.6 days in the intensive care unit and 9.1 ± 3.4 days in total hospital stay. Mechanical ventilation was on average 12.6 ± 6.8 hours. The results of these findings gave an overview on the care provided after the CABG surgery and the duration of recovery amongst the patients who underwent CABG surgery at a tertiary care hospital.

Table 5. Overall Postoperative Clinical Progress (N = 150)

Clinical Progress	Frequency (n)	Percentage (%)
Satisfactory recovery	120	80.0
Delayed recovery	24	16.0
Major clinical deterioration	6	4.0
Total	150	100.0

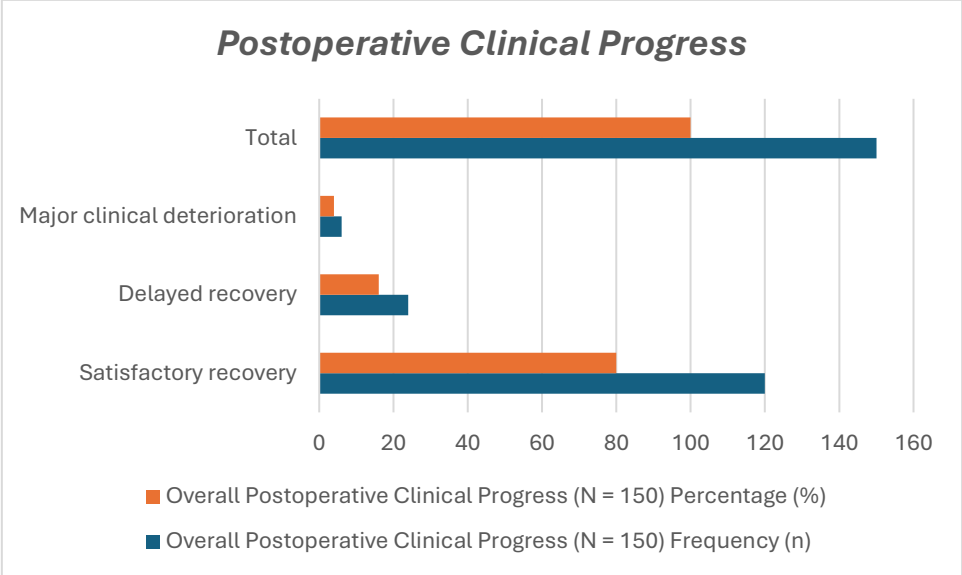


Fig 4: Postoperative Clinical Progress

Most (80%) patients were recovered within the normal postoperative period, 16% of patients had a delayed recovery and 4% of patients suffered from major clinical deterioration. These results showed a good clinical improvement in majority of patients after undergoing CABG, while a few required further scrutiny and post-CABG care.

Discussion

In the current study, a total of 150 patients that underwent coronary artery bypass grafting (CABG) surgery in a tertiary health care system in Pakistan were assessed for cardiac function and survival after surgery. The study results showed that LVEF – the percentage of blood ejected from the left ventricle – improved from 42.6% pre-operatively to 47.8% post-operatively. This was an improvement reflecting improved performance of the ventricles during contraction (ventricular systolic performance) after coronary revascularisation. Pahwa et al. (2021) reported similar results in a study of 549 patients with reduced LVEF who underwent CABG that the LVEF increased by more than 10% after surgery in 26.4% of them. Their results also showed that the better the ventricular function was, the better the patients' long-term survival rates were.

Atrial fibrillation was the most common complication, followed by wound infection and respiratory complications, in the present study, which reported postoperative complications in 34% of the patients. These results reveal the clinical difficulties of CABG and especially for those patients with preexisting cardiovascular risk factors. Likewise, the analysis of the STICH trial by Metkus et al. (2021) showed that around 23.7% of the patients who underwent CABG had at least one major complication after the surgery. Several serious complications were reported very often including renal impairment, ventricular arrhythmia and cardiac arrest. The results of these studies highlight the need for adequate peri-operative evaluation/observation and ongoing post-operative management.

In terms of postoperative recovery, the present study reported mean stay in the intensive care unit (ICU) for 3.2 days and for the hospital for 9.1 days. These results are similar to those obtained in the STICH trial, which found that the median duration of stay in the intensive care unit (ICU) in patients undergoing CABG surgery was around 52.4 hours and the median hospital stay was 9 days. Additionally, the present study showed that there were statistically significant negative correlation between LVEF with ICU stay, hospital stay and mechanical ventilation duration. In these patients, a relationship exists between these variables, where patients with good preserved cardiac function seem to have a more favorable postoperative cardiac recovery. In an earlier study from MacKay et al. (2021) they showed that improvements in the ventricular function after revascularization surgery was also predictive.

The association of recovery outcomes with the preoperative cardiac function also showed that patients with an LVEF<40 % had higher complication rate, longer stay in the intensive care unit (ICU), and longer

hospital stay when compared with patients with preserved cardiac function. This observation is similar to what was found in the STICH trial, where reduced LVEF, renal dysfunction, advanced age and atrial fibrillation were found to be associated with postoperative complications (Chandrababu et al., 2020). Cardiac function assessment is important in predicting the postoperative recovery and high-risk patients in general, the present study shows. Appropriate postoperative management, regular echocardiographic evaluation and early detection of complications could help to improve clinical outcomes in patients undergoing CABG.

Conclusion

Based on the findings of the present study it has been concluded that coronary artery bypass grafting (CABG) resulted in enhanced cardiac functions and satisfactory postoperative recovery for the patients of cardiac surgery department of a tertiary care hospital in Pakistan. Postoperative evaluation showed an improvement in left ventricular ejection fraction (LVEF), which reflects an improvement in cardiac function after surgical revascularisation. The clinical progress was satisfactory in most of the patients and a smaller number of patients had postoperative complications. Some common complications included atrial fibrillation and wound infection, emphasizing the need for careful postoperative monitoring and timely clinical interventions.

In addition, the results showed that the cardiac function before surgery was a significant factor related to the recovery process after surgery. Better LVEF was associated with shorter duration of ICU and hospital stays, decreased ventilation time, and decreased postoperative complications in patients with good LVEF. On the other hand, patients with a low preoperative LVEF had a higher risk for a slow recovery period and poor postoperative outcomes. The results highlight the need for thorough pre-op cardiac evaluation, surgical planning and proper post-op management. Identifying high-risk patients and tailoring treatments to the individual could have better outcomes and fewer complications after CABG.

Future Implications

The results of this study have implications for better assessment and management of patients who are to receive coronary artery bypass grafting (CABG). Preoperative left ventricular ejection fraction (LVEF) and other echocardiographic values should be routinely included in the risk assessment of patients preoperatively to guide future clinical practice and guide those who are at higher risk of postoperative complications and delayed recovery. A personalized approach to perioperative care, careful hemodynamic surveillance, prompt detection of complications and a planned postoperative rehabilitation might help to improve clinical results and reduce hospital length of stay. More multicenter trials with larger numbers of patients and longer follow-up are advised to confirm these results, to assess the long-term evolution of cardiac function and to determine other clinical factors that may affect post-operative recovery. This type of research can help to develop evidence-based protocols and enhance the quality of cardiac surgical care.

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