International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-07-10*

Assessment of Postoperative Complications Following Coronary Artery Bypass Surgery in a Tertiary Care Center.

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Received: 07-05-2026
Revised: 02-06-2026
Accepted: 15-06-2026
Published: 01-07-2026

Abstract

Background: Coronary artery disease (CAD) is a leading cause of morbidity and mortality worldwide. Coronary artery bypass grafting (CABG) remains the standard surgical treatment for patients with multivessel coronary artery disease and complex coronary lesions. Although advances in surgical techniques, myocardial protection, anesthesia, and intensive care management have significantly improved outcomes, postoperative complications continue to contribute substantially to patient morbidity, prolonged hospitalization, increased healthcare costs, and mortality. Identification of common complications and associated risk factors is essential for optimizing perioperative care and improving clinical outcomes. ***Aim:*** To assess the incidence, pattern, and predictors of postoperative complications following coronary artery bypass graft surgery in a tertiary care center. ***Materials and Methods:*** This prospective observational hospital-based study was conducted in the Department of Cardiothoracic and Vascular Surgery, Mahatma Gandhi Medical College and Hospital, Sitapura, Jaipur, Rajasthan, from April 2024 to March 2026. A total of 100 patients undergoing elective or urgent CABG surgery were enrolled using consecutive sampling. Demographic characteristics, cardiovascular risk factors, preoperative cardiac status, intraoperative variables, and postoperative outcomes were recorded. Postoperative complications evaluated included atrial fibrillation, pulmonary complications, acute kidney injury, surgical site infection, excessive postoperative bleeding, prolonged mechanical ventilation, stroke, and mortality. Statistical analysis was performed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Chi-square test, Fisher's exact test, and Student's t-test were applied where appropriate. A p-value <0.05 was considered statistically significant. ***Results:*** Among the 100 patients studied, 78% were male and 22% were female. The majority of patients (74%) belonged to the age group of 50–70 years. Hypertension (62%), dyslipidemia (55%), diabetes mellitus (48%), and smoking history (42%) were the most common preoperative risk factors. Postoperative complications occurred in 42% of patients. Pulmonary complications were the most common adverse event, occurring in 10% of patients, followed by prolonged mechanical ventilation (9%), atrial fibrillation (8%), excessive postoperative bleeding (5%), surgical site infection (4%), acute kidney injury (4%), and stroke (1%). The overall in-hospital mortality rate was 4%. Advanced age greater than 60 years (73.8% vs 32.8%, p<0.001), diabetes mellitus (64.3% vs 36.2%, p=0.006), left ventricular ejection fraction below 40% (35.7% vs 10.3%, p=0.002) and ICU stay exceeding 5 days (54.8% vs 13.8%, p<0.001) were significantly associated with postoperative complications. ***Conclusion:*** Postoperative complications remain common following CABG surgery despite advances in perioperative management. Pulmonary complications, prolonged mechanical ventilation, and atrial fibrillation were the most frequently encountered adverse even. Early identification of high-risk patients, optimization of perioperative care, and multidisciplinary postoperative management may reduce complications and improve surgical outcomes following CABG.

Keywords: Coronary artery disease; Coronary artery bypass grafting; Postoperative complications; Pulmonary complications; Atrial fibrillation; Cardiac surgery outcomes.

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INTRODUCTION

Coronary artery disease (CAD) is one of the most significant cardiovascular disorders and continues to be the leading cause of death globally. Rapid urbanization, sedentary lifestyles, tobacco consumption, unhealthy dietary habits, obesity, diabetes mellitus, and hypertension have contributed substantially to the increasing burden of CAD, particularly in developing countries such as India. Despite remarkable advances in medical therapy and percutaneous coronary interventions, coronary artery bypass grafting (CABG) remains the preferred method of revascularization for patients with complex multivessel disease, left main coronary artery disease, and diabetic coronary artery disease because of its proven long-term survival benefits and superior clinical outcomes compared with other treatment modalities [1].

Since the first successful CABG procedures were performed, substantial improvements have been achieved in operative techniques, myocardial preservation, cardiopulmonary bypass systems, anesthesia protocols, and postoperative critical care management. These advances have significantly reduced perioperative mortality and improved long-term graft patency and patient survival [2]. Nevertheless, CABG remains a major surgical intervention associated with considerable physiological stress and a risk of postoperative complications affecting multiple organ systems.

Postoperative complications following CABG represent an important cause of morbidity and mortality. These complications may involve the cardiovascular, respiratory, renal, neurological, hematological, and infectious systems. The occurrence of such adverse events frequently results in prolonged mechanical ventilation, increased ICU stay, extended hospitalization, greater healthcare expenditure, and diminished quality of life [3]. Identification of patients at increased risk of complications is therefore crucial for implementing targeted preventive strategies and improving surgical outcomes.

Among cardiac complications, postoperative atrial fibrillation (POAF) is the most common arrhythmia following CABG and has been reported in approximately 20–40% of patients undergoing cardiac surgery [4]. POAF is associated with increased risk of stroke, thromboembolic events, hemodynamic instability, prolonged hospitalization, and increased healthcare costs. Other cardiac complications include myocardial infarction, low cardiac output syndrome, ventricular arrhythmias, and graft-related complications.

Respiratory complications are another major source of postoperative morbidity. Atelectasis, pleural effusion, pneumonia, respiratory failure, and prolonged mechanical ventilation frequently occur after CABG due to sternotomy-related pain, impaired cough reflex, cardiopulmonary bypass-induced inflammatory responses, and pre-existing pulmonary disease. These complications can significantly delay recovery and adversely affect survival [5].

Acute kidney injury (AKI) remains one of the most serious complications following cardiac surgery. Even mild postoperative renal dysfunction has been associated with increased mortality and prolonged hospitalization. Risk factors such as advanced age, diabetes mellitus, pre-existing renal impairment, prolonged cardiopulmonary bypass time, and perioperative hypotension contribute to the development of AKI after CABG [6]. Similarly, neurological complications including stroke, transient ischemic attacks, delirium, and postoperative cognitive dysfunction continue to be important concerns because of their impact on functional recovery and quality of life [7].

Postoperative infections, including surgical site infections, mediastinitis, pneumonia, urinary tract infections, and bloodstream infections, also contribute substantially to postoperative morbidity. The incidence of these complications is influenced by factors such as diabetes mellitus, obesity, prolonged operative duration, poor glycemic control, and prolonged ICU stay [8].

Although several international studies have evaluated postoperative outcomes following CABG, regional data from tertiary care centers in India remain relatively limited.

Variations in patient demographics, prevalence of comorbidities, surgical practices, and healthcare infrastructure may influence complication patterns and outcomes. Therefore, assessment of postoperative complications in local settings is essential to identify institution-specific risk factors and formulate effective preventive measures.

The present study was undertaken to evaluate the incidence and pattern of postoperative complications following CABG surgery at Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, and to analyze factors associated with adverse postoperative outcomes.

MATERIALS AND METHODS

Study Design

This study was a prospective observational hospital-based study conducted to evaluate postoperative complications among patients undergoing coronary artery bypass graft surgery.

Study Setting
The study was carried out in the Department of Cardiothoracic and Vascular Surgery, Mahatma Gandhi Medical College and Hospital, Sitapura, Jaipur, Rajasthan, a tertiary care teaching hospital catering to patients from Rajasthan and neighboring states.

Study Duration
The study was conducted over a period of two years from April 2024 to March 2026.

Study Population
All patients undergoing coronary artery bypass graft surgery during the study period and fulfilling the eligibility criteria were considered for inclusion.

Sample Size
A total of 100 patients undergoing CABG surgery were enrolled in the study using consecutive sampling.

Inclusion Criteria
1. Patients aged 18 years and above.
2. Patients undergoing elective or urgent CABG surgery.
3. Patients willing to provide written informed consent.
4. Patients undergoing isolated CABG or CABG with standard operative techniques.

Exclusion Criteria
1. Patients undergoing concomitant valve replacement or major cardiac procedures.
2. Patients with congenital heart disease.
3. Patients undergoing redo CABG surgery.
4. Patients with incomplete clinical records.
5. Patients unwilling to participate in the study.

Ethical Considerations
Institutional Ethics Committee approval was obtained prior to commencement of the study. Written informed consent was obtained from all participants. Confidentiality and anonymity of patient information were maintained throughout the study.

Preoperative Assessment
All enrolled patients underwent detailed clinical evaluation including:

Demographic Data
- Age
- Gender
- Body mass index (BMI)

Clinical History
- Hypertension
- Diabetes mellitus
- Smoking status
- Dyslipidemia
- Previous myocardial infarction
- Chronic kidney disease
- Chronic obstructive pulmonary disease
- Family history of coronary artery disease

Clinical Examination
Comprehensive cardiovascular and systemic examination was performed in all patients.

Laboratory Investigations
- Complete blood count
- Renal function tests
- Liver function tests
- Blood glucose profile

- Lipid profile
- Coagulation profile
- Serum electrolytes

Cardiac Evaluation
- Electrocardiography
- Transthoracic echocardiography
- Coronary angiography
- Assessment of left ventricular ejection fraction

Intraoperative Variables Assessed
The following operative parameters were recorded:
- Number of diseased coronary vessels
- Number of grafts used
- Use of left internal mammary artery
- Aortic cross-clamp time
- Total operative duration
- Requirement of intraoperative blood transfusion
- Intraoperative hemodynamic instability

Postoperative Monitoring
All patients were monitored in the cardiothoracic intensive care unit immediately after surgery. Continuous monitoring included:
- Heart rate
- Blood pressure
- Oxygen saturation
- Electrocardiographic monitoring
- Urine output
- Arterial blood gas analysis

Outcome Measures
Primary Outcome
Occurrence of postoperative complications during hospital stay.

Postoperative Complications Evaluated
Cardiac Complications
- Atrial fibrillation

Respiratory Complications
- Pulmonary complication

Renal Complications
- Acute kidney injury

Neurological Complications
- Stroke

Infectious Complications
- Surgical site infection

Hemorrhagic Complications
- Excessive postoperative bleeding

Secondary Outcomes
- Duration of mechanical ventilation

Data Collection Procedure
Data were collected using a predesigned and prevalidated case record form. Patients were followed from admission until discharge or death. Clinical events, laboratory findings, operative details, and postoperative outcomes were systematically documented.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used for comparison of categorical variables. Independent Student's t-test was used for continuous variables. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 100 patients undergoing coronary artery bypass graft (CABG) surgery were included in the study. The demographic characteristics, prevalence of postoperative complications, and factors associated with adverse postoperative outcomes were analyzed.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (N=100)

Variable	Number (%)
Age <50 years	12 (12%)
Age 50–60 years	38 (38%)
Age 61–70 years	36 (36%)
Age >70 years	14 (14%)
Male	78 (78%)
Female	22 (22%)
Diabetes Mellitus	48 (48%)
Hypertension	62 (62%)
Dyslipidemia	55 (55%)
Smoking History	42 (42%)
COPD	14 (14%)
LVEF <40%	21 (21%)

The majority of patients belonged to the 50–70-year age group (74%). Males constituted 78% of the study population, reflecting the higher prevalence of advanced coronary artery disease among men. Hypertension (62%) and dyslipidemia (55%) were the most prevalent cardiovascular risk factors, followed by diabetes mellitus (48%). Reduced left ventricular ejection fraction (<40%) was present in 21% of patients, indicating a significant proportion of patients with impaired cardiac function before surgery.

Table 2: Incidence of Postoperative Complications Following CABG (N=100)

Postoperative Complication	Number (%)	p value
Atrial Fibrillation	8 (8%)	0.041*
Pulmonary Complications	10 (10%)	0.028*
Surgical Site Infection	4 (4%)	0.312
Acute Kidney Injury	4 (4%)	0.287
Prolonged Mechanical Ventilation (>24 h)	9 (9%)	0.036*
Excessive Postoperative Bleeding/Re-exploration	5 (5%)	0.214
Stroke	1 (1%)	0.648
Mortality	4 (4%)	0.298

Among the postoperative complications following CABG, pulmonary complications (10%), prolonged mechanical ventilation (9%), and atrial fibrillation (8%) were the most frequently observed adverse events. Surgical site infection and acute kidney injury were each reported in 4% of patients, while stroke (1%) was the least common complication. Overall mortality was 4%. The findings suggest that respiratory and cardiac complications constitute the major postoperative concerns after CABG, whereas neurological complications were relatively rare.

Table 3: Factors Associated with Postoperative Complications

Variable	Complication Present (n=42)	No Complication (n=58)	P value
Age >60 years	31 (73.8%)	19 (32.8%)	<0.001*
Diabetes Mellitus	27 (64.3%)	21 (36.2%)	0.006*
LVEF <40%	15 (35.7%)	6 (10.3%)	0.002*
ICU Stay >5 days	23 (54.8%)	8 (13.8%)	<0.001*

*Statistically significant

Patients older than 60 years demonstrated significantly higher postoperative complication rates compared with younger patients (73.8% vs 32.8%; p<0.001). Diabetes mellitus was significantly associated with adverse postoperative outcomes (64.3% vs 36.2%; p=0.006). Patients who developed complications required significantly longer ICU stays.

DISCUSSION

The present study evaluated the incidence and predictors of postoperative complications among patients undergoing coronary artery bypass grafting (CABG). Despite significant advances in surgical techniques, perioperative care, myocardial protection strategies, and postoperative monitoring, CABG continues to be associated with a spectrum of complications that influence morbidity, mortality, duration of hospitalization, and healthcare costs. The findings of the present study demonstrated that postoperative pulmonary complications, prolonged mechanical ventilation, and atrial fibrillation were the most frequent adverse events, while advanced age, diabetes mellitus, reduced left ventricular ejection fraction (LVEF) were significant predictors of postoperative morbidity.

The demographic profile of the study population revealed that the majority of patients belonged to the 50–70-year age group, with males accounting for 78% of cases. This pattern is consistent with the epidemiological characteristics of advanced coronary artery disease and reflects the population commonly referred for surgical myocardial revascularization. Contemporary revascularization guidelines emphasize that CABG remains the preferred treatment strategy for complex multivessel coronary artery disease, particularly among patients with diabetes mellitus and extensive atherosclerotic burden, who constitute a significant proportion of surgical candidates [2].

Among postoperative complications, pulmonary complications were the most common, occurring in 10% of patients. Cardiac surgery is known to adversely affect pulmonary function through several mechanisms, including general anesthesia, median sternotomy, cardiopulmonary bypass, diaphragmatic dysfunction, atelectasis, and postoperative pain. These factors contribute to reduced lung compliance and impaired gas exchange during the immediate postoperative period. Previous investigations have similarly reported pulmonary dysfunction as one of the major causes of prolonged hospitalization and increased resource utilization following cardiac surgery [4]. The significant incidence observed in the present study underscores the importance of aggressive pulmonary rehabilitation, early mobilization, chest physiotherapy, and optimization of perioperative ventilatory strategies.

Prolonged mechanical ventilation beyond 24 hours was observed in 9% of patients and showed a statistically significant association with adverse outcomes. Prolonged ventilatory support often reflects underlying pulmonary dysfunction, hemodynamic instability, ventricular impairment, systemic inflammation, or postoperative complications. Earlier studies have demonstrated that prolonged ventilation is associated with increased intensive care unit (ICU) stay, higher risk of nosocomial infections, and greater mortality [4]. The findings of the current study further support the role of early extubation protocols and multidisciplinary postoperative care pathways in improving recovery after CABG.

Postoperative atrial fibrillation (POAF) occurred in 8% of patients and represented the most common cardiac complication. Although the incidence reported in the literature frequently ranges from 20% to 40%, variation may occur depending on patient selection, monitoring duration, and preventive pharmacological strategies [3]. POAF contributes substantially to postoperative morbidity because it increases the risk of thromboembolic events, hemodynamic instability, prolonged hospitalization, and healthcare expenditure. Current evidence suggests that inflammation, oxidative stress, autonomic imbalance, and atrial remodeling are important mechanisms underlying the development of POAF after cardiac surgery [3]. The relatively lower incidence observed in the present study may reflect improvements in perioperative management and prophylactic use of beta-blockers or antiarrhythmic therapy.

Acute kidney injury (AKI) developed in 4% of patients. Although less frequent than pulmonary or rhythm-related complications, AKI remains one of the most clinically significant adverse events after cardiac surgery because of its strong association with mortality and long-term renal dysfunction. Cardiac surgery-associated AKI results from ischemia-reperfusion injury, inflammatory responses, hemodynamic fluctuations, and exposure to nephrotoxic agents [6]. Recent literature continues to identify postoperative renal dysfunction as an important determinant of outcomes following CABG, emphasizing the need for careful perioperative fluid management and renal protective strategies [6].

The incidence of surgical site infection was 4%, while excessive postoperative bleeding requiring intervention occurred in 5% of patients. Infectious complications remain an important cause of prolonged hospitalization and increased healthcare costs after CABG. Similarly, postoperative bleeding contributes to transfusion requirements, hemodynamic instability, and re-exploration procedures. Previous investigations have shown that blood product utilization and postoperative bleeding may increase the risk of adverse neurological outcomes and other postoperative complications [7].

Stroke was observed in only 1% of patients, representing the least frequent complication. Although uncommon, postoperative stroke remains one of the most devastating complications of CABG because of its profound impact on functional outcomes and quality of life. Previous studies have identified advanced age, aortic atherosclerosis, and perioperative transfusion requirements as important contributors to postoperative cerebrovascular events [7].

A major finding of the present study was the significant association between advanced age and postoperative complications. Patients older than 60 years experienced substantially higher complication rates than younger patients. Aging is associated with reduced physiological reserve, increased burden of comorbidities, impaired organ function, and diminished capacity to tolerate surgical stress. Similar observations have been reported in large national cardiac surgery databases, where elderly patients demonstrated increased postoperative morbidity and mortality despite advances in perioperative care [8].

Diabetes mellitus emerged as another important predictor of adverse outcomes. Patients with diabetes experienced significantly higher complication rates compared with non-diabetic individuals. Hyperglycemia is known to impair immune function, delay wound healing, increase susceptibility to infection, and contribute to endothelial dysfunction. Contemporary evidence suggests that optimized perioperative glycemic control significantly improves outcomes following cardiac surgery [5,9]. Therefore, strict glucose management should remain an essential component of perioperative care.

Reduced LVEF (<40%) was strongly associated with postoperative complications in the present study. Ventricular dysfunction reflects advanced myocardial disease and reduced cardiac reserve, making patients more vulnerable to perioperative hemodynamic instability and organ dysfunction. Previous landmark investigations have demonstrated that patients with impaired ventricular function represent a particularly high-risk subgroup undergoing CABG and require meticulous perioperative management [10].

Finally, patients who developed complications experienced significantly longer ICU stays, highlighting the substantial impact of postoperative morbidity on healthcare utilization. Contemporary outcome studies continue to demonstrate that postoperative complications remain among the strongest determinants of prolonged hospitalization, reduced quality of life, and increased mortality after CABG [11-13].

CONCLUSION

The present study demonstrated that pulmonary complications, prolonged mechanical ventilation, and atrial fibrillation were the most common postoperative complications following CABG. Advanced age, diabetes mellitus, reduced left ventricular ejection fraction, and extended ICU stay were significantly associated with adverse postoperative outcomes. Early identification of high-risk patients, optimization of perioperative risk factors, strict glycemic control, preservation of ventricular function may contribute to improved postoperative outcomes. Continuous risk stratification and multidisciplinary postoperative care remain essential for minimizing morbidity and enhancing recovery following CABG surgery.

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