



CORONARY ARTERY BYPASS GRAFTING (CABG): OUTCOMES OF OFF-PUMP VS ON-PUMP CABG IN HIGH-RISK PATIENTS

Aamir Zeb¹, Farah Sobia^{2*}, Mehvish Nazneen³, Riaz Anwar Khan⁴, Muhammad Azam⁵,
Muhammad Abdur Rauf⁶

¹Senior Registrar, Department of Cardiac Surgery, Prime Teaching Hospital, Peshawar Medical College, Peshawar, Pakistan

^{2*}Assistant Professor, Department of Cardiac Surgery, AFIC/NIHD Rawalpindi, Pakistan

³Medical Officer, Department of Cardiac Surgery, Ayub Teaching Hospital, Abbottabad, Pakistan

⁴Professor, Department of Cardiac Surgery, Jinnah Teaching Hospital, Peshawar, Pakistan

⁵Medical Officer, Department of Cardiac Surgery, NIH Rawalpindi, Pakistan

⁶Associate Professor, Department of Cardiology, Peshawar Medical College, Peshawar, Pakistan

***Corresponding author:** Farah Sobia

*Assistant Professor, Department of Cardiac Surgery, AFIC/NIHD Rawalpindi, Pakistan

Email: farhamano@hotmail.com

ABSTRACT

Background: Patients with advanced coronary artery disease often require CABG, but the choice of surgical technique becomes more important when patients have added clinical risk factors. In such cases, avoiding cardiopulmonary bypass may influence early recovery, postoperative complications, and length of hospital stay

Objective: This study assessed differences in early postoperative recovery and complication patterns among high-risk patients undergoing off-pump and on-pump CABG

Methods: This cross-sectional comparative study was performed at Prime Teaching Hospital, Peshawar, between January 2024 and January 2025. Of the 72 enrolled patients, 36 underwent CABG without cardiopulmonary bypass, while the remaining 36 underwent CABG using cardiopulmonary bypass. Demographics, clinical profile, surgical and postoperative details were recorded. Data analysis was done with the help of SPSS (version 25) and a p-value of ≤ 0.05 was taken as significant.

Results: Both groups had similar demographic and preoperative clinical profiles. Compared with the on-pump group, patients in the off-pump group had shorter ICU admission (2.3 ± 0.9 vs 3.5 ± 1.2 days), reduced hospital stay (6.2 ± 1.5 vs 8.1 ± 2.0 days), and fewer hours of ventilatory support (10.5 ± 3.2 vs 16.8 ± 4.5 hours), with $p=0.001$ for each comparison. Acute kidney injury and atrial fibrillation were also less frequent after off-pump CABG. Mortality during admission and at 30 days did not show a statistically significant difference.

Conclusion: Off-pump CABG demonstrates better early postoperative outcomes with reduced complications in high-risk patients, although mortality outcomes remain comparable to on-pump CABG. It may be considered a preferable option in selected patients to improve recovery.

Keywords: Coronary Artery Bypass, Off-Pump CABG, On-Pump CABG, Cardiopulmonary Bypass, Postoperative Outcomes, High-Risk Patients

INTRODUCTION

Cardiovascular disease continues to place a heavy clinical and economic load on hospitals, particularly because many patients present with advanced coronary artery disease requiring surgical revascularization. Coronary artery bypass grafting (CABG) surgery is a time-tested procedure used to treat patients with multivessel disease who are not eligible for percutaneous coronary interventions. CABG surgery is typically done with the use of cardiopulmonary bypass (on-pump), which provides a still, bloodless operating field but can trigger a systemic inflammatory response and potentially lead to organ dysfunction(1-3).

Over the last few years, off-pump CABG, which does not involve cardiopulmonary bypass, has gained popularity. Off-pump CABG is designed to perform the procedure on a beating heart to minimise the physiological consequences of cardiopulmonary bypass. This technique is especially important in patients at high risk of complications, such as the elderly, patients with impaired left ventricular function, diabetes, and renal disease (4-6).

While off-pump CABG offers theoretical benefits, the results of studies comparing it with traditional on-pump CABG are not unanimous. While some research has shown fewer complications and shorter hospital lengths of stay with off-pump CABG, other studies have shown no difference in long-term outcomes, such as death and graft patency. These findings suggest that more research is needed, especially in subsets of patients like high-risk patients (7-9).

Given the increasing prevalence of high-risk cardiac patients and the ongoing debate regarding the optimal surgical technique, this study was designed to compare the postoperative outcomes of off-pump versus on-pump CABG in high-risk patients. The findings aim to provide evidence to guide surgical decision-making and improve patient outcomes in this vulnerable group.

METHODOLOGY

This comparative cross-sectional study was carried out in the cardiac surgical unit of Prime Teaching Hospital, Peshawar, from January 2024 to January 2025. The study evaluated early postoperative recovery among high-risk patients undergoing coronary artery bypass grafting, comparing procedures performed with cardiopulmonary bypass to those performed without it. Before data collection, approval was granted by the hospital ethical review committee.

Written informed consent was obtained from all participants, and confidentiality of clinical information was maintained throughout the study. In this study, 72 high-risk patients were selected for CABG using a non-probability consecutive sampling method. The study enrolled patients aged 40 to 75 years of either sex with the diagnosis of coronary artery disease and considered high-risk (defined as patients with low left ventricular ejection fraction, diabetes mellitus, or high EuroSCORE). Emergency CABG, redo CABG and CABG with valve surgery were excluded. Among the 72 patients, 36 underwent CABG without cardiopulmonary bypass, while the remaining 36 were operated using the conventional cardiopulmonary bypass technique. The choice of operative approach was made by the treating cardiothoracic surgeon according to the patient's clinical condition and routine hospital practice.

A proforma was used to collect data, which included demographic characteristics (age, sex, body mass index, smoking status), clinical characteristics (diabetes, hypertension, chronic renal disease, history of previous myocardial infarction, left ventricular ejection fraction, EuroSCORE), and operative variables (number of grafts, total time of surgery, time on cardiopulmonary bypass, time of aortic cross-clamp).

Outcomes (ICU and hospital stay, time on ventilator, blood transfusion, complications (myocardial infarction, stroke, acute renal failure, atrial fibrillation, infection)) were documented. Operative mortality (in-hospital and 30-day) was also recorded. Among the 72 patients, 36 underwent CABG without cardiopulmonary bypass, while the remaining 36 were operated using the conventional cardiopulmonary bypass technique. The choice of operative approach was made by the treating cardiothoracic surgeon according to the patient's clinical condition and routine hospital practice.

RESULTS

The average age was almost similar in both surgical groups, and the difference did not reach statistical significance ($p > 0.05$). Male patients were more frequent in both groups; however, gender distribution remained statistically comparable.

Table 1: Demographic Characteristics

Variable	Off-pump (n=36)	On-pump (n=36)	p-value
Age (years, Mean $\pm$ SD)	61.4 $\pm$ 8.2	62.1 $\pm$ 7.9	0.68
Male (%)	25 (69.4%)	27 (75.0%)	0.59
BMI (kg/m ²)	27.6 $\pm$ 3.4	28.1 $\pm$ 3.7	0.52
Smokers (%)	18 (50.0%)	20 (55.6%)	0.63

Risk factors (diabetes, hypertension, low LVEF) were well matched between groups.

Table 2: Baseline Clinical Characteristics

Variable	Off-pump	On-pump	p-value
Diabetes Mellitus	22 (61.1%)	24 (66.7%)	0.62
Hypertension	26 (72.2%)	28 (77.8%)	0.57
CKD	6 (16.7%)	7 (19.4%)	0.76
Previous MI	14 (38.9%)	16 (44.4%)	0.64
LVEF (%)	42.5 $\pm$ 6.3	41.9 $\pm$ 6.7	0.71
EuroSCORE (Mean $\pm$ SD)	5.8 $\pm$ 1.2	6.0 $\pm$ 1.3	0.49

The total number of grafts was comparable; however, surgical time was marginally shorter in the off-pump group and bypass-related parameters were only applicable to the on-pump group.

Table 3: Operative Variables

Variable	Off-pump	On-pump	p-value
Number of grafts	2.8 $\pm$ 0.6	3.0 $\pm$ 0.7	0.18
Operative time (min)	210 $\pm$ 25	235 $\pm$ 30	0.001
CPB time (min)	—	95 $\pm$ 15	—
Cross-clamp time (min)	—	65 $\pm$ 12	—

Off-pump CABG patients had a shorter ICU stay, ventilation time and hospital stay than on-pump CABG patients ($p < 0.05$).

Table 4: Postoperative Outcomes

Outcome	Off-pump	On-pump	p-value
ICU stay (days)	2.3 $\pm$ 0.9	3.5 $\pm$ 1.2	0.001
Hospital stay (days)	6.2 $\pm$ 1.5	8.1 $\pm$ 2.0	0.001
Ventilation time (hrs)	10.5 $\pm$ 3.2	16.8 $\pm$ 4.5	0.001
Blood transfusion (%)	12 (33.3%)	22 (61.1%)	0.02

The on-pump group had more complications, including atrial fibrillation and acute kidney injury. Stroke and MI rates were comparable.

Table 5: Postoperative Complications

Complication	Off-pump	On-pump	p-value
Myocardial Infarction	2 (5.6%)	3 (8.3%)	0.64
Stroke	1 (2.8%)	2 (5.6%)	0.55
AKI	3 (8.3%)	8 (22.2%)	0.04

Atrial Fibrillation	5 (13.9%)	12 (33.3%)	0.04
Infection	4 (11.1%)	7 (19.4%)	0.32

While mortality was reduced in the off-pump group, this was not significant.

Table 6: Mortality Outcomes

Outcome	Off-pump	On-pump	p-value
In-hospital mortality	2 (5.6%)	4 (11.1%)	0.39
30-day mortality	3 (8.3%)	5 (13.9%)	0.46

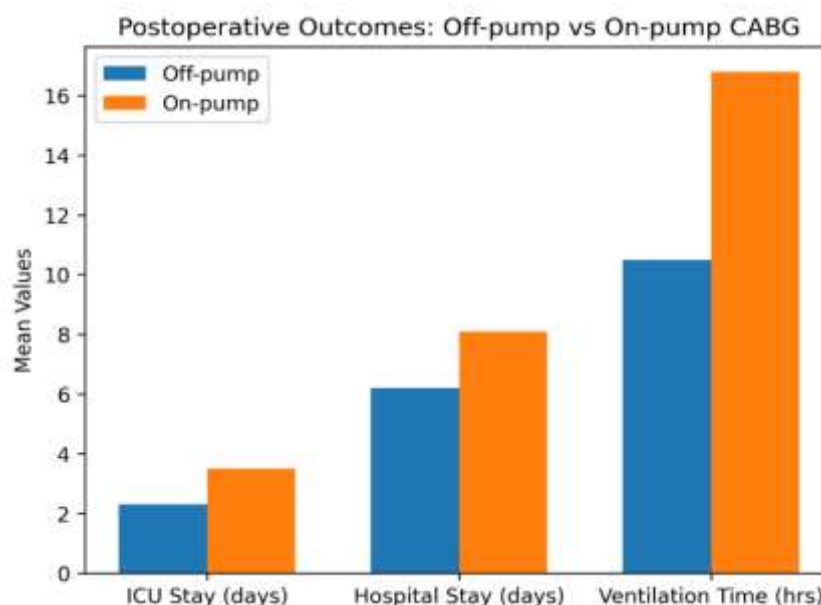


Figure 1: Clustered column chart comparing postoperative outcomes between off-pump and on-pump CABG patients. The off-pump group demonstrated reduced ICU stay (2.3 vs 3.5 days), shorter hospital stay (6.2 vs 8.1 days), and decreased ventilation time (10.5 vs 16.8 hours), indicating improved postoperative recovery.

DISCUSSION

The present study compared postoperative outcomes of off-pump and on-pump coronary artery bypass grafting (CABG) in high-risk patients and demonstrated that off-pump CABG is associated with improved early postoperative recovery. Although baseline demographic and clinical characteristics were comparable between the two groups, significant differences were observed in postoperative outcomes, favoring the off-pump technique. These findings suggest that avoiding cardiopulmonary bypass may reduce perioperative physiological stress, particularly in high-risk populations (10-12).

In our study, off-pump CABG resulted in significantly shorter ICU stay, reduced ventilation time, and decreased hospital stay compared to on-pump CABG. Contemporary studies (2019–2024) have reported that the avoidance of cardiopulmonary bypass minimizes systemic inflammatory response, leading to improved pulmonary function and earlier extubation. Contemporary studies (2019–2024) have reported that the avoidance of cardiopulmonary bypass minimizes systemic inflammatory response, leading to improved pulmonary function and earlier extubation. This aligns with our observation of reduced ventilation time in the off-pump group, highlighting its advantage in patients with compromised physiological reserve (13-15).

Postoperative morbidity differed between the two techniques, with fewer cases of acute kidney injury and atrial fibrillation observed among patients who underwent off-pump CABG. This finding is supported by multiple recent studies, which indicate that cardiopulmonary bypass contributes to renal hypoperfusion and systemic inflammation, increasing the risk of AKI. Similarly, the reduced

incidence of atrial fibrillation in off-pump CABG has been attributed to decreased myocardial manipulation and inflammatory burden. Our results reinforce these observations and emphasize the potential protective role of off-pump surgery in high-risk patients (16-18).

Although off-pump CABG demonstrates promising results, no considerable difference mortality. This finding is in line with large-scale randomized controlled trials and meta-analyses, which have shown similar short-term mortality outcomes with off-pump and on-pump techniques. Although off-pump CABG has benefits regarding morbidity and recovery, it has limited effect on mortality, probably because of complex factors, such as patient characteristics and surgeon expertise (19, 20). The results of this study must be placed in context of some limitations. The limited sample size and single institution may affect the applicability of the findings. The non-random assignment of patients could lead to bias. Our study did not evaluate long-term outcomes, including graft patency and survival, which are important when considering the success of CABG techniques. We suggest that future studies use a larger sample size with a multicenter, randomized approach to confirm the present results and investigate long-term outcomes.

CONCLUSION

In this study, high-risk patients managed with off-pump CABG had a more favorable early recovery pattern than those who underwent the conventional on-pump technique. This was reflected by shorter ICU admission, fewer hours of ventilatory support, reduced hospital stay, and fewer cases of acute kidney injury and atrial fibrillation. Mortality during admission and within 30 days remained statistically similar between the two groups. These findings suggest that off-pump CABG can be useful in carefully selected high-risk patients when the clinical priority is to reduce early postoperative morbidity and support faster recovery.

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