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Association of Glycemic Status and Admission Serum Troponin-I Level in Acute ST-Elevation Myocardial Infarction

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Abstract

A cross-sectional, analytical study was conducted in Mymensingh Medical College Hospital, Mymensingh, Bangladesh, between January and December of 2021, to observe glycemic status in patients of acute ST-elevation myocardial infarction and its association with admission serum troponin-I level. Patients were recruited from the Department of Cardiology. All physical parameters were studied and recorded in the Department of Cardiology, while the biochemical tests were done in the Department of Physiology of the same institution. A total of 70 patients having acute ST-elevation myocardial infarction participated in this study. They were grouped as control group (Group-I) i.e., normoglycemic, and study group (Group-II) i.e., hyperglycemic but non-diabetic. Patients' general (demographic) information, personal history, physical parameters, i.e., height, weight, BMI, temperature, pulse, systolic and diastolic blood pressure, results of biochemical tests (e.g., serum troponin-I, random plasma glucose, and HbA1c), and ECG reports were recorded. Serum troponin-I, random plasma glucose and HbA1c were measured using Time-resolved Fluorescence Immunoassay Autoanalyzer. Serum troponin-I levels during admission were found 11.65±8.38 ng/ml and 21.75±9.53 ng/ml in group I and group II respectively ($p<0.001$). Simultaneous plasma glucose levels (random) were estimated 5.69±0.86 mmol/L and 10.24±1.35 mmol/L respectively ($p<0.001$), while HbA1c were found 5.18±0.34% and 5.54±0.51% respectively ($p>0.05$). A positive correlation was found between serum troponin-I and random plasma glucose levels both in control and study groups ($r=0.539$; $p<0.001$). However, no correlation was observed between serum troponin-I and Hb1c in both groups ($r=0.363$; $p>0.05$).

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Introduction

Research revealed that South Asian populations have high cardiovascular disease (CVD) burden in the world.[1] The role of hyperglycemia in the development of cardiovascular complications in acute myocardial infarction (AMI) patients is often overlooked, and thus, remains unclear.[2] Surprisingly, hyperglycemia, as determined by using a simple, low-cost laboratory test, has been associated with a worse prognosis in MI patients, even in the absence of diabetes.[3-5] Moreover, AMI patients with new hyperglycemia had a 3.6-fold increased risk of mortality during hospitalization in comparison to those who were normoglycemic Patients either with or without a prior history of diabetes mellitus may present with hyperglycemia during acute myocardial infarction.[5] Among patients with no prior history of diabetes, hyperglycemia may reflect previously undiagnosed diabetes, preexisting carbohydrate intolerance, stress -related carbohydrate intolerance, or a combination

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of these.[7-10] Several studies have reported an association between elevated blood glucose upon admission and subsequent increased adverse events such as congestive heart failure, cardiogenic shock, and death.[3-10] Hence, observation of plasma glucose level in non-ST elevation myocardial infarction is crucial.

Now-a-days, acute myocardial infarction has become a very common disease in a low-resource country like Bangladesh. Invasive method like angiogram facility is very limited here, which is very crucial to assess the severity of coronary artery diseases. However, an elevation of troponin-I level in the early phase of AMI has been recently advocated as an important prognostic factor by several studies. In our low-resource settings, we can avail evaluation of serum troponin-I level to predict the disease severity and correlate it with plasma glucose level, which is also a cheap and easily available method.

A few studies were conducted in patients with non ST-elevation myocardial infarction patients in the country;[2,11-13] however, there is scarcity of evidence on ST-elevation myocardial infarction. Hence, we proposed this study to compare glycemic status in patients of acute ST-elevation myocardial infarction and determine its association with admission serum troponin-I level.

Methods

This prospective, analytical study was conducted in Mymensingh Medical College Hospital, Mymensingh, Bangladesh, between January and December of 2021. Patients were recruited from the Department of Cardiology.

Inclusion Criteria:

1) Patients with first attack of ST-elevation myocardial infarction (the diagnosis was done according to the 'third universal definition of myocardial infarction');[14]
2) For the control group (Group-I): normal plasma glucose level (Random) <7.8 mmol/L, with ST elevation myocardial infarction; plasma glucose level; and
3) For the study group (Group-II): elevated plasma glucose level (but not diabetic) plasma glucose level (Random) >7.8 mmol/L.

Exclusion Criteria:

1) Patients having any previous history of myocardial infarction (MI);
2) Patient known to having diabetes mellitus (DM), valvular heart disease, congenital heart disease and cardiomyopathies;
3) Patients having major non-cardiovascular disorders which may cause elevation of troponin-I, such as severe renal impairment, prolonged immobilization, major surgery, chest trauma, rheumatoid arthritis, myocarditis (pericarditis), acute pulmonary embolism, prolonged tachyarrhythmia, etc;
4) Patients having any systemic infection; and
5) Patients under chemotherapy for any known malignancy.

In the data collection sheet, the items included were patients' general (demographic) information, personal history, physical parameters, i.e., height in meters, weight in kg, BMI, temperature, pulse, systolic and diastolic blood pressure (in mm of Hg) and results of biochemical tests (e.g., serum troponin-I, plasma glucose, and HbA1c). Baseline and prognostic ECG were done and recorded. All physical parameters and ECG were studied and recorded in the Department of Cardiology, while the biochemical tests were done in the Department of Physiology. The troponin kit reagent used in this study has a cut-off value of 0.30

ng/ml for diagnosis of acute myocardial infarction. Diagnostic cut-off value for raised troponin indicating myocardial infarction were set at 2µg or higher (according to the ACC/AHA guidelines).[15] Serum troponin-I, plasma glucose (random) and HbA1c levels were measured using Time-resolved Fluorescence Immunoassay Autonalyzer (Bioscience Axceed P200; made in China). ECG was done by using Fukuda Denshi-FX-2111 EKG Machine (made in Japan).

Collected data were screened through editing, coding, and final verification. Data analysis was performed by using Statistical Package for Social Sciences (SPSS) version 23.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Data was expressed as mean±SD. Comparison between the groups was done using unpaired Student's 't' test. A p-value <0.05 was considered as statistically significant. Correlations between admission serum troponin-I levels and plasma glucose (random) and HbA1c levels were determined using Pearson's correlation test.

The study protocol was approved by the Institutional Review Board (IRB) of Mymensingh Medical College, Mymensingh, Bangladesh (MMC/IRB/2021/342).

Results

Among the study participants, BMI were found 20.24±1.65 kg/m^2 and 20.61±1.97 kg/m^2 in group-I and group-II respectively. Mean systolic blood pressure was 113.70±16.44 mm of Hg in group-I and 118.60±19.34 mm of Hg in group-II, while mean diastolic blood pressure were observed 73.33±10.38 mm of Hg and 74.65±11.41 mm of Hg respectively. No difference was observed in BMI and blood pressure between the groups (p>0.05) (Table-I). Serum troponin-I levels at admission were found 11.65±8.38 ng/ml and 21.75±9.53 ng/ml in group I and group II respectively and the difference was statistically significant (p<0.001). Significant difference was also observed in random plasma glucose levels between the groups (5.69±0.86 mmol/L vs. 10.24±1.35 mmol/L; p<0.001). However, no difference was observed in HbA1c between the groups (5.18±0.34% vs. 5.54±0.51%; p>0.05) (Table-II). A positive correlation was found between serum troponin-I and random plasma glucose levels both in control and study groups (r=0.539; p<0.001) (Fig. 1). However, no correlation was observed between serum troponin-I and Hb1c in both groups (r=0.363; p>0.05) (Fig. 2).

Table-I: Comparison of BMI and blood pressure between two groups

Physical Parameters	Group I (n=27)	Group II (n=43)	p-value
BMI (kg/m^2)	20.24±1.65	20.61±1.97	0.407^{NS}
Systolic blood pressure (mm of Hg)	113.70±16.44	118.60±19.34	0.262^{NS}
Diastolic blood pressure (mm of Hg)	73.33±10.38	74.65±11.41	0.621^{NS}

Data was expressed as mean±SD. p-value reached from unpaired Student's 't' test; NS=not significant.

Table-II: Comparison of serum troponin-I, plasma glucose (random) and Hb1c between two groups

Biochemical parameters	Group I (n=27)	Group II (n=43)	p-value
Serum troponin-I during admission (ng/ml)	11.65±8.38	21.75±9.53	0.000^{S}
Random plasma glucose level (mmol/L)	5.69±0.86	10.24±1.35	0.000^{S}
HbA1c (%)	5.18±0.34	5.54±0.51	0.094^{NS}

Data were expressed as mean±SD. P value reached from unpaired Student's 't' test; S=significant, NS=not significant.

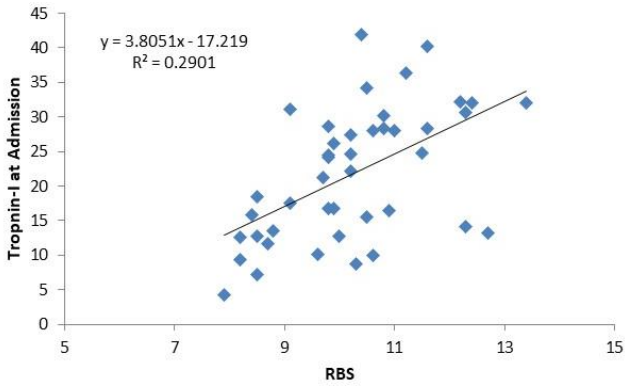

Fig. 1: Scatter diagram showing positive correlation between serum troponin-I and random plasma glucose levels (r=0.539; p<0.001)

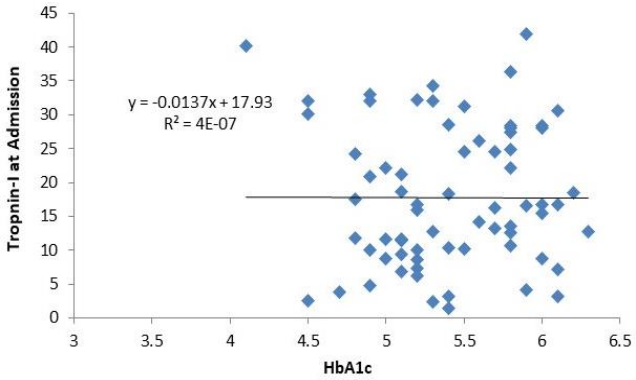

Fig. 2: Scattered diagram showing no correlation between serum troponin-I and HbA1c (r=0.363; p>0.05).

Discussion

In the present study, random plasma glucose levels were found 5.69±0.86 mmol/L and 10.24±1.35 mmol/L in control group (normoglycemic STEMI) and study group (hyperglycemic non-diabetic STEMI) respectively (p<0.001). A study done in Italy suggests that hyperglycemia is not simply an epiphenomenon of a stress response, rather, at the time of MI, it acts a crucial and potentially modifiable risk factor for poor outcome of the patients.[16] Another study conducted in Bangladesh showed that the rate of complications was higher in patients with hyperglycemia compared to normoglycemic patients; hyperglycemia was significantly associated with higher mortality as well.[17] Similar results were reported by another study done in Canada showing that hyperglycemia in AMI is associated with poorer outcomes even in patients without known diabetes.[10]

We also observed a significant positive correlation between serum troponin-I and plasma glucose levels; it signifies that plasma glucose level increases when serum troponin-I increases following AMI. Evidence showed that in non-diabetic patients, stress hyperglycemia was associated with an increased risk of in-hospital death. In addition, glucose concentrations ranging from 8 to 10 mmol/L were associated with a higher risk of developing heart failure or cardiogenic shock in patients with AMI.[18] Similar findings were reported by another study done in France as hyperglycemia was associated with an increased risk of developing cardiogenic shock in AMI patients.[19] Moreover, evidence showed that hyperglycemia in acute coronary syndrome (ACS) is a powerful predictor of survival, increasing the risk of immediate and long-term complications in patients both with and without previously known diabetes mellitus.[20]

Regarding glycated hemoglobin, we found that the mean values of HbA1c were 5.18±0.34 % and 5.54±0.51% in control group (normoglycemic STEMI) and study group (hyperglycemic non-diabetic STEMI) respectively (p>0.05). Evidence showed that HbA1c level is characterized by lower biological variability and relatively unaffected even in acute stress or sepsis.[21] Besides, a previous study done in Japan reported that in chronic hyperglycemia as assessed by HbA1c ultimately failed to predict infarct size, short-term outcomes or in-hospital mortality in patients with AMI even though all patients were non-diabetic.[22]

Apart from that, we also observed no correlation between serum troponin-I and HbA1c in both control and study groups; it signifies that HbA1c may remain unaffected even though the serum troponin-I level increases in acute myocardial infarction. However, another study done in Croatia showed a causal relation between serum troponin-I and HbA1c, which may occur during chronic condition, but not in acute, stressful condition without any history of diabetes mellitus[23] – that could be considered similar to the findings of our study. Similar report of no association between serum troponin-I and HbA1c levels came from another study done in Bangladesh where HbA1c levels in both control and study groups were found within the normal range.[24]

The limitations of the study include smaller sample size as the study subjects were selected purposively, limited follow up of the patients due to time constraint, and unavailability of coronary angiogram to all the patients due to their financial problem. Hence, it is difficult to generalize our findings to the reference population.

Conclusion

Our data suggest that serum troponin-I level was more increased in hyperglycemic non-diabetic STEMI patients in comparison to normoglycemic STEMI patients. Serum plasma glucose level was also found much higher in hyperglycemic non-diabetic group than normoglycemic ones, while HbA1c was within the normal range in both groups. A positive correlation was found between serum troponin-I and random plasma glucose levels, while no correlation was observed between serum troponin-I and Hb1c.

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