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Early Postoperative Outcome between Off-Pump and On-Pump CABG Operation

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Abstract: ***Introduction:*** Coronary artery bypass grafting (CABG) is a vital surgical procedure for coronary heart disease, addressing significant morbidity and mortality. Off-pump CABG (OPCAB) offers potential advantages over conventional on-pump CABG by avoiding cardiopulmonary bypass (CPB)-associated complications. This study examines early postoperative outcomes between these two techniques at the Department of Cardiac Surgery, BSMMU, emphasizing the increasing adoption of OPCAB for safer and effective cardiac surgery. ***Objectives:*** To compare early postoperative morbidity and mortality between off-pump and on-pump CABG procedures. ***Methods and Materials:*** This prospective cohort study included 40 patients undergoing elective CABG at BSMMU from July 2011 to June 2013. Patients were grouped equally into OPCAB and on-pump CABG cohorts. Data on clinical characteristics, complications, and outcomes were collected through preoperative evaluations, postoperative monitoring, and one-month follow-ups. Statistical analysis assessed significant differences in recovery, morbidity, and mortality between the groups. ***Results:*** The study compared Off-pump and On-pump CABG groups. Off-pump patients had shorter operative time (174.3±20.9 vs. 235.3±48.4 min) and required less blood during surgery (1.57±0.69 vs. 2.83±1.04 units), both statistically significant ($p<0.05$). Mechanical ventilation (7.5±2.7 vs. 16.5±15.7 hours), hospital stay (6.3±0.8 vs. 8.7±2.1 days), and ICU blood usage (1.8±0.76 vs. 3.1±1.12 units) were also lower in Off-pump, with significant differences ($p<0.05$). NYHA improvement and LVEF changes were comparable ($p>0.05$). ***Conclusion:*** Off-pump CABG showed lower morbidity, mortality, and faster recovery compared to On-pump CABG, with similar functional improvements.

Keywords: Off-pump CABG, On-pump CABG, Postoperative morbidity, Renal dysfunction.

INTRODUCTION

Coronary heart disease is the most common form of heart disease and the single most important cause of premature death. The incidence of the condition is increasing rapidly in Europe and many developing countries[1]. Among all surgical revascularization procedure Coronary Artery Bypass Grafting (CABG) procedure is the most vital one. It is the procedure which is more thoroughly studied, provide more symptom relief and prolong lives[2]. The first coronary artery bypass surgery was performed in the United States on May 2, 1960, at the Albert Einstein College of Medicine Bronx Municipal Hospital Center by a team led by Dr. Robert Goetz. In this technique the vessels were held together with circumferential ligatures over an inserted metal ring. The internal mammary artery was used as the donor vessel and was anastomosed to the right coronary artery[3]. The safety and efficacy of surgical coronary revascularization in terms of hospital complication, immediate and long term outcome greatly der depends on the quality of anastomosis and some other important factors. In order to predictably create this delicate and very precise hand sewn anastomoses, the surgeon needs a still and bloodless field with full exposure of the target area, enabling the required complex and coordinated

manipulation of the microsurgical instruments. In this respect, the introduction of the Provel Cardiopulmonary Bypass (CPB) and cardiac arrest by Favaloro in 1967 proved to be tremendous step forward. This procedure is commonplace and quite safe, although there is growing concern about associated risk such as inflammation, stroke and neurological complications[4]. In recent years an alternative procedure has been developed called off pump bypass surgery. In an of pump bypass (OPCAB) procedure the heart continues to beat and just the portion of the heart being operated on is stabilized during surgery. Since the heart continues beating, circulation is maintained without use of heart lung machine[4]. With the improvement of surgical techniques and the development of cardiac stabilizing retractors, OPCAB has become an established procedure[5]. Despite advances in perfusion, an aesthetic and surgical technique, cardiopulmonary bypass (CPB) is still associated with significant morbidity due to its nonphysiologically nature. The morbidity rate has indeed remained high. OPCAB surgery, by means of avoiding CPB and cardioplegic arrest, is expected to produce significant benefits[6]. Cardiopulmonary bypass (CPB) has pathophysiologic sequel that may be more severe in high risk subsets. In some older patients with significant atherosclerotic disease of their aorta, poor kidney function or significant lung disease, these risks may be more considerable and OPCAB might be a reasonable and safer approach than conventional CABG[7]. Cardiopulmonary bypass is widely regarded as an important contributor to renal failure following CABG. OPCAB considered reno protective[8,9,10]. Cardiac Surgery Dept. of BSMMU, Dhaka, Bangladesh has been performing an establish an important role in the field of cardiac surgery countrywide. It is an established referral centers for coronary artery bypass graft (CABG) operation. CABG surgery has been performing since 2005 and off pump coronary artery bypass grafting (OPCAB) is being performed since 2008 in BSMMU which is increasing gradually. Last year 3/4th of coronary bypass surgery was done on beating heart. A comparative study of early postoperative outcome between OPCAB and conventional CABG operation may be of interest. With this aim this study is designed to determine whether off pump coronary bypass surgery has a better outcome than on pump procedure.

OBJECTIVES

General objective: To find out post-operative early outcome of off pump and on pump CABG patients.

Specific objective:

- To determine major post-operative morbidity and mortality of on pump CABG procedure.
- To determine major post-operative morbidity and mortality of off pump CABG procedure.

METHODS AND MATERIALS

Study Design:

This study is a prospective cohort study aimed at comparing the early postoperative outcomes between off-pump coronary artery bypass grafting (CABG) and on-pump CABG procedures. The study design is intended to observe and analyze key postoperative complications, morbidity, mortality, and other clinical outcomes in patients undergoing either off-pump or on-pump CABG.

Study Population:

The study included patients who were admitted to the Department of Cardiac Surgery at Bangabandhu Sheikh Mujib Medical University (BSMMU) for elective first-time isolated CABG. The study focused on a cohort of patients who were scheduled to undergo either off-pump or on-pump CABG procedures. These patients were followed from the time of admission through their postoperative recovery period.

Formula for sample size calculation:

The sample size for this study was calculated using the following formula:

$$n= \left[\frac{Z\alpha\sqrt{2P_1(1-P_1)}+Z\beta\sqrt{P_1(1-P_1)+P_2(1-P_2)}}{P_1-P_2}\right]^2$$

Here,

n = sample size

P_1 = proportion of one group (off pump CARG) = 0.63

P_2 = Proportion of another group (on pump CARG) = 0.37

$Z\alpha$ =1.96 at 5% level of significance

$Z\beta$ =Z value (one tail) at a definite power that is 0.85 at 80% power.

Using the above values, the sample size was estimated to be 58 patients (29 in each group). However, a total of 40 patients (20 in each group) were enrolled in the study to account for potential dropouts.

Inclusion Criteria:

Patients were included in the study if they were undergoing elective first-time isolated coronary artery bypass grafting (CABG) and met the clinical criteria for either off-pump or on-pump CABG. Participants were required to be hemodynamically stable, with no immediate surgical emergencies, and willing to provide informed consent for participation. Additionally, only patients with preserved cardiac function, defined as an ejection fraction (EF) of ≥35%, were considered eligible. These criteria ensured the selection of a homogeneous study population for accurate comparison of postoperative outcomes between the two techniques.

Exclusion Criteria:

Patients were excluded if they had significant comorbid conditions or surgical complexities that could confound the study results. This included those

undergoing CABG with associated valvular diseases or congenital anomalies, emergency CABG procedures, or redo surgeries. Patients with pre-existing hepatic or renal impairment, malignancies, or low cardiac function (EF <35%) were also excluded. These exclusions minimized potential biases and ensured that the observed outcomes were primarily attributable to the surgical technique employed.

Grouping of Patients:

The patients were grouped into two distinct cohorts:

Group I: Patients undergoing off-pump CABG, where the surgery is performed without the use of a cardiopulmonary bypass machine.

Group II: Patients undergoing on-pump CABG, where the surgery is performed with the assistance of a cardiopulmonary bypass machine, which temporarily takes over the functions of the heart and lungs during the procedure.

Both groups were selected purposively, with an equal number of patients (20 in each group) to ensure comparability between the two surgical approaches.

Study Period:

The study was conducted over a period of two years from July 2011 to June 2013, providing sufficient time for data collection, patient follow-up, and outcome assessment.

Study Setting:

The study took place at the Department of Cardiac Surgery, BSMMU, Dhaka, Bangladesh. This institution was selected for its specialized cardiac surgery department and its access to a high volume of patients requiring CABG, making it an ideal setting for conducting this study.

Data Collection:

Data were collected prospectively through patient records, interviews, and clinical examinations. All patients were monitored during their hospital stay, including their time in the intensive care unit (ICU) postoperatively. Key data points were recorded, including preoperative clinical characteristics, intraoperative details, and postoperative outcomes such as complications, recovery time, and survival.

Follow-up:

Patients were followed up for one month after discharge. During the follow-up period, patients were assessed for complications, recovery progress, and quality of life. A color Doppler echocardiogram was performed at the one-month follow-up visit to assess heart function, left ventricular dimensions, and regional wall motion abnormalities (RWMA), comparing these findings with preoperative echocardiogram results.

Study Procedure:

The study was conducted on patients undergoing elective coronary artery bypass grafting (CABG) who met the inclusion criteria and consented to participate. Eligible patients were divided into two groups: off-pump CABG and on-pump CABG, with 20 patients in each group. Preoperatively, detailed history-taking, clinical examination, and necessary investigations were completed and recorded in pre-designed data sheets. All patients received premedication with midazolam and metoprolol the night before surgery. During surgery, standard anesthesia techniques were employed, and procedures were performed by the same surgical team. Postoperatively, patients were monitored in the ICU for complications, including arrhythmias, renal function, and myocardial infarction, with serum creatinine and CK-MB levels measured at 24 and 48 hours. Data on ventilation time, ICU stay, total hospital stay, blood transfusion, and use of inotropic agents were recorded. Continuous ECG monitoring was conducted for ST segment changes and arrhythmias. At discharge and during the one-month follow-up, color Doppler echocardiography was performed to assess cardiac function and compare outcomes between the two groups. All data were systematically collected and analyzed for statistical significance.

Statistical Analysis:

Data were analyzed using SPSS software (latest version). Continuous variables were presented as mean ± standard deviation (SD), and categorical data were analyzed using the Chi-square test. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated. A p-value of <0.05 was considered statistically significant.

Ethical Considerations:

The study was conducted in accordance with ethical guidelines, ensuring that all participants provided informed consent prior to enrollment. The study protocol was approved by the academic and technical committee of the Department of Cardiac Surgery and the Institutional Review Board (IRB) at BSMMU. Participants were fully informed about the study's objectives, procedures, and potential risks, and their rights to withdraw at any stage without consequences were emphasized. Confidentiality was strictly maintained, with all patient data anonymized and stored securely. Additionally, the study adhered to the principles outlined in the Declaration of Helsinki, ensuring the protection of patient welfare throughout the research process.

RESULT

Out of total 40 patients selected for study, 20 were in the Off-pump CABG group and the rest 20 were in the On-pump CABG group. The findings of data analysis are stated below:

Table 1: Age, Sex and Preoperative NYHA Distribution of the Patients between Off-pump and On-pump CABG Group

Age of the Patients (yrs.)	Off-pump CABG freq. (%)	On-pump CABG freq. (%)
50-54	2(10.0)	3(15.0)
55-59	3(15.0)	3(15.0)
60-65	15(75.0)	14(70.0)
Mean age (yrs.)	62.4±5.1	61.7±5.2
Sex		
Male	17(85.0)	18(90.0)
Female	3(15.0)	2(10.0)
Preoperative NYHA functional Class		
Class 1	1(5.0)	1(5.0)
Class II	10(50.0)	10(50.0)
Class III	9(45.0)	9(45.0)

Table 1 shows the age distribution of the selected patients between Off-pump and On-pump groups. The mean age of Off-pump and On-pump patients were 62.4±5.1 years and 61.7±5.2 years respectively. Depicts the sex distribution of the patients. It was found that 85.0% were male and 15.0% were female in Off-pump CABG patients. In On-pump CABG patients 90.0% were male and 10.0% were female. The preoperative NYHA Functional Class in the study groups. The figure shows that the preoperative NYHA Functional Class I, II and III occupied 5.0%, 50.0% and 45.0% respectively in both Off-pump CABG and On-pump CABG.

Table 2: Comparison of Risk Factors between Off-pump and On-pump CABG Patients

Risk Factors	Off-pump CABG frequency (%)	On-pump CABG frequency (%)	X^2 value	df	P-value
Smoking	12(60.0)	10(50.0)	0.40	1	0.525
Diabetes mellitus	7(35.0)	8(40.0)	0.11	1	0.743
Hypertension	12(60.0)	8(40.0)	1.60	1	0.206
Hyperlipidaemia	6(30.0)	3(15.0)	0.57	1	0.225

Table 2 compares the common risk factors. Smoking was 60.0% and 50.0% in Off-pump and On-pump CABG respectively. Diabetes mellitus was found 35.0% in Off-pump and 40.0% in On-pump CABG group. It was found that Hypertension was 60.0% in Off-pump and 40.0% in On-pump CABG group, whereas Hyperlipidaemia was 30.0% and 15.0% in Off-pump and On-pump CABG respectively. The common risk factors smoking, Diabetes mellitus, were Hypertension and Hyperlipidaemia were statistically insignificant ($p>0.05$) in chi square test with 1 df, which indicate that the common risk factors were almost uniformly distributed in both Off-pump and On-pump CABG group.

Table 3: Comparison of Number of Coronary Arteries Involved

No. coronary arteries	Off-pump CABG freq. (%) (n=20)	On-pump CABG Freq. (%) (n=20)
Double Vessel	8(40.0)	7(35.0)
Triple Vessel	12(60.0)	13(65.0)

Table 3 compares the number of coronary arteries involved between the groups. In Off-pump group, 40% patients had double coronary artery involvements and rest 60% had triple coronary artery involvements. In On- pump group, double and triple coronary artery involvements were found in 35% and 65% patients respectively. There was no patient with single vessel involvement in either of the groups.

Table 4: Comparison of Total Operative Time, Number of Grafts and Blood Required between Off-pump and On-pump CABG Patients

Findings	off-pump CABG (Mean±SD)	On-pump CABG (MeaniSD)	t value	df	P-value
Total Operative Time (Min)	174.3±20.9	235.3±48.4	-5.17	38	<0.001
No. of graft	2.9+0.7	3.2±0.8	-1.28	38	$0.21O^{ns}$
Amount of Blood required (unit)	1.57±0.69	2.83±1.04	-4.33	38	$<0.001^{s}$

S-Significance; P-value<0.05 was considered significant. (Student's t-test)
ns- non-significants, 25-degree of boredom.

Table-4 compares the total operative time between Off-pump and On-pump CABG groups. The mean duration of total operation time was 174.3±20.9 min in Off-pump group and it was 235.3±48.4 min in On-pump group. The mean difference was statistically significant (p<0.05) in Student's t-test. The average number of grafts was 2.9±0.7 in Off-pump and it was 3.2±0.8 in On-pump CABG groups. The mean difference was not statistically significant (p>0.05) in Student's t-test. The average amount of blood required during operation was 1.57±0.69 (unit) in Off-pump and it was 2.83±1.04 (unit) in On-pump CABG. The mean difference of blood required was statistically significant (p<0.05) in Student's t-test.

Table 5: Comparison of Some Postoperative Outcome Parameters Between Off-pump and On-pump CABG Patients

Findings	off-pump CABG (Mean±SD)	On-pump CABG (MeaniSD)	t value	df	P-value
Period of mechanical ventilation (hours)	7.5±2.7	16.5±15.7	-2.46	36	0.019[s]
ICU Stay (hours)	291±14.6	36.6±26.6	-1.07	36	0.291[ns]
Total hospital stay (days)	6.3±0.8	8.7±2.1	-4.62	36	<0.001[s]
Amount of blood required at ICU (Units)	. 1.8±0.76	3.1±1.12	-4.33	36	<0.001[s]

Significance; P-value<0.05 was considered significant. (Student t Test).
s- significant, ns- not significant & df - dogter of Suom

Table 5 highlights the distribution of period of mechanical ventilation, ICU Stay, total hospital stay (days) and amount of blood required at ICU (Units) between Off pump and On pump CABG groups. The mean period of mechanical ventilation was 7.5±2.7 hours in Off-pump and it was 16.5±15.7 hours in On-pump CABG. The mean duration of ICU stay was 29.1±14.6 hours in Off-pump and it was 36.6±26.6 hours in On-pump CABG. The mean duration of hospital stay was 6.3±0.8 days in Off-pump and it was 8.7±2.1 days in On-pump CABG. The mean amount of blood required at ICU was 1.8±0.76 units in Off-pump and it was 3.1±1.12 units in On-pump CABG. The mean difference were statistically significant (p<0.05) in student t-test between Off-pump and On-pump CABG groups in all variables except ICU stay, which was statistically insignificant (p>0.05) in student t- test between Off-pump and On-pump CABG groups. The mean period of mechanical ventilation, total hospital stay and blood required at ICU were observed to be significantly (p<0.05) higher in On-pump group as opposed to the Off-pump group. The ICU stay in On-pump group was also comparatively high in On-pump CABG group compared to Off-pump group but not statistically significant (p>0.05). (p- 0.291)

Table 6: Comparison of Major Post-Operative Complications Between Off-pump and On-pump CABG Patients

Major post-operative Complications	Off-pump CABG freq. (%) (n=20)	On-pump CABG freq. (%) (n=20)
Stroke	0	0
Renal dysfunction	1(5.0)	2(10.0)
Prolonged ventilation>48 hours)	0	1(5.0)
Deep sternal wound infection	0	1(5.0)
Reoperation	0	0

Table 6 compares the major post-operative complications encountered during postoperative period. Renal dysfunction was 1(5.0%) and 2(10.0%) cases in Off-pump CABG and On-pump CABG group respectively. Prolonged ventilation 48 hours and deep sternal wound infection was 1(5.0%) in On-pump group whereas none was observed in Off-pump group Re-exploration for bleeding was not found in any group.

Table 7: Change in NYHA functional Class

NYHA Class	Before operation freq. (%)	After 3 month post operatively freq. (%)	X^2-value	df	P-value
Off-pump CABG					
Class I	1(5.0)	12(63.2)	14.83	1	0.001[s]
Class II	10(50.0)	6(31.5)	1.37	1	0.242[ns]
Class III	9(45.0)	1(5.3)	6.12	1	0.005[s]
On-pump CABG					
Class I	1(5.0)	11(61.1)	13.80	1	0.001[ns]
Class 11	10(50.0)	6(33.3)	1.08	1	0.2985[s]
Class III	9(45.0)	1(5.6)	5.70	1	0.007[s]

Table 7 shows the mortality was found 1(5.0%) in Off-pump CABG due to preoperative ventricular fibrillation and 2(10.0%) in On-pump, one due to failure to wean from cardiopulmonary bypass and another due to low output syndrome. Figures in the parentheses indicate corresponding %; any p-value<0.05 was considered significant. (Chi-square test).

Table 8: Changes in Echocardiographic Findings in the Off-pump CABG and On-pump CABG Groups

Findings	Preoperative	1 month after operation	t value	df	P-value
Off-pump CABG					
LVIDd (mm)	51.32±6.98	47.47±7.81	3.68	18	0.002[s]
LIVDs (mm)	42.02±6.75	36.54±8.08	5.49	18	<0.001[s]
LVEF (%)	45±8	53±7	-4.22	18	0.001[s]
On-pump CABG					
LVIDd(mm)	49.67±4.85	47.56±4.78	8.76	17	<0.001[s]
LIVDs (mm)	40.22±4.53	36.71±4.13	7.58	17	<0.001[s]
LVEF (%)	47±6	54±5	-4.68	17	<0.001[s]

Table 8 depict the change of NYHA Functional Class in the Off-pump CABG and On-pump CABG groups. In Off-pump CABG group the figure shows that the NYHA Functional Class I occupied 1(5.0%) before operation and it was 12(63.2%) post operatively after months, which was statistically significant (p<0.05) in chi square test. Regarding the NYHA Functional Class II in Off-pump CABG group occupied 10(50.0%) before operation and it was 6(31.3%) post operatively after months, which was statistically insignificant (p>0.05) in chi square test The NYHA Functional Class III in Off-pump CABG group occupied 9(45.0%) before operation and it was 1(5.3%) in post operatively after months, which was statistically significant (p<0.05) in chi square test on the other hand in On-pump CABG group the figure shows that the NYHA Functional Class I occupied 1(5.0%) before operation and it was 11(61.1%) post operatively after months, which was statistically significant (p<0.05) in chi square test. Regarding the NYHA Functional Class II in On-pump CABG group occupied 9(45.0%) before operation and it was 6(33.3%) post operatively after months, which was statistically insignificant (p>0.05) in chi square test. The NYHA Functional Class III in On-pump CABG group occupied 10(50.0%) before operation and it was 1(5.6%) post operatively after months, which was statistically significant (p<0.05) in chi square test.

Table 9: Status of Wall Motion in Pre-and Postoperative Echocardiography

	Abnormal freq. (%)	Normal freq. (%)	Chi(G) value	df	P-value
Off-Pump-CABG					
Preparative	18(90.0)	2(10.0)	28.00	1	<0.001
Postoperative	1(5.3)	18(94.7)		-	
On-Pump-CABG					
Preparative	17(85.0)	3(15.0)	20.69	1	<0.001
Postoperative	2(11.1)	16(88.9)		-	

S=Significant, P value reached from chi square test (p<0.05)
df- degree of freedom

Table 9 Shows Pre-operative and Post-operative wall motion in Off-pump CABG and On-pump-CABG In Off-pump group 18(90.0%) patients had abnorinal wall motion and 2(10.0%) had normal wall motion during the pre- operative period. But Post-operatively, only 1(5.3%) patient had abnormal wall motion and 18(94.7%) patients had normal motion. The difference was statistically significant (p<0.05) in chi square test in 1 df at 95% confidence level In On-pump group 17(85.0%) patients had abnormal wall motion and 3(15.0%) patients had normal wall motion during the pre-operative period where as during-post-operatively, only 2(11.1%) patient had abnormal wall motion and 16(88.9%) patients had normal motion, which was statistically ✓ significant (p<0.05) in chi square tesyl df at 95% confidence level.

Table 10: Changes in LVEF in between Off-pump CABG and On-pump CABG groups

	Off-pump CABG	On-pump CABG	t-value	df	P-value
Change of LVEF after 1 month (%)	8.78±8.0	7.78±3.4	1.95	35	0.059

Table 10 shows the mean difference of LVEF from pre-operative period to Post operatively after 1 month between Off-pump was 8.78±8.0 (%) and On-pump CABG was 7.78±3.4 (%). The improvement of

LVEF between Off-pump and On-pump was statistically insignificant (p>0.05) in unpaired students't-test.

DISCUSSION

Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, has been performing in impotent role in the field of cardiac surgery countrywide. BSMMU is one of the best referral hospital for coronary artery bypass graft (CABG) operation. CABG surgery has been performing since 2005 and off pump coronary artery bypass grafting (OPCAB) is being performed since 2008 in BSMMU which is increasing in proportion Last year 3/4th of coronary bypass surgery was done on beating heart. This study was conducted in BSMMU from June 2011 to July 2013,-40 patients were selected for this study of them 20 were off-pump CABG while other 20 were on-pump CABG group. The data were collected, compiled and compared with data of similar studies reported in various International Literature in the following sections. The mean age was 67 years for the off-pump and 68 years for the on-pump groups in the study of Yokoyama *et al*.[11 A study by Calafiore *et al*.[12] had a mean age of 64.4±9.6 years for OPCAB patient and 63.3±9.7 years for on-pump CABG patients. In a study of laco *et al*.[13] average of patients was 64.3±9.4 years in off-pump CABG group and 62.8±9.2 years in on-pump CABG group.

In this study the patients of both groups had been divided into age ranges of 50-54 years, 55-59 years, 60-65 years. All the age groups were almost proportionately distributed in both the study groups (Table-1). The mean ages of off-pump and On-pump group of patients were 62.4±5.1 years and 61.7±5.2 years respectively. There is no significant difference of age distribution between two groups. In a study on 1570 consecutive high risk patients for CABG Chamberlain *et al*.[14] found 79.5% male patient in on-pump and 77.7% in off-pump group. In a study by Bull *et al*.[15] male patient was 88% in OPCAB and 93% in on-pump CABG. In this study among 20 patients in off-pump CABG 3 (15%) patients were female and in on-pump CABG 2 (10%) patients were female. So both sexes were equally distributed in both the groups. Male patients were predominant in this study but female ratio was much higher in this series. This finding suggests that atherosclerotic coronary artery disease is more prevalent in male than in female. were In Off-pump group 5% of patients were in NYHA functional class I, 50% into class II and 45% into class III. found dabble vessel disease and tripple vessel disease were 36.8% and 63.2% in OPCAB and 23.9% and 76.1% in on-pump CABG group respectively. Chamberlain *et al*.[22] reported double vessel affected-and vessel affeeted were 28.2% and 60.4% in off-pump and 18.9% and 77.3% in on-pump CABG group respectively. In the observation of Hernandez *et al*.[16] 2 diseased vessel was 35.6% and 35.3% and 3 diseased vessel was 39% and 44.7% in OPCAB and on-pump respectively. As regards to the number of coronary artery involvement either group included only double and triple vessel diseases. In this study, in off-pump group 40% cases had double vessel disease and 60% case had triple vessel disease. In On-pump group, 35% patients had double vessel disease and 65% patients had triple vessel disease. But this difference was not statistically significant.

In a study of Arom *et al*.[17] smoker was 22% and 18.8% in off-pump and on-pump group, diabetes was 33.3% in off-pump and 33.8% in on-pump. Hypertension was 66.7% and 53.4% in off-pump and on-pump patient. Arom *et al*.[25] reported that total operation time was 175 (36) min and 235 (63) min in off-pump and on-pump group respectively. In a study by Shennib *et al*.[18] observed that total operation time was 192.1±42.2 min and 199.8±42.2 in off-pump and on-pump respectively. Czerny *et al*.[19] in a study reported duration of operation in OPCAB and CCAB were 178±49 min and 254±64 min respectively. Comparison of peroperative variable between groups demonstrates that total operative time in off-pump group (174.3±20.9 min) is significantly less than that of on-pump group (235.3±48.4 min) in this study. The average number of grafts in off-pump group was 2.9±0.7 and in on-pump group was (3.2±0.8). In a study of Shennib *et al*.[18] The amount of blood transfused intraoperatively in OPCAB group was 1.5-2.1 unit and in on-pump 3.0±3.2 units. Czerny *et al*.[19] reported that amount of blood required was 1.1±1.73 units in OPCAB and 1.7±1.6 units in On-pump. In this study amount of blood requirement in off-pump group (1.57±0.69 units) was significantly less than On-pump group (3.1±1.12 units). This has definite impact on clinical and economic outcome of the patients. Shad Several post-operative variables have been compared between groups such as period of mechanical ventilation, ICU-stay, total postoperative period in hospital and amount of blood required at ICU during post-operative period.

In a study by Czerny *et al*.[19] reported intubation time (hours) was 4.8±2.9 in OPCAB and 17.7±24.4 in on-pump CABG, mean ICU stay (days) was 1.2-0.3 day in OPCAB and 2.0±2.8 days in on-pump, in hospital stay was 13.5±8.2 in OPCAB and 12.6±7.3 in on-pump. Shennib *et al*.[18] found in a study intubation time (hours) was 16.5±22.4 in off-pump and 22.2+32.5 in on-pump, ICU length of stay (hours) was 45.5+52.2 in off-pump and 57±67.6 in on-pump, postoperative length of stay (days) was 9.3±9.2 in off-pump and 11.1±11.5 in on-pump. Boyd *et al*.[20] reported ventilation time (hour) was 7.9±5.2 in off-pump and 16.3±9.7 in on-pump, ICU stay (hour) 24±10.9 in off-pump and 36.6±33.5 in on-pump and hospital stay (days) was 6.3±1.8 in OPCAB and 7.7±3.9 in on-pump groups. In this study mean (Mean±SD) ventilation period in off-pump group was 7.5±2.7 hours

and that in on-pump group was 16.5±15.7 hours. This shows that ventilation time was significantly higher in on-pump group. But this is much lower than that in the series of Shenib *et al*.[18] suggesting a trend towards carly extubation in our institution. Total postoperative stay in hospital weraged 6.3±0.8 days in off-pump group of patients and 8.7±2.1 days in on- pump group of patients. The mean blood requirement in off-pump patients during postoperative period was 1.8±0.76 units and that in on-pump patients was 3.1 ±1.12 units. That total transfusion requirement in OPCAB procedure is much less. Thus the mean period of mechanical ventilation, ICU-stay period, total post- operative stay in hospital and amount of blood required at ICU during post- operative period-all were significantly greater in on-pump group as opposed to off-pump group. All these reflect definite clinical advantage as well as favorable economic outcome associated with off-pump group of patients. Most of the patient improved by 1 or II NYHA class from their preoperative values. Most of the patients of both groups return to NYHA class I and class II (63.2% and 31.5% in off-pump group while 61.1% and 33.3% in on-pump group). Improvement is statistically significant. In echocardiographic evaluation in off-pump CABG mean difference of LVIDd and LVIDs (51.32±6.98 vs 47.47±7.81 and 42.02 ±6.75 vs 36.54±8.08 mm) was statistically significant ($p<0.05$) in after 1 month postoperative period compare to preoperative period. During the preoperative period LVEF was 45±8% and 1 months postoperatively LVEF was 53±7 which was significantly higher compared to peroperative period. In on-pump CABG mean difference of LVIDd and LVIDS (49.67±4.85 mm vs 47.56±4, 78 mm and 40.22±4.53 mm vs 36.71±4.13 mm) was statistically significant in after I months postoperative period compare to preoperative period. LVEF also improved from 47±6% to 54±5% after 1 month's postoperative period compare to preoperative period. The mean difference of LVEF from preoperative period to postoperatively after 1 month between off-pump was 8.78±8.0% and on-pump CABG was 1.78±3.4%. The improvement of LVEF between off-pump and on-pump was statistically insignificant ($p>0.05$).

Arnese *et al*.[21] in a study on prediction of improvement of regional left ventricular function after surgical revascularization reported postoperative improvement occurred in 79% of severe hypokinatic segment of ventricular wall. In this study in off-pump CABG 95% patients showed improvement of wall motion abnormality after 1 month postoperatively compared to preoperative period and in on-pump CABG 88.9% patients showed normal wall motion after 1 month postoperatively compared to preoperative period. Both these findings conclusively demonstrated functional improvement and effectiveness of revascularization in both off-pump CABG and on-pump CABG. Similarly in on-pump CABG group perfusion area and ejection fraction also improved after 1 month postoperatively compared to preoperative period all are significant. But mean±SD difference between preoperative to postoperative area was 5.7±2.1 in off-pump and on-pump CABG was 7.8±8.6. The mean±SD difference of ejection fraction was 8.5±2.5 in off-pump and on-pump CABG was 8.9±7.5 (Table-12). Above findings indicate functional improvement as well as revascularization of ischaemic zone occur due to coronary artery bypass grafting.

CONCLUSION

It may be concluded that major postoperative morbidity like renal dysfunction, deep sternal wound infection and prolonged ventilation were higher in group B (on-pump CABG) patients than group A (off-pump CABG) patients, resulting in prolonged ICU stay and total hospital stay. 30 day mortality was higher in on-pump CABG patients compare to off-pump CABG patients. Among the surviving patients, NYHA functional class and LVEF significantly improved by 1 postoperative month. From this study we concluded that surgical revascularization using the off-pump technique with good results and less morbidity and mortality than on-pump CABG procedure.

Recommendation

We recommended that off-pump CABG should be considered better than on-pump CABG. is A prospective randomized trial and long term follow up is necessary to confirm our findings and to define the long term clinical and functional results of both off-pump and on-pump CABG. Development of well-trained cardiac surgical and anesthetic team and establishment of modern equipment quiped for operative liters recouver adequate logistic support should be done in Medical Collage Hospitals of Bangladesh to ensure up to date services and research for ischaemic heart disease.

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