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Original Article

Effect of preoperative glycemic status on postoperative complications of coronary artery bypass graft surgery in patients with diabetes

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Abstract

Objectives: Diabetes mellitus is one of the major risk factors for cardiovascular disease, and increases the risk of postoperative mortality. HbA_{1c} is a measure of glycemic control. This study aimed to determine the effect of glycemic status on the complications of coronary artery bypass graf (CABG) surgery in diabetic patients.

Methods: This cross-sectional study was performed on 300 diabetic patients including 186 (62%) men and 114 (38%) women who underwent CABG from March 2010 to August 2011 and selected via census method. Preoperative blood glucose control status was determined using HbA_{1c} levels, and the patients were evaluated for postoperative in-hospital complications.

Results: The mean age of the patients was 62.3 ± 6.9 years. In-hospital mortality was 1.0% (3/300). New-onset atrial fibrillation was the most common complication (35%). HbA_{1c} level above 7.5% was a predictor of in-hospital mortality after CABG (unadjusted odds ratio 1.9, 95٪ CI: 1.1-3.2, p = 0.006). After stratifying analysis with Chi-sqaure test we found that gender history of myocardial infarction had no significant relationship with HbA_{1c} level in two groups with or without complication.

Conclusions: Long-term uncontrolled blood glucose before CABG is associated with increased postoperative complications. Preoperative HbA_{1c} measurement can be a predictor of high-risk patients.

Keywords: Diabetes mellitus; HbA_{1c}; CABG; Postoperative mortality; Glycemic control

Introduction

Diabetes mellitus is one of the major risk factors for coronary artery disease with a global prevalence of 8.5% (1, 2). The rapid growth of diabetes has become a major challenge for health systems due to aging, inactivity, obesity, and poor eating habits (3). Currently, 25-50% of patients undergoing coronary artery bypass graf (CABG) surgery have diabetes (4). Studies have shown that uncontrolled blood sugar leads to more postoperative complications in both diabetic and non-diabetic patients. On the other hand, by controlling blood sugar before surgery, complications are reduced. HbA1c is a measure of both the diagnosis and control of diabetes. Studies have shown that elevated preoperative HbA1c is an important predictor of in-hospital mortality after CABG (5-9). The prevalence of prediabetes and diabetes in the ancient city of Yazd in the centrr of Iran is 25.8% and 14.1%,

respectively (10, 11). One-third of the patients undergoing CABG surgery in Iran have diabetes (12). Due to the high prevalence of diabetes mellitus and glycemic dysfunction in this area as well as the high volume of the patients with coronary artery disease undergoing CABG surgery, this study was performed to evaluate the effect of preoperative glycemic status on postoperative complications.

Materials and Methods

This cross-sectional study was performed on 300 diabetic patients, including 186 (62%) men and 114 (38%) women who were undergone coronary artery bypass grafting (CABG) from March 2010 to August 2011 via census method. The study was conducted after approval by the Ethics Committee of Yazd Islamic Azad Medical School. Patients with diabetes who were previously diagnosed according to criteria provided by the American Diabetes Association (ADA) were included in this study. Diabetic patients with chronic kidney disease or stroke or chronic liver or lung disease or redo surgery and patients who did not consent to the study were excluded from the study. For each patient, a questionnaire containing demographic information and past medical history and coronary angiography data, and echocardiographic findings was completed. All the patients were evaluated for left ventricular systolic and diastolic function and valvular function before surgery by transthoracic echocardiography. To assess glycemic status, a venous blood sample was obtained to measure HbA1c (Pars Azmoun, Tehran, Iran) at the preoperative time and HbA1c levels were reported as a percentage of total hemoglobin. Complications related to the operation were also recorded during the hospital stay. All the surgeries were performed by off-pump CABG (opCABG) and by one cardiac surgeon. All the patients were consulted by an endocrinologist during hospitalization and their blood sugar was adjusted. After surgery, the patients were undergone hemodynamic monitoring and taken medical treatments in the intensive care unit. Patients with complications were kept in the hospital until complete recovery.

All statistical analyses were performed by using SPSS version 11 (SPSS inc. Chicago il.USA). Continuous variables are expressed as mean and standard deviation and categorical variables were expressed as percentage and number. Quantitative variables were analyzed through the Chi-square test and continuous variables with the Student T-test. ANOVA test was used to compare the means of groups, and for correlation of variables, Spearman regression analysis was used. Linear regression models were used for confounder adjustment. A p-value of less than 0.05 was considered significant.

Results

The mean age of the patients was 62.3±6. 6.9 years. Diabetes control was 20% with insulin injection and 71% with oral antihypertensive agents, and 9% did not receive treatment. 32% of the patients had some degree of retinopathy or neuropathy or nephropathy. 69% of patients had severe stenosis in all territories of the coronary artery and 81% had a history of myocardial infarction. The mean preoperative LVEF was 47.6±9.8%. The mean duration of surgery was 165±38.4 minutes. The mean preoperative HbA1c level was 7.86±1.15%. The in-hospital mortality rate was 1% (3 cases). All three deceased patients had HbA1c above 7.5%. The prevalence of new atrial fibrillation (AF) was 35% (105 cases) (Table 1). HbA1c level was significantly higher in the patients with positive histories of diabetes complications or CAD (Coronary Artery Disease) risk factors other than diabetes or insulin therapy for control of DM or age of less than 80 yr (Table 2).

After stratifying analysis with Chi-square test we found that gender or history of myocardial infarction MI had no significant relationship with HbA1c level in two groups with or without complication.

The mean hospital stay was 6.4±1.2 days and during this period,153 patients had at least one complication (51%). 141 patients had an HbA1c level of less or equal to 7.5% (60 patients with complication) and 159 patients had an HbA1c level of higher than 7.5% (93 patients with complication) Unadjusted odds ratio of total complications was 1.9 (95% CI:1.1-3.2, p-value=0.006). There was a significant linear correlation between HbA1c level and LVEF (Rho=0.321),(p-value =0.001).

Discussion

This study showed that uncontrolled preoperative glycemic status, characterized by increased HbA1c levels, is a common finding and associated with an increased risk of postoperative death. HbA1c levels of more than 7.5% predicted a 1.9-fold increase in fatal and non-fatal complications. Our findings are similar to other studies. The studies showed an elevated HbA1c can predict short-term adverse outcomes, such as postoperative myocardial infarction, deep sternal wound infection, stroke, renal failure, and short-term mortality (9, 13). Carson et al. Showed that

deaths in diabetics were 40% higher than in non-diabetics within 30 days of CABG (14).

Table 1. Frequency of in-hospital nonfatal complications

Complication	Frequency(%)
New onset AF	105(35)
Bleeding	54(18)
Respiratory failure	24(8)
Heart failure	18(6)
Cardiac tamponade	15(5)
Wound infection	12(4)
Renal failure	9(3)
CVA	6(2)
GI bleeding	3(1)

Table 2. Comparison of HbA1c level and clinical characters between diabetic patients with and without post CABG complications

Clinical character	HbA1c level (mean± SD) without complication N=147	HbA1c level (mean± SD) with complication N=153	P-value
Prior MI (N=243)	7.63±1.14	7.87 ±0.07	0.118(NS)
DM complication (N=96)	7.37 ±0.9	8.68 ± 1.05	0.01 (S)
CAD risk factors (N=217)	7.01 ±1.17	7.89± 1.14	0.002 (S)
Insulin therapy (N=60)	7.22 ±0.64	8.47 ± 1.2	0.001 (S)

Mediastinitis and superficial sternal wound infections are more common in diabetes (15). Diabetes also predicts neurological and renal complications and more longer stay in the intensive care unit. Diabetics are five times more likely to have renal failure than non-diabetics following cardiac surgery (16). Poor outcomes in diabetic patients have been attributed to left ventricular dysfunction, endothelial dysfunction, diffuse coronary artery disease, platelet dysfunction and abnormal fibrinolysis, and impaired glucose utilization (17). Intensive glycemic control in acute coronary syndrome, as well as post-CABG surgery, can improve survival. A study of 141 diabetic patients undergoing CABG surgery showed that tight control of blood glucose (serum glucose, 125-200 mg/dL) with the use of glucose-insulin-potassium (GIK) solution versus standard treatment with the use of intermittent subcutaneous insulin injection before anesthesia and its continuation for 12 hours after the surgery has reduced the risk of atrial fibrillation and the length of hospital stay. Meanwhile, intensive control of blood glucose using GIK solution improves survival and reduces the incidence of wound complications and ischemic events (18). Van den Berghe's study on 1,548 patients undergoing CABG surgery confirmed a reduction in mortality from 8% to 4.6% using intensive insulin therapy. In another trial on 1,200 ICU patients, intensive insulin therapy not only did not reduce mortality but also increased the hypoglycemia rate to 18.7% (19, 20). However new studies show that the risk of hypoglycemia is not less than hyperglycemia and it is recommended to maintain blood glucose in the range of 140-180 mg/dl before surgery (21). The prevalence of atrial fibrillation (AF) after CABG is 25% to 40% and is associated with a two-fold increase in the risk of postoperative stroke and it is also the most common cause of longer stay in hospital. Pathogenesis of postoperative AF is assumed adrenergic activation, atrial ischemia, inflammation, electrolyte disturbances, and genetic factors. Diabetes is known as one of several risk factors for AF after open-heart surgery (22). New-onset arterial fibrillation after coronary artery bypass grafting can cause an increase in short- and long-term mortality (23). Although DM control may appear to reduce the risk of postoperative AF, it is noted that there is an inverse relationship between the incidence of AF and HbA1c levels, which may be related to insulin (24).

Our study has some limitations such as selection bias due to non-random selection of diabetic

patients with the preference of the surgeon and therefore did not include all diabetic patients. Patients have only been observed for complications during their hospital stay, while there is a chance of complications after discharge and we are unaware. There were some confounding factors in this study that certainly affected the study, but we have not been able to eliminate them all.

Conclusion

Our study showed that an uncontrolled glycemic state for a long time before coronary artery bypass grafting is associated with increased postoperative complications. The chance of fatal and non-fatal complications is approximately 1.9 times higher at the HbA1c level above 7.5%.

According to the results of this study, screening patients before CABG surgery and determining the patient's glycemic status, and correcting glycemic disorders for at least three months before surgery is acceptable if the operation can be postponed.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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