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ORIGINAL ARTICLE

Effect of Off-pump Coronary Artery Bypass Graft Surgery in Patients with Diabetes Mellitus

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ABSTRACT

Background & objective : Myocardial revascularization in diabetic patients is challenging. Off pump coronary artery bypass (OPCAB) surgery has been widely used for the treatment of coronary artery disease. The goal of this study was to compare outcomes of OPCAB in diabetic patients relative to non diabetic patients.

Methods: The present prospective study was conducted between January 2014 to June 2017. During the period a total of 193 patients (of whom 70 had diabetes and 123 patients were non-diabetics) were included in the study. All of them underwent coronary artery bypass grafting (CABG) without cardiopulmonary bypass surgery. The early clinical outcomes of OPCAB were evaluated during the postoperative hospital stay.

Result: Over three-quarters of the patients in both diabetic and non-diabetic groups were ≥ 50 years old with no significant intergroup difference (p = 0.825). Majority(90%) of the patients in either group was male (p = 0.786). Nearly half (48.5%) of the patients in diabetic and 45% in non-diabetic group were overweight or obese (p = 0.557). The smokers weremuch higher in non-diabetic group than that in the diabetics (p = 0.009). The average number of grafts needed was considerably higher in the diabetic group (p = 0.079). All the postoperative outcome variables like pneumonia, stroke, arrhythmia, renal failure requiring dialysis and postoperative mortality in both the groups were almost identical (p > 0.05).

Conclusion: Off-pump coronary artery bypassis the preferred choice of revascularization for multi-vessel coronary artery disease in diabetic patients. However, continuous, strict glycemic control is essential to have a good postoperative outcome.

Key words: Off-Pump, Coronary artery bypass surgery (CABG), Postoperative outcome etc.

INTRODUCTION:

Diabetes has become a worldwide health problem that affected 415 million people in 2015.[1] A further 318 million people are estimated to have impaired glucose tolerance.[2] Diabetes is associated with an increased risk of coronary artery disease (CAD) as a result of multiple thrombotic and inflammatory pathways that are enhanced by hyperglycemia, dyslipidaemia, obesity, insulin resistance & oxidative stress. Coronary artery disease is not only more prevalent in diabetic patients compared with nondiabetic patients but also tends to be more

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extensive, involving multiple coronary vessels and rapidly progressive.[3,8] Compared to non-diabetics, the diabetics are at greater risk of adverse events after coronary revascularization.[9,10]

In type 2 diabetes, endothelial dysfunction is a key step in the development of myocardial ischemia that impairs endothelium-dependent vasodilatation in coronary conductance and coronary resistance arteries.[11] The accelerating role of diabetes in coronary artery disease (CAD) has been recognized and is related to the greater atherosclerotic burden, metabolic derangements, and the proinflammatory and thrombotic state associated with diabetes.[12] Similarly, the unfavorable effect of diabetes on both short and long-term survival after CABG has been reported by several authors.[13,14] In diabetes with multi-vessel disease[15] coronary artery bypass grafting (CABG) was repeatedly proven to be superior to percutanuous interventions in terms of myocardial infarction, cardiac death, and need for repeat revascularization. Nevertheless, CABG with cardiopulmonary bypass support and cardioplegia induced cardiac arrest (On-pump CABG) may lead to severe complication, such as, stroke[16] and renal dysfunction[17] as demonstrated in prospective studies that show 1-3% incidence of ischemic & hemorrhagic insult after CABG.[18,19] This risk is particularly high for patients with diabetes mellitus.

In recent years, the standard technique of on-pump CABG has been challenged by emerging off-pump technique, which avoids the use of cardiopulmonary bypass & cardioplegia. Comparative data regarding the effect of off-pump CABG in diabetic and non-diabetic patients are scarce and remain inconclusive with respect to mortality, stroke and renal dysfunction,[20-23] The aim of this study was to investigate the outcome of off-pump CABG in diabetic patients compared to their non-diabetic counterparts.

METHODS:

This prospective study was conducted at Ibrahim Cardiac Hospital & Research Institute, Dhaka between January 2014 to June 2017 on 193 patients (70 diabetics and 123 non-diabetics) who underwent isolated off-pump CABG surgery. The diagnosis of DM was based on diagnostic criteria from American diabetic association.[24] Accordingly, diabetes was considered if a patient's HbA1c was > 6.5% or fasting (fasting is defined as no caloric intake for at least 8 hours) plasma glucose > 126 mg/dl (7 mmol/L) or 2 hours postprandial plasma glucose > 200 mg/dl (11 mmol/L) (the test was performed using a glucose load containing the equivalent of 75 gm glucose dissolved in water). However, patients with concomitant left ventricular aneurysm, concomitant post infarction, ventricular septal defect, concomitant moderate to severe mitral or aortic regurgitation and concomitant acquired or congenital cardiac or aortic surgery, emergency surgery, preoperative Intra-aortic balloon pump for any cause, infectious disease, and malignancy were excluded. Both groups of patients were operated on without cardiopulmonary bypass and were evaluated for their early clinical outcomes.

In our center, off-pump CABG has been performed routinely for over 5 years by a single surgeon. Data were collected on demographic variables (age and sex) anthropometrics (weight & height), risk factors of ischemic heart diseases (smoking, hypertension, diabetes, hyperlipidaemia), cerebrovascular disease (CVD), chronic obstructive pulmonary diseases (COPD), chronic heart failure, renal dysfunction, recent myocardial infarction, extent of coronary artery disease, peripheral vascular disease, left main disease, history of myocardial infarction, left ventricular ejection fraction, congestive heart failure.The main outcome measures were in-hospital mortality, IABP on and needed basis, neurological deficit (stroke), post-operative renal failure, pneumonia, duration of ventilator support, drainage during 24 hours (ml), perioperative MI and length of ICU stay. In-hospital mortality was defined as death in the hospital of admission regardless of causes. Post-operative neurological

deficit was defined as a new focal neurological deficit and comatose states occurring post-operatively that persisted >24 hours after its onset and were noted before discharge. Postoperative myocardial infarction was defined as a new Q-wave seen post-operatively in two or more continuous leads on an electrocardiogram or significant rise in post-operative cardiac enzymes. Post-operative bleeding was bleeding that required surgical re-exploration in Operation Theater; intraoperative low cardiac output syndrome was termed when there was requirement of Intra-aortic balloon pump. Patients were installed with an IABP when they developed low cardiac output after CABG surgery. Post-operative pneumonia was defined as growth of pathogenic microorganisms in a sputum culture requiring antibiotics or an X-ray diagnosing pneumonia following cardiac surgery. Post-operative respiratory failure was defined as duration of mechanical ventilation for more than 72 hours or reintubation following cardiac surgery. Wound infection (bone related or any drainage of purulent material from the sternotomy wound).

Data were processed and analyzed using SPSS (statistical Package for social sciences), version 25.0. Data presented on categorical scale were expressed as frequency with corresponding percentage and were compared between groups using Chi-square (χ^2) Test, while the data pertaining to continuous variable presented as mean ± standard deviation (SD), or as median and range and were compared using Student's t-Test. The level of significance was set at 5% and $p < 0.05$ was considered significant.

SURGICAL PROCEDURE:

All patients underwent CABG through median full sternotomy. The in situ left internal mammary artery, was always preferred as the first choice for revascularization of the left anterior descending coronary artery territory. Saphenous vein graft was harvested with an open technique. Heparin was given to all patients receiving off-pump CABG to reach ACT (Activated Clotting Time) of more than 300s. The central temperature was maintained above 36°c to avoid hypothermia induced ventricular arrhythmia. The heart was displaced using a posterior pericardial sling and gauge swabs. For good presentation of the target arteries on the lateral and inferior aspect of the heart, patients were placed in right decubitus tendelenburg position. Stabilization of target coronary arteries was accomplished with these stabilizers. A CO_2 blower was used for a bloodless field. An intra-coronary shunt was used in all patients to maintain coronary flow thereby reducing myocardial ischemia and at the same time minimizing bleeding from the coronary arteriotomy. The same exposure, stabilization and immobilization technique to allow exposure of the lateral, posterior and inferior walls of the heart was used during grafting. The LAD was usually grafted first. The grafting was achieved without much displacement of the heart and without much hemodynamic compromise. Distal anastomosis were performed with continuous 7-0 or 8-0 polypropylene (prolene) monofilament suture. Proximal anastomoses were performed with 6-0 continuous prolene suture.

RESULTS:

The age distribution shows that more than three-quarters of the patients in both diabetic and non-diabetic groups were 50 or > 50 years old with no significant intergroup difference ($p = 0.825$). Over 90% of the patients were male in either group ($p = 0.786$). Nearly half (48.5%) of the patients in non-diabetic and 45% in diabetic group were overweight or obese ($p = 0.557$) (Table I). Risk factors distribution between groups demonstrate that prevalence of smoking was significantly higher in non-diabetic group than that in the diabetic ones ($p = 0.009$). No other conventional risk factors demonstrated their significant presence in either group. None of the clinical and biochemical characteristics was significantly different between the study groups ($p > 0.05$) (table III). However, the average number

of grafts needed was considerably higher in the diabetic group than that in the non-diabetic group (p = 0.079). None of the outcome variables presented in table IV was any different between diabetic non-diabetic groups (p > 0.05).

Table I. Comparison of demographic and anthropometric characteristics between groups

Baseline characteristics	Group		p-value
	Diabetic (n = 70)	Non Diabetic (n = 123)	
Age (years)			
30-39	3 (2.4)	2(2.9)	
40-49	25(20.3)	14(20.0)	0.825
50-59	47(38.2)	31(44.3)	
≥ 60	48(39.0)	23(32.9)	
Sex			
Male	111(90.2)	64(91.4)	0.786
Female	12(9.8)	6(8.6)	
BMI (kg/m2)			
Under weight	2(1.6)	0(0.0)	
Normal weight	67(54.5)	36(51.4)	0.557
Over weight	45(36.6)	26(37.1)	
Obese	9(7.3)	8(11.4)	

Figures in the parentheses indicate corresponding %;
***Chi-squared Test** (χ^2) was done to analyze the data.

Table II. Comparison of risk factors between diabetic and non-diabetic groups

Risk factors	Group		p-value
	Diabetic (n = 70)	Non Diabetic (n = 123)	
Smoking*	15(12.2)	19(27.1)	0.009
Hypertension*	89(72.4)	52(74.3)	0.772
Hyperlipidemia /DL*	99(80.5)	57(81.4)	0.873
Cerebrovascular disease (CVD) **	0(0.0)	2(2.9)	0.130
Peripheral vascular disease (PVD)**	2(1.6)	0(0.0)	0.405

Figures in the parentheses indicate corresponding %;
* **Chi-squared Test** (χ^2) was done to analyze the data.
****Fisher's Exact Test** was done to analyze the data.

Table III. Comparison of clinical, biochemical and peroperative data between groups

Risk factors	Group		p-value
	Diabetic (n = 70)	Non Diabetic (n = 123)	
Chronic pulmonary disease (COPD) *	8(6.5)	3(4.3)	0.523
S. Creatinine (Pre-operative) *	1.1 ± 0.3	1.0 ± 0.3	0.074
Chronic heart failure*	22(17.9)	8(11.4)	0.234
Recent MI*	45(36.6)	29(41.4)	0.506
Congestive heart failure*	6(4.9)	2(2.9)	0.498
Extent of CAD*			
Single vessel disease	6(4.9)	4(5.7)	0.801
Multi-vesseldisease	117(95.1)	66(94.3)	
LM disease*	26(21.1)	15(21.4)	0.962
LVEF (%)#	53.3 ± 9.3	53.1 ± 8.9	0.859
Number of grafts needed*	3.0 ± 0.8	2.7 ± 0.8	0.079

Figures in the parentheses indicate corresponding %;
***Chi-squared Test** (χ^2) was done to analyze the data.
#Data were analyzed using **Unpaired t-Test** and were presented as **mean ± SD.**

Table IV. Comparison of early postoperative outcome between the study groups

Early postoperative outcomes	Group		p-value
	Diabetic (n = 70)	Non Diabetic (n = 123)	
Drainage during the first 24 h (ml)#	196.5 ± 69.8	193.2 ±74.1	0.758
Pneumonia**	1(0.8)	2(2.9)	0.298
Respiratory failure**	2(1.6)	2(2.9)	0.460
Stroke**	0(0.0)	1(1.4)	0.363
Arrhythmia**	1(0.8)	1(1.4)	0.595
Renal failure requiring hemodialysis**	0(0.0)	1(1.4)	0.363
Duration of MV (>12 h) ** LVEF before	3(2.4)	1(1.4)	0.540
discharge (%)#	56.5 ± 8.0	56.6 ± 8.2	0.962
ICU stay (days)#	3.3 ± 0.7	3.4 ± 1.0	0.735
In-hospital mortality**	0(0.0)	1(1.4)	0.363

Figures in the parentheses indicate corresponding %;
****Fisher's Exact Test** was done to analyze the data.
#Data were analyzed using **Unpaired t-Test** and were presented as **mean ± SD.**

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DISCUSSION:

The prevalence of diabetes continues to increase worldwide. Although patients with diabetes have a greater chance of coronary disease & poor prognosis than nondiabetic subjects, CABG has consistently shown improved survival over percutanuous coronary intervention (PCI).[25,26] The recent randomized FREEDOM trial has clearly demonstrated that CABGs are superior to PCI in reducing major adverse cardiovascular events and all cause of mortality in diabetic patients with multivessel disease.[27]

Now a days CABG is the first choice for revascularization strategy in diabetic patients. However, clinical outcomes after CABGs in patients with diabetes are still inferior to those of nondiabetic patients[28], although in the present study early outcome was observed to be almost similar between the diabetics and non-daibetics. Conventional CABG with cardiopulmonary bypass is associated in part with cardiopulmonary bypass.[29] In order to prevent serious complications caused by cardiopulmonary bypass, off-pump coronary artery bypass was used to treat DM patients. OPCAB has a lower mortality rate and postoperative outcomes in diabetic patients compared to conventional on-pump CABG.[30] Many studies also suggested that OPCAB is superior for high risk patients with DM.[31] CABG without cardiopulmonary bypass is a technique that generally has a lower incidence of hematological, neurological and renal complication[32] which is why could be especially advantageous in diabetics. CABG surgery without CPB reduces manipulation of the aorta and elimination of the cardiopulmonary bypass circuit reduces the incidence of neurological complication in diabetic patients.[33]

In the present study, the baseline and perioperative data of patients with and without DM admitted at Ibrahim cardiac Hospital and Research Institute were studied. The results of the study showed that the diabetics needed more bypass grafts than their non-diabetic counterparts, that may be due to diffuse nature of coronary lesion in diabetics. Postoperatively the ejection fraction improved equally in both diabetic and nondiabetic patients. There is no significant difference in terms of postoperative pneumonia, stroke, arrhythmia, renal failure requiring dialysis or postoperative mortality between the study groups, which might be due to strict perioperative glucose control–an important consideration in diabetic patients undergoing CABG surgery.

CONCLUSION:

OPCAB surgery generally has a lower incidence of perioperative complication in diabetic patients. When patients with DM undergo OPCAB surgery with strict perioperative glucose control, the chances of higher postoperative complications compared to the non-diabetics patients are drastically reduced. The current study shows that OPCAB surgery is safe in patients with DM in terms of reduced postoperative complications provided strict perioperative glycemic control is maintained.

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