Original Article

Off-Pump Coronary Artery Bypass Grafting for Poorly Controlled Diabetic Patients

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Objective: To estimate the postoperative outcome of off-pump coronary artery bypass grafting (OPCAB) for patients with poorly controlled diabetes mellitus as evaluated by preoperative hemoglobin A1c (HbA1c).
Patients and Methods: The preoperative value of HbA1c in 101 diabetic patients who had undergone OPCAB from January 2000 to January 2007 was reviewed. A value of 6.5% was used as an indicator of poorly controlled hyperglycemia, and patients were distributed into a well-controlled group (group A: HbA1c <6.5, n = 47) or a poorly controlled group (group B: HbA1c >6.5, n = 54). The average follow-up period was 2.2 ± 1.3 years.
Results: There was no difference in the number of anastomoses (group A: 2.76 ± 1.00 vs. group B: 2.63 ± 0.80; p = 0.45) or the use of bilateral internal thoracic arteries (78.7% vs. 81.4%; p = 0.80). Postoperative angiography was carried out in 97 patients. The graft patency rate was 96.9% (126/130) in group A and 99.2% (131/132) in group B (p = 0.37). The stenosis free rate was 92.3% (120/130) in group A and 93.1% (123/132) in group B (p = 0.82). There were no operative deaths, no hospital deaths, and no late cardiac deaths. Postoperative atrial fibrillation occurred in 14 patients (29.7%) of group A and 12 (22.2%) of group B (p = 0.49). Wound dehiscence occurred in 2 patients (4.3%) of group A and 5 (9.3%) of group B (p = 0.44). Postoperative hospital stay lasted 22.1 ± 9.5 days in group A and 21.7 ± 9.1 days in group B (p = 0.86).
Conclusions: OPCAB is feasible in patients having poorly controlled diabetes mellitus, and their condition does not compromise the surgical outcome. (Ann Thorac Cardiovasc Surg 2009; 15: 18–22)

Key words: off-pump, diabetes mellitus, coronary artery bypass grafting, morbidity

Introduction

Modern coronary revascularization treatment, which includes coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI), has been rapidly evolving and is widely applied. Off-pump coronary artery bypass grafting (OPCAB) has been used even in high-risk groups, a result of the development of equipment and techniques.[1–7]

Especially, the indication for PCI has been expanded along with the emergence of drug-eluting stents and patients previously considered at a high risk being referred for cardiac surgical intervention.[8] Patients with diabetes mellitus are now considered suitable to undergo CABG by means of more reliable and possible revascularization.[9] However, diabetes mellitus has been reported to be associated with poor long-term outcome

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Table 1. Preoperative variables

Variables	Group A (n = 47)	Group B (n = 54)	P value
Age	66.2 ± 10.3	64.8 ± 9.7	0.49
Female (%)	10 (21%)	11 (20%)	0.99
Body mass index	23.7 ± 3.4	24.6 ± 4.9	0.26
Preop NYHA class	2.2 ± 0.9	2.2 ± 0.9	0.86
Preop EF	54.5 ± 14.8	53.2 ± 13.6	0.67
AMI (%)	0	5 (9.3%)	0.06
Hypertension (%)	32 (68%)	39 (72%)	0.67
Diabetes treatment			0.05
Diet therapy (%)	26 (55.3%)	20 (37.0%)	0.28
Oral medication (%)	14 (29.8%)	19 (35.2%)	0.99
Insulin therapy (%)	7 (14.9%)	15 (27.8%)	0.07
Hyperlipidemia	26 (55.3%)	37 (68.5%)	0.22
Chronic renal failure	8 (17.0%)	3 (5.5%)	0.10
Peripheral vascular disease	8 (17.0%)	5 (9.3%)	0.37
COPD	2 (4.3%)	0	0.15
LMT	13 (27.7%)	13 (24.1%)	0.56
History of preoperative PCI	8 (17.0%)	10 (18%)	0.99
HbA1c	5.7 ± 0.5	7.5 ± 0.8	0.0001

NYHA, New York Heart Association; EF, ejection fraction; AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease; LMT, left main trunk; PCI, percutaneous catheter intervention; HbA1c, hemoglobin A1c.

after CABG as compared with other low-risk patients.[10,11]

On the other hand, it is well known that hemoglobin A1c (HbA1c), which reflects long-term glycemic control, is related to diabetic morbidity and mortality. But the relationship between preoperative glycemic control and early postoperative surgical outcome after OPCAB has not yet been clearly established.[12] The aim of this study is to preoperatively estimate the postoperative outcome of the OPCAB in patients with poorly controlled diabetes mellitus.

Patients and Methods

A total of 183 patients underwent OPCAB from January 2000 to January 2007. Of these, 101 who had been diagnosed as diabetic and treated medically were assigned to this study. Those who required concomitant cardiac procedures or who had previously undergone bypass surgery were excluded from the analysis. HbA1c was determined preoperatively for all the patients by ion capture assay on serum, and a value of 6.5% was used as a threshold for controlled hyperglycemia. Patients were allocated to group A (HbA1c <6.5, n = 47) or group B (HbA1c >6.5, n = 54).

All preoperative medications, including β blockers, angiotensin-converting enzyme inhibitors, and calcium antagonists, were continued up to the day of the operation—except for nonsteroidal anti-inflammatory drugs, which were discontinued one week before surgery, and Digoxin, which was discontinued 3 days before surgery.

We have favored multiple and complete coronary revascularization with composite or sequential grafting. Arterial grafts, especially *in situ* arterial grafts, are preferred. To prevent arterial spasm, diltiazem (0.5–1.0 μg/kg) or nicardipine (0.1–0.2 μg) was continuously infused (IV) intraoperatively and during the first 16 hours after the operation. Oral diltiazem (100 mg/day) or amlodipine (2.5–5.0 mg/day) was then prescribed in conjunction with aspirin (81 mg/day), beginning on the next morning. The blood sugar level was controlled intraoperatively and in the intensive care unit by a continuous intravenous infusion of insulin; preoperatively, it was controlled by the specialists, using medications or diet restriction. During several postoperative days, medical therapy was gradually adjusted based on consultation with the diabetes specialists.

Baseline demographic and clinical data were available for all patients, and initial data were collected from the medical records. Preoperative variables are shown in Table 1. As preoperative status, there was no difference in age (p = 0.49), sex (p = 0.99), body mass

Table 2. Intraoperative variables

Variables	Group A (n = 47)	Group B (n = 54)	P value
Operative time (min)	346 ± 95	344 ± 89	0.89
Number of anastomoses	2.76 ± 1.00	2.63 ± 0.80	0.45
Use of bilateral ITA (%)	37 (78.7%)	44 (81.4%)	0.80
Use of GEA	11 (23.4%)	6 (11.1%)	0.12
Use of IABP (%)	4 (8.8%)	13 (24.1%)	0.07

ITA, internal thoracic artery; GEA, gastroepiploic artery; IABP, intra-aortic balloon pump.

Table 3. Postoperative outcome

Variables	Group A (n = 47)	Group B (n = 54)	P value
Neurological complication (%)	0	1 (1.9%)	0.99
Wound dehiscence (%)	2 (4.3%)	5 (9.3%)	0.44
Atrial fibrillation (%)	14 (29.7%)	12 (22.2%)	0.49
Reexploration (%)	0	1 (1.9%)	0.99
Postoperatrive renal failure (%)	3 (6.4%)	0	0.09
Mediastinitis (%)	1 (2.1%)	1 (1.9%)	0.99
Early postoperative respiratory dysfunction	3 (6.4%)	1 (1.9%)	0.15
Postoperative stay (days)	22.1 ± 9.5	21.7 ± 9.1	0.86
Operative deaths (%)	0	0	0.99
Hospital deaths (%)	0	0	0.99
Late cardiac deaths (%)	0	0	0.99

index (p = 0.26), New York Heart Association (NYHA) class (p = 0.86), preoperative ejection fraction (EF) (p = 0.67), or presence of left main trunk (LMT) lesion (p = 0.56). Postoperative angiography was routinely performed approximately one week after surgery.

Pre- and postoperative renal failures were defined as a rise in serum creatinine of 1 mg/100 mL above baseline. Postoperative mortality and morbidity were examined retrospectively. The mean follow-up term was 2.4 ± 1.6 years.

The institutional approval for this study was obtained, and each patient within the study gave informed consent to serve as a subject.

Statistical methods

All data were reviewed retrospectively. All continuous values are expressed as the mean ± standard deviation (SD). Intergroup differences were evaluated by univariate analysis (the χ^2 test, the two-tailed *t*-test, and the Mann-Whitney U test, as appropriate). A p value of <0.05 was set as the level of statistical significance.

Results

Intraoperative variables are shown in Table 2. There was no difference in operation time (p = 0.89), number of anastomoses (p = 0.45), or use of intra-aortic balloon pumping (IABP) (p = 0.07).

Postoperative angiography during hospital stay after surgery was routinely carried out in 97 patients (96%). Graft patency rate was 96.9% (126/130) in group A and 99.2% (131/132) in group B (p = 0.37). The stenosis free rate (stenosis of more than 75%) was 92.3% (120/130) in group A and 93.1% (123/132) in group B (p = 0.82). There was no difference between the two groups in angiographic results.

The postoperative outcome is presented in Table 3. There were no operative deaths, hospital deaths, or late cardiac deaths. Postoperative neurological complications occurred in 1 patient in group B (p = 0.99). Wound dehiscence occurred in 2 patients (4.3%) in group A and in 5 (9.3%) in group B (p = 0.44). Atrial fibrillation occurred in 14 patients (29.7%) in group A and in 12 (22.2%) in group B (p = 0.49). A reexploration was performed in 1 patient in group B (1.9%). Mediastinitis occurred in 1 patient in both groups (p = 0.99). The duration of postoperative hospital stay was similar in the two groups (group A: 22.1 ± 9.5 days; group B: 21.7 ± 9.1 days) (p = 0.86).

Table 1 shows the preoperative diabetic treatment provided in each group. Seven patients of group A received insulin therapy preoperatively, and the average dose was

29.3 ± 15.5 mg per day. In group B, 15 patients of group B had received the insulin therapy preoperatively, and the average dose was 33.3 ± 14.7 mg per day.

Discussion

Therapy for coronary artery disease has advanced dramatically in the past decade. In the area of cardiac surgery, OPCAB has been widely accepted because of the remarkable improvement of both adjuncts and techniques.[1–8] With this less invasive strategy, the operative indication has been expanded to older and high-risk patients.[9]

Diabetes mellitus is a well-known significant risk factor for coronary disease. Most patients who need surgical or medical treatment for coronary disease have diabetes mellitus of a greater or lesser severity.

The influence of diabetes mellitus on the operative outcome of CABG has been discussed in many reports.[10,11,13] Ono et al. reported that the presence of diabetic retinopathy was a strong independent risk factor of all causes of mortality after CABG.[13] On the other hand, Choi et al. reported that diabetes with or without insulin treatment was not a risk factor for operative mortality and morbidity.[10] Several authors previously reported the relationship also between diabetes and surgical site infection.[14] Latham et al. reported that postoperative hyperglycemia and previously undiagnosed diabetes were associated with the development of surgical site infections among the cardiothoracic surgery patients in a group of 1,000 consecutive patients.[14]

It is well known that poor glycemic control is strongly related to diabetic complications. HbA1c, which is a marker of long-term glycemic control, is also related to diabetic complications. HbA1c reflects the average glucose level over the preceding 2 to 3 months.[12] Medhi et al. used this variable as a predictor of the surgical outcome of CABG. They reported that HbA1c was a predictor of the postoperative hospital stay after CABG.[11] In the present study we found no significant difference in operative outcome, occurrence of surgical site infection, or postoperative hospital stay. This result suggested that OPCAB can be safely performed in patients with even poorly controlled diabetes.

In this group, the therapeutic status did not correlate with the preoperative HbA1c level. This result suggested that it is important to accurately determine the status of diabetic control preoperatively, regardless of preoperative diabetic therapy. Latham et al. also found this discrepancy between preoperative HbA1c and preoperative therapeutic status.[14] They reported that 42 out of 700 patients who had not been considered to have diabetes had > 7% HbA1c level. O'Sullivan et al. described the prognostic significance of HbA1c in patients without diabetes undergoing vascular surgery.[15] In their report, suboptimal HbA1c levels were found in 58% of the patients without diabetes. These results remind us that there are many potentially diabetic patients who are not treated preoperatively. It is important to determine the real diabetic status before surgery to properly control the blood sugar level.

Study Limitations

This was a retrospective study that involved a small number of patients in a single institution. Moreover, the postoperative hospital stay was much longer than that previously reported. This was because we routinely performed postoperative angiography one week or 10 days after the operation.

Conclusions

OPCAB can be safely performed in patients with poorly controlled diabetes mellitus without compromising surgical quality and strategy.

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