Coronary Artery Bypass Grafting (CABG) -Complications In Diabetics

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Abstract
Introduction: To study the post operative complications in diabetics, who underwent Coronary Artery Bypass Grafting (CABG).
Methods: A cohort study of two months was conducted on 48 diabetic patients who underwent CABG. The blood sugar levels of insulin dependent diabetics, who were given intermittent insulin infusion were monitored pre-operatively, intra-operatively and post-operatively. The patients were followed up for a period of two months for development of stroke and infections. Significance of association was found between glycemic control and the incidence of stroke and infection in these patients.
Results: The incidence of stroke in the total of 48 patients was found to be 2.08%. The mean blood sugar level in patients with Grade 1 and Grade 2 infection were 247.22 mg per dL and 247.63 mg per dL respectively. The incidence of mortality was 8.33%. Risk of infection was 16.21% while risk of stroke in patients with poor glycemic control was assessed as 8.1%.
Conclusion: The incidence and risk of stroke, mortality and infection, though not remarkably high but was higher in patients with poor glycemic control within two months of CABG procedure.
Key Words: CABG, Diabetes, Blood Sugar, Infection, Stroke, Mortality, Insulin.

Introduction
In 2008, about 17.3 million people died due to cardiac vascular diseases (CVDs) and on global scale, it approximated to be 30% of deaths. Pakistan is a low-income country and according to WHO conducted studies, about 80% of CVD deaths and diabetes deaths, occur in low and middle-income countries.1,2 The statistics on the incidence of ischemic heart disease (IHD) in Pakistan are currently not established. Worldwide, about 347 million people are diabetic.3 According to a recent national survey in Pakistan 35% of people above 45 years of age are diabetic.4 It is estimated that about 30-40% of CABG patients also have diabetes mellitus or metabolic syndrome.5
IHD can be treated by medication, interventional methods (stents) and through surgery, depending upon the health and disease profile of the patient. CABG (coronary artery bypass grafting) is the open heart surgery done to treat people with severe Coronary Heart Disease (CHD). In CABG, saphenous vein or internal mammary artery is used to bypass the stenosed coronary artery.
American Heart Association (AHA) guidelines, 2011 prefer CABG on interventional treatment as diabetics have diffuse disease. Mortality rate has been more in patients treated with stents than those who underwent CABG.6 Complications occur more in diabetics after CABG surgery. These include stroke and deep sternal wound infection, increased morbidity and mortality.6
In AHA guidelines, the perioperative glucose control by continuous, short acting intra venous insulin is preferred over the intermittent subcutaneous insulin administration and according to American Diabetes Association and American Association of Clinical Endocrinologists the treatment of critically ill patients should start from the threshold of >180 mg per dL and blood sugar level should be maintained within 140 to 180 mg per dL with IV insulin therapy.7,8

Patients and Methods
This cohort study was carried out for three months duration at Rawalpindi Institute of Cardiology. Patients with coronary artery disease, who were insulin dependent diabetics were included in this study. Non-insulin dependent diabetics and patients aged above 80 years were excluded from the study. Two blood sugar samples were taken during surgery and during the following five post-op days three blood sugar samples were taken each day, that is, one fasting reading (BSF) and two random readings (R1 and R2) were taken eight hours apart. Blood sugar concentration <70 mg per dL or >200 mg per dL was considered poor blood sugar control, whereas those having blood sugar within the range of 70 to 200 mg
per dL were considered to have acceptable blood sugar control. All 48 patients were followed up over a period of 2 months when at completion of second month of procedure they were again assessed for any incidence of stroke and infection. One patient died on day 3 and another on day 8 after procedure. Patients were divided into two groups. Group 1 patients having inadequate glycemic control (average blood sugar > 200 mg/dl) and Group 2 patients with adequate glycemic control (average blood sugar < 200 mg/dl). The average levels of the blood sugar levels determined at 8 different times including the preoperative, intraoperative and 15 postoperative readings.

According to U.S. Centers for Disease Control and Prevention (CDC), during sternal exploration, if pathogens from the mediastinal fluid or tissue were obtained then infection of mediastinum was diagnosed. Combination of clinical features including chest pain, fever (>38 degree Celsius), pus discharge from mediastinum and/or sternal instability (the failure of sternum to heal after surgery or trauma, indicated by persistent pain and grinding or clicking sensations) also indicate mediastinitis. After surgery, patients were monitored for 5 days and the incidence of chest pain, pus discharge, fever (>38 degree Celsius) and sternal instability was checked for 5 days post-op with the interval of 24 hours, to ascertain the presence or absence of infection in mediastinum. Presence of pus discharge and sternal instability were considered as prime indicators.

Post-operative infection in three subclasses: Those patients were said to have grade three infection who developed neither pus discharge nor sternal instability but had chest pain and/or fever, while patients were said to have grade two infection who had pus discharge or sternal instability along with chest pain and/or fever. Patients with grade one infection had all the above mentioned parameters positive. Stroke was defined as the loss of brain’s function due to vascular causes which include infarction and hemorrhage of the cerebrum and subarachnoid hemorrhage, resulting in brain ischemia (loss of blood supply). Independent samples t-test was applied to compare the mean blood sugar levels for groups based on gender, infection and stroke. Stratified analysis was performed to determine the difference of crude relative risk and adjusted relative risk based on hypertension status, a potential confounder, in those who developed stroke and those who did not. A difference of less than 10% showed absence of any confounding effect.

**Results**

Out of the total of 48 patients, 70.8% of the subjects were male. Age ranged from 35 to 73 years with a mean of 56.56±8.14 years. The time in years since diabetes had been diagnosed in patients ranged from 0 to 38 years with a mean value of 7.10 (±7.05) years. The mean value of pre-operative blood sugar fasting was 179.39 (±71.23) mg/dl, intra-operative was 261.71 (±81.23) mg/dl and of day 5 1st random sugar level was 244.04 (±85.17) mg/dl. The average (mean) of all the blood sugar levels for readings of 5 days for each patient was determined and its overall mean value was calculated to be 233.82 (±42.38) mg/dl. The mean of average blood sugar of 5 days was 222.9382 (±38.09) mg/dl for males and 243.01 (±51.53) mg/dl for females, difference not statistically significant (p=0.33) exhibiting homogeneity of average blood sugar levels based on gender. The number of patients falling in ‘group 1’ was 10 (20.8%) and ‘group 2’ was 38 (79.2%). One patient expired on 3rd post operative day. Another patient died on 8th post operative day. The incidence of development of stroke was 3 in those with poor glycemic control, whereas no one developed amongst those with good glycemic control. The risk of development of stroke in those with poor glycemic control was assessed as 8.1%. The mean values of average blood sugar levels of 5 days of those who developed stroke compared to those who did not were 242.20 (± 15.86) mg/dl and 233.25 (± 43.64) mg/dl respectively and this difference was not statistically significant with a p-value of 0.72. The differences of
blood sugar levels monitored pre operatively, intra operatively and then thrice daily for 5 post operative days for those who developed or did not develop stroke were also not statistically significant (Figure 1). The incidence of infection in patients with good glycemic control was nil while it was 6 amongst those who had poor glycemic control indicating a risk of infection as 16.21% in patients with poor glycemic control. The mean values of average blood sugar levels of 5 days of those who developed infections compared to those who did not were 229.38 \(+11.89\) mg/dl and 234.24 \(+44.22\) mg/dl respectively and this difference was not statistically significant with a p-value of 0.82 (Figure 2). Amongst the 6 patients who developed infection two patients presented with grade 1 infection while 4 patients presented with grade 2 infection, no one was found to have grade 3 infection. The risk of development of grade 1 infection was therefore 5.3%, while that of grade 2 was 10.5%. The mean of average blood sugar level in patients with Grade 1 infection was 247.22 \(+14.34\) mg per dL. The mean of average blood sugar level in patients with Grade 2 was 247.63 \(+48.36\) mg per dL.

Considering the confounding effect of Hypertension on development of stroke, stratified analysis showed that the difference of crude relative risk (risk of stroke without stratifying) and the adjusted relative risk was 1.42\% (less than 10\%), hence there was no confounding effect of hypertension in our sample (Figure 3).

![Figure 3](image)

**Figure 3:** Comparison of incidence of stroke with glycemic controls amongst hypertensives and non hypertensives

**Discussion**

In patients of coronary artery disease the risk of cardiovascular events in comparison to non-diabetics is higher in diabetic patients.\(^{11}\) In patients undergoing CABG, diabetes happens to be the most common co-morbid factor, that is, 34\%.\(^{12,13}\) A study in America showed that type-2-diabetes was most frequent in people within the age group ≥65 years and in our study the findings were ≥55 years.\(^{14}\) In Bangladesh, the mean age group was 53.2 \±10.5 years and in our study it was 56.56\±8.14 years. The mean age of the onset of diabetes was 46.9\±9.9 years and in our study it was 49.46\±10.48.\(^{15}\)

In Rawalpindi Institute of Cardiology, diabetic patients undergoing CABG are given intermittent insulin infusion intra-operatively and the blood sugar levels are safely maintained ≤200 mg/dl, but Society of Thoracic Surgeons recommends that continuous insulin infusion intra-operatively is the preferred method and the blood sugar levels are to be maintained ≤180mg/dl.\(^{16}\) The Society for Healthcare Epidemiology of America suggests that postoperatively the blood glucose levels should be maintained below 200mg/dl and this measure is taken in RIC as well.\(^{17}\) The mean value of Pre-Op glucose serum levels in a study published in Texas Heart Journal Institute was 174.4 mg/dL and on 5\th Post-Op Day the mean value was 206.2 mg/dL. In contrast, our study showed 179.39 mg/dL and 244.04 mg/dL respectively.\(^{18}\)
Post-operative infection after surgical procedure is commonly caused by uncontrolled hyperglycemia. The analysis of relation between glycemic control and complications (infection and stroke) was not statistically significant in our study. In another study including eighty-two diabetic patients who had tight glycemic control (90-120 mg/dl) peri-operatively and those diabetics who had moderate glycemic control (120-180 mg/dl) had not many differences regarding major adverse effects after CABG. These patients particularly had no difference given the rate of mortality. With aggressive glycemic control attained by intravenous insulin infusion patients had decreased incidence of surgical site infections. It has been repeatedly shown in different studies that continuous insulin infusion and controlling blood sugar levels post-operatively below 150-160 mg/dl decreases the incidence of sternal wound infection. The frequency of sternal wound infection was 4.8% in one of these studies while our finding was 2.08%. National Surgical Quality Improvement Program concludes that for the post-operative prevention of surgical site infections, serum glucose levels should be >200 mg/dl in cardiothoracic patients during immediate post-operative period. The probability of stroke in diabetic patients is more in women as compared to men. Results of this study did not show remarkable incidence of infection and stroke in diabetic patients undergoing CABG, who were given intermittent insulin injections.

Conclusion

The incidence and risk of stroke, mortality and infection was not remarkably higher in diabetic patients within two months of CBAG procedure who had received intermittent Insulin infusion during procedure, but these parameters were higher in patients with poor glycemic control as compared to the patients with good glycemic control.

References