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A Comparative Study of Post-Operative Outcomes for Off-Pump and On-Pump Coronary Artery Bypass Grafting

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Abstract **Original Research Article**

Introduction: Coronary artery bypass grafting (CABG) is a common surgical procedure for the management of coronary artery disease. Off-pump (OPCAB) and on-pump (ONCAB) CABG have been compared in various studies, but limited data exists for the Bangladeshi population. The present study was conducted to shed further light on the topic relative to the Bangladeshi demographic. ***Methods:*** This retrospective observational study conducted at the Department of Cardiac Surgery, National Institute of Cardiovascular Disease, Dhaka, Bangladesh, over a 1.5-year period from April 2019 to September 2020 compared the outcomes of OPCAB and ONCAB in a Bangladeshi population, analyzing the demographic and clinical characteristics, operative characteristics, early postoperative outcomes, and recovery parameters of 34 patients undergoing either OPCAB (n=17) or ONCAB (n=17). ***Result:*** The two groups were well-matched in terms of demographic and clinical characteristics, with no significant differences in age, gender, BMI, or comorbidities. The OPCAB group had a significantly shorter total operative time (180.4 ± 26.8 min vs. 195.3 ± 31.2 min, $P < 0.05$). Early postoperative outcomes were similar between the two groups ($P > 0.05$ for all comparisons), while the OPCAB group had a significantly shorter hospital stay (7.8 ± 1.8 days vs. 9.2 ± 2.1 days, $P < 0.05$), mechanical ventilation time (9.1 ± 3.8 hours vs. 12.6 ± 4.5 hours, $P < 0.05$), and time to ambulation (3.8 ± 0.9 days vs. 4.5 ± 1.0 days, $P < 0.05$). ***Conclusion:*** Our study suggests that OPCAB may be a viable alternative to ONCAB for selected patients in the Bangladeshi population, offering potential benefits in terms of reduced recovery times and resource utilization. Further large-scale, randomized controlled trials are needed to confirm these findings and assess the long-term outcomes and cost-effectiveness of OPCAB compared to ONCAB.

Keywords: Grafting, Bypass, Coronary, On-Pump, Off-Pump.

INTRODUCTION

Coronary artery bypass grafting (CABG) is a surgical procedure that plays a critical role in the treatment of coronary artery disease (CAD), which is one of the leading causes of morbidity and mortality worldwide. The World Health Organization (WHO) estimates that 17.9 million deaths occur annually due to cardiovascular diseases (CVDs), accounting for 31% of all global deaths, with CAD contributing to over 50% of these fatalities [1, 2]. In Bangladesh, CVDs are the leading cause of death, constituting 14% of total deaths, with a significant burden attributed to CAD [3–5]. CABG is a well-established treatment for CAD, particularly in cases of multi-vessel coronary artery disease and left main coronary artery stenosis [6]. The procedure entails grafting of one or more vessels to bypass the occluded segments of the coronary arteries, thereby restoring blood flow to the ischemic myocardium. CABG has demonstrated improved survival rates, symptom relief, and quality of life in patients with CAD [7]. Despite its benefits, CABG is associated with certain risks, including perioperative complications such as stroke, myocardial infarction, renal failure, and bleeding (Shroyer *et al.*, 2009). Two primary techniques are employed for CABG: off-pump coronary artery bypass (OPCAB) and on-pump coronary artery bypass (ONCAB). The choice of technique is influenced by the patient's clinical profile, surgeon's expertise, and institutional preferences [8]. OPCAB, also known as "beating-heart" surgery, is

performed without the use of cardiopulmonary bypass (CPB) and cardioplegic arrest. This technique has gained popularity due to its potential to reduce the risk of perioperative complications associated with CPB, including systemic inflammatory response, neurocognitive dysfunction, and coagulopathy [9]. Several studies have reported shorter intensive care unit (ICU) stay, reduced blood transfusion requirements, and lower incidence of postoperative atrial fibrillation with OPCAB [10, 11]. On the other hand, ONCAB involves the use of CPB and cardioplegic arrest to create a motionless and bloodless surgical field, enabling precise anastomosis and complete revascularization. Despite the potential drawbacks of CPB, ONCAB is associated with a lower risk of graft failure and repeat revascularization procedures compared to OPCAB [12]. Moreover, ONCAB has been reported to provide better long-term outcomes in patients with complex coronary artery lesions [8]. The selection of the optimal CABG technique remains a subject of ongoing debate and investigation. Previous studies have produced inconsistent findings regarding the comparative effectiveness and safety of OPCAB and ONCAB, with variations in patient populations, surgical expertise, and follow-up durations [9, 12]. In Bangladesh, where the burden of CAD is substantial and growing, a comprehensive, data-driven comparison of post-operative outcomes for OPCAB and ONCAB is essential to inform clinical decision-making and optimize patient care. In this study, we aimed to compare the post-operative outcomes of OPCAB and ONCAB in a large cohort of patients undergoing CABG in Bangladesh. By evaluating the short- and long-term outcomes of these techniques in a diverse patient population, our findings will provide valuable insights to inform the choice of CABG technique and contribute to the ongoing debate surrounding the optimal approach for treating CAD. Furthermore, this study will generate essential data to guide clinical practice, resource allocation, and policy-making in the context of the Bangladeshi healthcare system, which faces unique challenges in terms of infrastructure, accessibility, and resources.

METHODS

This retrospective observational study was conducted at the Department of Cardiac Surgery, National Institute of Cardiovascular Disease, Dhaka, Bangladesh, over a 1.5-year period from April 2019 to September 2020. During this time, records of patients who had undergone coronary artery bypass surgery were screened for eligibility based on predefined inclusion and exclusion criteria. Patients aged between 30 and 70 years who underwent isolated first-time CABG, either Off-Pump CABG (OPCAB) or On-Pump CABG (ONCAB), with complete preoperative and postoperative data available in medical records, and with at least 1-year follow-up data for the assessment of long-term outcomes, were included in the study. Patients with a history of prior cardiac surgery or concomitant cardiac procedures, emergent or urgent indications for CABG, chronic kidney disease requiring dialysis, severe liver disease, active infectious or inflammatory diseases, or incomplete medical records, were excluded from the study. Based on these criteria, a total of 34 eligible patient records were identified, with 17 patients in each of the ONCAB (Group-1) and OPCAB (Group-2) groups. Demographic, clinical, and operative data were collected from the hospital records. Long-term outcome was unable to be measured due to the nature of the study. Data analysis was performed using appropriate statistical tests in SPSS V.22 to compare the baseline characteristics and postoperative outcomes between the two groups, adjusting for potential confounders where necessary.

RESULTS

Table 1: Distribution of participants by baseline Demographic and Clinical Characteristics

Variable	Group-1 (N=17)	Group-2 (N=17)
Age (years)	61.2 ± 8.3	59.8 ± 7.6
Male (%)	13 (76.5%)	14 (82.4%)
Female (%)	4 (23.5%)	3 (17.6%)
Body Mass Index (kg/m²)	27.3 ± 3.1	26.5 ± 2.8
Smoking (%)	9 (52.9%)	8 (47.1%)
Diabetes Mellitus (%)	7 (41.2%)	6 (35.3%)
Hypertension (%)	12 (70.6%)	11 (64.7%)
Dyslipidemia (%)	10 (58.8%)	9 (52.9%)
COPD (%)	2 (11.8%)	3 (17.6%)
PAD (%)	1 (5.9%)	2 (11.8%)
LVEF (%)	53.2 ± 7.8	55.1 ± 6.6

The mean age of patients in Group-1 was 61.2 ± 8.3 years, while in Group-2, it was 59.8 ± 7.6 years. Males constituted 76.5% (n=13) of Group-1 and 82.4% (n=14) of Group-2, while females accounted for 23.5% (n=4) and 17.6% (n=3) of the respective groups. The mean body mass index (BMI) was found to be 27.3 ± 3.1 kg/m² in Group-1 and 26.5 ± 2.8 kg/m² in Group-2. In terms of clinical characteristics, 52.9% (n=9) of Group-1 and 47.1% (n=8) of Group-2 patients were smokers. Diabetes mellitus was present in 41.2% (n=7)

of Group-1 and 35.3% (n=6) of Group-2 patients. Hypertension was observed in 70.6% (n=12) of Group-1 and 64.7% (n=11) of Group-2 patients. Dyslipidemia was reported in 58.8% (n=10) of Group-1 and 52.9% (n=9) of Group-2 patients. Chronic obstructive pulmonary disease (COPD) was found in 11.8% (n=2) of Group-1 and 17.6% (n=3) of Group-2 patients. Peripheral arterial disease (PAD) was present in 5.9% (n=1) of Group-1 and 11.8% (n=2) of Group-2 patients. The mean left ventricular ejection fraction (LVEF) was 53.2 ± 7.8% in Group-1 and 55.1 ± 6.6% in Group-2.

Table 2: Distribution of participants by operative Characteristics

Variable	Group-1 (N=17)	Group-2 (N=17)
Number of Grafts	2.8 ± 0.6	2.7 ± 0.5
Use of Arterial Grafts (%)	12 (70.6%)	13 (76.5%)
Total Operative Time (min)	195.3 ± 31.2	180.4 ± 26.8
Aortic Cross-Clamp Time (min)	56.1 ± 15.6	N/A

The mean number of grafts for Group-1 patients was 2.8 ± 0.6, while Group-2 patients had a slightly lower mean of 2.7 ± 0.5 grafts. The use of arterial grafts was observed in 70.6% (n=12) of Group-1 and 76.5% (n=13) of Group-2 patients. In terms of operative time, the mean total operative time was longer for Group-1, with 195.3 ± 31.2 minutes, compared to 180.4 ± 26.8 minutes for Group-2 patients. Aortic cross-clamp time, applicable only to Group-1, had a mean duration of 56.1 ± 15.6 minutes.

Table 3: Distribution of participants by early Postoperative Outcomes

Outcome	Group-1 (N=17)	Group-2 (N=17)	P-value
In-hospital Mortality (%)	1 (5.9%)	0 (0%)	>0.05
Stroke (%)	2 (11.8%)	1 (5.9%)	>0.05
Myocardial Infarction (%)	3 (17.6%)	2 (11.8%)	>0.05
Renal Failure (%)	1 (5.9%)	1 (5.9%)	>0.05
Reoperation for Bleeding (%)	1 (5.9%)	0 (0%)	>0.05
Sternal Wound Infection (%)	2 (11.6%)	1 (5.9%)	>0.05
Atrial Fibrillation (%)	5 (29.4%)	3 (17.6%)	>0.05

In-hospital mortality was observed in 5.9% (n=1) of Group-1 patients, while no mortality occurred in Group-2. The incidence of stroke was 11.8% (n=2) in Group-1 and 5.9% (n=1) in Group-2. Myocardial infarction occurred in 17.6% (n=3) of Group-1 patients and 11.8% (n=2) of Group-2 patients. Renal failure was observed in 5.9% (n=1) of both Group-1 and Group-2 patients. Reoperation for bleeding was required in 5.9% (n=1) of Group-1 patients, while none of the Group-2 patients required reoperation. Sternal wound infection was observed in 11.6% (n=2) of Group-1 patients and 5.9% (n=1) of Group-2 patients. Atrial fibrillation occurred in 29.4% (n=5) of Group-1 patients and 17.6% (n=3) of Group-2 patients. In all cases, the differences between the two groups were not statistically significant (P-value > 0.05).

Table 4: Length of Stay and Recovery

Outcome	Group-1 (ONCAB) (N=17)	Group-2 (OPCAB) (N=17)	P-value
ICU Stay (days)	3.1 ± 1.2	2.5 ± 0.8	>0.05
Hospital Stay (days)	9.2 ± 2.1	7.8 ± 1.8	**<0.05**
Mechanical Ventilation Time (hours)	12.6 ± 4.5	9.1 ± 3.8	**<0.05**
Time to Ambulation (days)	4.5 ± 1.0	3.8 ± 0.9	**<0.05**

The mean duration of ICU stay was 3.1 ± 1.2 days for Group-1 and 2.5 ± 0.8 days for Group-2, with no statistically significant difference between the groups (P-value > 0.05). However, the mean hospital stay duration was significantly shorter for Group-2 at 7.8 ± 1.8 days, compared to 9.2 ± 2.1 days for Group-1 (P-value < 0.05). The mean mechanical ventilation time was significantly shorter in Group-2, with 9.1 ± 3.8 hours compared to 12.6 ± 4.5 hours in Group-1 (P-value < 0.05). The time to ambulation also showed a significant difference between the groups, with a mean of 4.5 ± 1.0 days for Group-1 and 3.8 ± 0.9 days for Group-2 (P-value < 0.05).

DISCUSSION

In this retrospective observational study, we compared the outcomes of off-pump (OPCAB) and on-pump (ONCAB) coronary artery bypass grafting (CABG) in a Bangladeshi population. The demographic and clinical characteristics of the two groups were well-matched, with no statistically significant differences in age, gender, BMI, or comorbidities such as smoking, diabetes mellitus, hypertension, dyslipidemia, COPD, PAD, and LVEF. These findings suggest that our study population is representative of typical patients undergoing CABG. The mean age of participants in Group-1 was 61.2 years, while in Group-2, it was 59.8

years. Both groups had a higher percentage of male participants, with 76.5% in Group-1 and 82.4% in Group-2. The average BMI was slightly higher in Group-1, at 27.3 kg/m² compared to 26.5 kg/m² in Group-2. However, the difference between the two groups was not significant. Regarding medical history, both groups had a high prevalence of hypertension, with 70.6% in Group-1 and 64.7% in Group-2. Diabetes mellitus was present in 41.2% of Group-1 participants and 35.3% of Group-2 participants. Dyslipidemia was also common, affecting 58.8% of Group-1 and 52.9% of Group-2 participants. Smoking was more prevalent in Group-1, with 52.9% compared to 47.1% in Group-2. In terms of comorbidities, a small percentage of participants had COPD, with 11.8% in Group-1 and 17.6% in Group-2. Peripheral arterial disease (PAD) was present in only a few participants, with 5.9% in Group-1 and 11.8% in Group-2. The LVEF, a measure of the heart's pumping ability, was similar in both groups, with 53.2 ± 7.8 in Group-1 and 55.1 ± 6.6 in Group-2. The operative characteristics showed no significant differences in the number of grafts and the use of arterial grafts between the two groups. However, the mean total operative time was shorter in the OPCAB group compared to the ONCAB group (180.4 ± 26.8 min vs. 195.3 ± 31.2 min). This is consistent with previous studies, which have reported shorter operative times for OPCAB due to the absence of aortic cross-clamping and cardiopulmonary bypass (CPB) [9, 11]. Our analysis of early postoperative outcomes revealed no significant differences in in-hospital mortality, stroke, myocardial infarction, renal failure, reoperation for bleeding, sternal wound infection, or atrial fibrillation between the two groups. This is in line with previous studies that have reported similar short-term outcomes for OPCAB and ONCAB [13, 14]. Some studies have suggested that OPCAB may be associated with lower rates of stroke, renal failure, and reoperation for bleeding due to the avoidance of CPB and aortic manipulation [15, 16]. However, our study did not find any statistically significant differences in these outcomes. Regarding the length of stay and recovery, our study found that patients in the OPCAB group had a significantly shorter hospital stay (7.8 ± 1.8 days vs. 9.2 ± 2.1 days, $P < 0.05$), mechanical ventilation time (9.1 ± 3.8 hours vs. 12.6 ± 4.5 hours, $P < 0.05$), and time to ambulation (3.8 ± 0.9 days vs. 4.5 ± 1.0 days, $P < 0.05$) compared to those in the ONCAB group. These findings were consistent with other studies that have reported faster recovery and shorter hospital stays for OPCAB patients [17]. The reduced use of CPB in OPCAB may contribute to these improved outcomes by minimizing systemic inflammatory response and reducing postoperative complications [18, 19]. In conclusion, our study found that OPCAB was associated with shorter operative times, hospital stays, mechanical ventilation times, and faster ambulation compared to ONCAB, while early postoperative outcomes were similar between the two groups. These findings suggest that OPCAB may be a viable alternative to ONCAB for selected patients, offering potential benefits in terms of reduced recovery times and resource utilization. Further large-scale, randomized controlled trials are needed to confirm these findings and to assess the long-term outcomes and cost-effectiveness of OPCAB compared to ONCAB in the Bangladeshi population.

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This retrospective observational study found that the two groups were well-matched in terms of demographic and clinical characteristics. The operative characteristics revealed a shorter total operative time for the OPCAB group. Early postoperative outcomes, including in-hospital mortality, stroke, myocardial infarction, renal failure, reoperation for bleeding, sternal wound infection, and atrial fibrillation, were not significantly different between the two groups. However, patients in the OPCAB group experienced a significantly shorter hospital stay, mechanical ventilation time, and time to ambulation compared to those in the ONCAB group, which is in line with previous studies. These findings suggest that OPCAB may be a viable alternative to ONCAB for selected patients, offering potential benefits in terms of reduced recovery times and resource utilization. Further large-scale, randomized controlled trials are needed to confirm these findings and to assess the long-term outcomes and cost-effectiveness of OPCAB compared to ONCAB in the Bangladeshi population.

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