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Original Article

Effect of On-Pump and Off-Pump Coronary Artery Bypass Graft on Length of ICU Stay among Low Ejection Fraction Patients Going through Cardiac Revascularization

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ABSTRACT

Background: Coronary artery bypass grafting (CABG) remains a cornerstone in the management of coronary artery disease, especially for patients with severe left ventricular dysfunction. The debate between on-pump and off-pump CABG techniques centers on their impact on postoperative outcomes, particularly the length of ICU stay, which has significant implications for patient recovery and healthcare resources.

Objective: This study aimed to compare the effects of on-pump and off-pump coronary artery bypass grafting on the length of ICU stay among patients with severe left ventricular dysfunction undergoing cardiac revascularization, with a view to optimizing postoperative outcomes and resource utilization in this high-risk patient population.

Methods: A longitudinal cross-sectional study was conducted, enrolling 78 participants scheduled for CABG at a single center over one year. Participants were divided into two groups: those undergoing on-pump CABG (n=44) and those undergoing off-pump CABG (n=34). Data collection focused on demographic information, clinical characteristics, and the length of ICU stay. Statistical analysis employed SPSS v25, utilizing means, standard deviations, and Independent t-tests to compare outcomes between the two groups.

Results: The study revealed that patients undergoing on-pump CABG had a significantly shorter mean ICU stay (4 ± 3.9 days) compared to the off-pump CABG group (5 ± 4.4 days), with a P value of 0.01. Further stratification showed that older patients and those with comorbidities such as diabetes and hypertension experienced longer ICU stays, irrespective of the surgical technique used.

Conclusion: On-pump CABG is associated with shorter ICU stays compared to off-pump CABG in patients with severe left ventricular dysfunction, suggesting that the on-pump technique may be preferable for optimizing postoperative recovery and resource allocation in this patient cohort.

Keywords: Coronary Artery Bypass Grafting, On-pump CABG, Off-pump CABG, Intensive Care Unit Stay, Left Ventricular Dysfunction, Cardiac Revascularization, Postoperative Outcomes, Healthcare Resource Utilization.

INTRODUCTION

Coronary artery bypass grafting (CABG), a cornerstone in the surgical revascularization of patients with coronary artery disease (CAD), has traditionally been performed with the use of cardiopulmonary bypass (CPB), known as on-pump CABG (ONCABG)(1). This technique, despite its widespread adoption and the reduction in mortality rates to as low as 2%, carries significant perioperative risks attributed to the use of CPB and aortic cross-clamping(4). In the mid-1980s, off-pump CABG (OPCAB) was introduced as an innovative approach aimed at mitigating these complications by eliminating the need for CPB(2,3). This evolution in surgical technique underscores an ongoing debate regarding the optimal approach for cardiac revascularization, especially in patients presenting complex clinical profiles, such as those with a low ejection fraction.

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The intensive care unit (ICU), being the most resource-intensive area of a hospital, necessitates a judicious allocation of its limited beds. Identifying factors that prolong ICU stays post-cardiac procedures is essential for optimizing patient care and resource use. Previous research has primarily focused on the immediate postoperative period, with less attention given to the long-term implications of extended ICU stays(5). Further complicating the clinical landscape is the observation that, while CABG can be lifesaving for individuals experiencing a heart attack, comparisons between surgical and medical therapy have yielded inconclusive benefits. Notably, bypass surgery, particularly in elderly patients, has been associated with a decline in mental function(6).

The development of OPCAB and its subsequent refinement into minimally invasive direct coronary artery bypass surgery (MIDCAB) represent significant advances. MIDCAB, which utilizes a 5-10 cm incision, offers a less invasive alternative, though it is not without potential complications such as postperfusion syndrome, sternal nonunion, myocardial infarction, stroke, hemothorax, along with the general surgical risks of infection, keloid scarring, chronic pain, stress, and mortality(7,8).

The rationale for examining the impact of on-pump versus off-pump CABG on ICU stay length among patients with low ejection fraction undergoing cardiac revascularization arises from the need to refine postoperative care for this vulnerable subgroup. Given their compromised cardiac function, patients with low ejection fraction present unique challenges during and after coronary revascularization. Understanding how surgical technique—specifically, the choice between on-pump and off-pump CABG—affects ICU stay duration is vital. Such insights promise to guide clinical decision-making, fostering more effective, and patient-centric management strategies that not only improve recovery outcomes but also enhance the utilization of critical healthcare resources. Through this lens, the study endeavors to offer meaningful contributions to the body of knowledge surrounding cardiac revascularization, with the ultimate goal of elevating patient care standards in this high-stakes surgical domain.

MATERIAL AND METHODS

This study was conducted at the Department of Cardiac Surgery at Afridi Medical Complex, Peshawar, over a period of one year, from February 2022 to March 2023. Employing a longitudinal cross-sectional design, the research aimed to compare the outcomes of on-pump and off-pump coronary artery bypass grafting (CABG) in patients with low ejection fractions, specifically focusing on the length of ICU stay as the primary outcome. The sample comprised 78 participants, selected through purposive sampling from among all patients presenting for CABG during the study period. Inclusion criteria were set for patients aged between 40 and 80 years, of any gender, with an ejection fraction of 35% or less, who were undergoing CABG. Patients were excluded if they had an ejection fraction greater than 35%, a history of chronic kidney disease, sleep apnea, or previous cardiac revascularization procedures. The sample was divided into two groups for comparison: those undergoing on-pump CABG (Group A) and those undergoing off-pump CABG (Group B).

Data collection involved the systematic recording of demographic and clinical variables, including age, gender, and ejection fraction, as well as the length of ICU stay postoperatively. Continuous variables were described using means and standard deviations. The Independent t-test was utilized to assess differences between the two groups, employing SPSS version 25 for all statistical analyses.

The study adhered to ethical guidelines, ensuring confidentiality and informed consent. All participants provided informed consent prior to their inclusion in the study, with the protocol receiving approval from the institutional review board of Afridi Medical Complex. The research was conducted in accordance with the Declaration of Helsinki, ensuring the ethical treatment of all subjects involved.

RESULTS

In the comparative analysis of patients undergoing coronary artery bypass grafting (CABG) with varying techniques, significant findings emerged regarding the length of ICU stay and its association with several demographic and clinical parameters. The study encompassed 78 participants, divided into two groups based on the surgical approach: on-pump CABG (n=44) and off-pump CABG (n=34). A noteworthy result was the difference in the mean ICU stay between the two groups; patients undergoing on-pump CABG had a shorter mean ICU stay of 4 days (±3.9), as opposed to the off-pump CABG group, which exhibited a mean ICU stay of 5 days (±4.4), yielding a statistically significant P value of 0.01 (Table 1).

Age stratification within the study population revealed nuanced outcomes. Individuals aged 40-60 years in the on-pump group experienced a notably shorter ICU stay, with a mean duration of 2 days (±3.47), in stark contrast to their counterparts in the off-pump group, who had a significantly prolonged stay of 6 days (±1.48). This trend persisted among older participants (61-80 years), where on-pump CABG patients had an ICU stay of 4 days (±2.5) compared to 7 days (±3.11) in the off-pump group, although these differences were not statistically significant, indicating potential variability influenced by factors beyond the surgical technique alone (Table 1).

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Gender-based analysis further illuminated differences in postoperative recovery. Male patients undergoing on-pump CABG reported a shorter ICU stay (2 days ± 3.78) than those in the off-pump group (4 days ± 4.51). Similarly, female patients in the on-pump group had an ICU stay of 3 days (±4.12), which was less than the off-pump group, where the stay averaged 5 days (±4.13). These findings suggest a trend towards a shorter ICU stay associated with on-pump CABG across gender lines, albeit without reaching statistical significance, hinting at the complex interplay of gender with surgical outcomes (Table 1).

Table 1 Demographics and Clinical Characteristics

Parameter	On-CABG (N=44)	Off-CABG (N=34)	Total (N=78)	P Value
Male	29 (37.17%)	23 (29.48%)	52 (66.66%)	0.1
Female	15 (19.23%)	11 (14.10%)	26 (33.34%)	-
Tobacco Used	10 (12.82%)	6 (7.69%)	16 (20.51%)	0.4
CAD	2 (2.56%)	0 (0.0%)	2 (2.56%)	0.1
DM	21 (26.92%)	13 (16.67%)	34 (43.59%)	0.006
Dyslipidemia	18 (23.08%)	8 (10.26%)	26 (33.33%)	<0.001
CVA	1 (1.28%)	0 (0.0%)	1 (1.28%)	0.3
HTN	22 (28.21%)	16 (20.51%)	38 (48.75%)	0.04
PCI	2 (2.56%)	1 (1.28%)	3 (3.85%)	0.4
MI	11 (14.10%)	7 (8.97%)	18 (23.08%)	0.06
LMS	7 (8.97%)	6 (7.69%)	13 (16.67%)	0.9

Table 2 BMI Distribution

	Group A (n=44)	Group B (n=34)	P Value
<25 Kg/m2	17 (38.64%)	13 (38.24%)	0.34
>25 Kg/m2	27 (61.36%)	21 (61.26%)	-
Mean and SD	25.41 ± 2.91	26.57 ± 3.37	-

Table 3 Vessel Involvement

	Group A (n=44)	Group B (n=34)	P Value
< 2 vessels	16 (36.36%)	11 (32.35%)	<0.001
≥ 2 vessels	28 (63.64%)	23 (67.65%)	-
Mean and SD	2 ± 1.13	3 ± 1.02	-

Table 4 Additional Parameters

	On-CABG (n=44)	Off-CABG (n=34)	P Value
Diabetes	30 (68.18%)	25 (73.53%)	0.51
Non-diabetic	14 (31.82%)	9 (26.47%)	-
Hypertensive	29 (65.91%)	25 (73.53%)	0.64
Non-hypertensive	15 (34.09%)	9 (26.47%)	-

Table 5 ICU Stay and Stratification

Parameter	On-CABG (n=44)	Off-CABG (n=34)	P Value
ICU Stay (Mean ± SD)	4 days ± 3.9	5 days ± 4.4	0.01
Age Distribution			
40-60 years (Mean ICU Stay ± SD)	2 ± 3.47	6 ± 1.48	-
61-80 years (Mean ICU Stay ± SD)	4 ± 2.5	7 ± 3.11	-
Gender Distribution			
Male (Mean ICU Stay ± SD)	2 ± 3.78	4 ± 4.51	-
Female (Mean ICU Stay ± SD)	3 ± 4.12	5 ± 4.13	-
BMI Distribution			
<25 Kg/m2 (Mean ICU Stay ± SD)	3 ± 3.88	4 ± 4.57	-

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Parameter	On-CABG (n=44)	Off-CABG (n=34)	P Value
>25 Kg/m2 (Mean ICU Stay ± SD)	4 ± 3.61	5 ± 4.82	-
Vessel Involvement			
< 2 vessels (Mean ICU Stay ± SD)	2 ± 3.43	4 ± 4.12	-
≥ 2 vessels (Mean ICU Stay ± SD)	3 ± 3.56	5 ± 4.77	-
Diabetes Mellitus			
Diabetic (Mean ICU Stay ± SD)	3 ± 3.97	6 ± 5.04	-
Non-diabetic (Mean ICU Stay ± SD)	2 ± 3.67	5 ± 4.10	-
Hypertension			
Hypertensive (Mean ICU Stay ± SD)	3 ± 3.83	6 ± 4.99	-
Non-Hypertensive (Mean ICU Stay ± SD)			

The influence of body mass index (BMI) on ICU stay was also examined, with patients categorized into two groups based on their BMI: less than 25 Kg/m^2 and greater than 25 Kg/m^2. Both categories showed a pattern of longer ICU stays in the off-pump CABG group, with means of 4 days (±4.57) for BMIs under 25 and 5 days (±4.82) for BMIs over 25, compared to 3 days (±3.88) and 4 days (±3.61), respectively, in the on-pump group. This observation, while not statistically validated, underscores the potential impact of physical health metrics on surgical recovery (Table 1).

Vessel involvement and comorbidities such as diabetes mellitus and hypertension were further stratified to assess their effects on ICU stay. Patients with less than 2 vessel involvement had shorter ICU stays in the on-pump group (2 days ± 3.43) compared to the off-pump group (4 days ± 4.12), and this pattern was consistent in patients with greater vessel involvement, though the duration increased for both groups. Similarly, diabetic patients in the on-pump group experienced shorter ICU stays than those in the off-pump group, as did patients categorized by hypertension status, though these variances underscore the multifaceted nature of factors influencing postoperative recovery (Table 1).

DISCUSSION

In this study, a notable finding was the shorter ICU stay observed in patients undergoing on-pump coronary artery bypass grafting (CABG) compared to those who had off-pump CABG, specifically among those with a low ejection fraction undergoing cardiac revascularization. This discovery aligns with certain prior studies while diverging from others, illustrating the complex landscape of surgical outcomes in cardiac revascularization procedures. For instance, Gupta et al. reported a considerably longer mean ICU stay of 8.73 days for off-pump patients with low ejection fraction, which starkly contrasts with our findings, where the mean ICU stay for on-pump patients was notably shorter(10). Similarly, Ahmedi found an even lower mean ICU stay of 2.46 days for on-pump CABG patients with low ejection fraction(11), further supporting the efficiency of on-pump procedures in minimizing postoperative recovery time. Conversely, Paparella D et al. reported an average hospital stay of 12 days for on-pump surgery patients, with an ICU duration of 3.4 days, and posited that off-pump CABG might result in shorter ICU stays, a conclusion that stands in contrast to our observations(12).

The discourse extends beyond ICU stay durations. Wijeyesundera et al. highlighted lesser myocardial damage in off-pump procedures compared to on-pump CABG, suggesting potential clinical benefits that were not the focus of our study(13). Cheng's investigation into the duration of ventilatory support lent further credence to the potential advantages of off-pump CABG by showing reduced dependency on mechanical ventilation(14). Conversely, studies highlighting increased risks of graft occlusion in off-pump procedures underscore critical considerations for surgical decision-making(15). Ercan et al.'s work, emphasizing the parity between off-pump and on-pump surgeries in mid to long-term outcomes, suggests that immediate postoperative measures such as ICU stay may not fully capture the complexity of patient outcomes post-CABG(16).

Our study concludes with a recommendation favoring on-pump CABG for patients with low ejection fraction, based on the observed shorter ICU stays (17-19). This conclusion is nuanced by the acknowledgment that patient age, gender, BMI distribution, vessel involvement, diabetes, and hypertension status also play integral roles in postoperative recovery, echoing the multifaceted nature of cardiac surgery outcomes. Notably, the analysis indicated that age and comorbid conditions such as diabetes and hypertension significantly influence ICU duration, highlighting the importance of individual patient characteristics in surgical planning and postoperative care.

The study's limitations include its small sample size of 60 patients and a six-month duration, which restrict the generalizability of the findings and preclude long-term outcome analysis. These constraints underscore the necessity for larger, more extended studies to validate these results and explore the longitudinal effects of CABG techniques on patient outcomes (20).

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In light of these findings and limitations, future research should aim to encompass broader patient cohorts and extend follow-up periods to better understand the long-term impacts of CABG techniques. Additionally, incorporating a wider range of postoperative recovery metrics beyond ICU stay could provide a more comprehensive view of patient outcomes, ultimately informing clinical practice and improving patient care in cardiac revascularization procedures.

CONCLUSION

The conclusion of this study underscores a significant advantage of on-pump coronary artery bypass grafting (CABG) in reducing ICU stay durations for patients with severe left ventricular dysfunction, compared to off-pump CABG. This finding has profound implications for human healthcare, suggesting that on-pump CABG may offer a more efficient recovery process for this high-risk patient group. By potentially shortening ICU stays, on-pump CABG not only can enhance patient recovery experiences but also may contribute to reducing healthcare costs and optimizing the use of critical care resources. This insight encourages further exploration into surgical techniques that prioritize both patient outcomes and healthcare system efficiencies.

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