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Correlation of serum magnesium with HbA1c in patients with diabetes mellitus

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Abstract

Background and objectives: Diabetes mellitus (DM) is a leading cause of death and disability world wide. Magnesium acts as a cofactor in glucose metabolism and its decreased level causes insulin resistance and many complications in diabetic patients. The present study evaluated the correlation of serum magnesium with HbA1c in DM patients.

Materials and methods: This cross sectional study was conducted in the Department of Biochemistry, Dhaka Medical College, Dhaka from July 2016 to June 2017. A total number of 100 individuals with and without diabetes mellitus were included in the study. HbA1c was measured by high performance liquid chromatography and estimation of serum magnesium was done by automatic biochemistry analyzer.

Results: Out of 100 enrolled participants, 50 were diagnosed patients of DM (Group-A) and 50 were age and sex matched apparently healthy individuals (Group-B). The mean age of Group-A and B individuals was 50.5 ± 6.0 and 50.4 ± 5.1 years respectively. Group-A had significantly ($p < 0.001$) lower serum magnesium concentration compared to Group-B (1.5 ± 0.6 mg/dl vs 2.3 ± 0.5 mg/dl). Serum magnesium levels showed significant negative correlations with HbA1c ($r = -0.511$, $p < 0.001$).

Conclusion: DM patients showed significant negative correlation of serum magnesium with HbA1c level. Routine screening for serum magnesium status would be helpful for the better management of diabetic cases.

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Introduction

World Health Organization (WHO) has reported alarming increase of diabetes mellitus (DM) globally. It has increased from 180 million in 1980 to 422 million in 2014 and during this period the prevalence of diabetes has almost doubled from 4.7% to 8.5% [1-3]. In diabetes mellitus, the metabolism of several minerals is altered resulting into various organ dysfunctions leading to increased morbidity and mortality of the diabetic patients. Trace elements like magnesium, zinc and copper are important for the normal growth and biological functions of the human body. In recent years the role of these minerals has been studied extensively in diabetes, autoimmune, neurological and psychiatric disorders [4-9].

Among the trace elements, magnesium (Mg) acts as a cofactor in the glucose transport mechanism of the cell and also plays an important role in glucose metabolism by acting as a cofactor of various enzymes involved at multiple steps in insulin secretion, binding and activity [10]. Magnesium deficiency decreases insulin sensitivity via alteration of the insulin receptor associated

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tyrosine kinase in type 2 DM patients [11]. Deficiency of magnesium has been implicated in insulin resistance, carbohydrate intolerance, dyslipidaemia and complications of DM [12].

Low serum magnesium levels may contribute to the development of diabetic complications such as retinopathy, abnormal platelet function, cardiovascular disease and hypertension via reduction of inositol transport rate and subsequent intracellular depletion. Hypomagnesaemia may occur following insulin therapy for diabetic ketoacidosis and may be related to the anabolic effects of insulin driving magnesium back into cells [10]. The reasons for high prevalence of Mg deficiency in diabetes are not clear, but may include increased urinary loss, lower dietary intake or impaired absorption of magnesium compared to healthy individuals. Increased urinary magnesium excretion due to hyperglycemia and osmotic diuresis may contribute to hypomagnesaemia in diabetes [13]. Therefore, the present study was aimed to determine the serum magnesium level and correlate it with HbA1c in DM patients.

Material and methods

Study population and place: This cross sectional study was conducted from July 2016 to June 2017 at the Department of Biochemistry, Dhaka Medical College, Dhaka. The study was approved by the Institutional Review Board. Informed written consents were obtained from all enrolled participants. By convenient and purposive sampling technique, a total of 100 individuals were enrolled according to the selection criteria. Out of 100 participants, 50 were diagnosed patients of DM (Group-A) attending the outpatient department of Endocrinology and Metabolism, Dhaka Medical College Hospital. Same number of age and sex matched apparently healthy individuals weas selected as control for comparison (Group-B). DM was defined as a condition of progressive pancreatic beta cell dysfunction having HbA1c level ≥ 6.5% or fasting plasma glucose (FPG) ≥ 7.0 mmol/l or two-hour plasma glucose ≥ 11.1 mmol/l during an oral glucose tolerance test (OGTT) or a random plasma glucose of ≥ 11.1 mmol/l in a patient with classic symptoms of hyperglycemia or hyperglycemic crisis [14]. Known cases of type 1 diabetes mellitus, DM with acute complications, hypertension, malignancy, chronic liver disease, chronic kidney disease, acute illness, pregnant and lactating women, recent history of acute infection and diarrheal disease were excluded. All data were recorded in a predesigned data collection sheet.

Collection of blood samples and tests: Blood samples were collected from each individual in designated sterile tubes with aseptic precautions. Fasting plasma glucose was estimated enzymatically by glucose oxidase method. Plasma HbA1c was measured by high performance liquid chromatography. Values for HbA1c were: <5.7% normal, 5.7–6.4% pre-diabetes and ≥ 6.5% diabetes mellitus [15]. Quantitative serum magnesium was determined by colorimetric dye-complexing method using Evolution-3000 flow cell semi-auto-analyzer. Normal level of serum magnesium is 1.8-3.6 mg/dl [16].

Data analysis: Continuous variables were expressed as mean ± SD and were compared between groups of patients by unpaired Student's t test. Categorical variables were compared using chi-square test. Pearson's correlation coefficient was used to test the relationship between the parameters. The quantitative observations were indicated by absolute frequencies. The result was considered as statistically significant when p value was less than 0.05.

Results

The study was aimed to correlate serum Mg levels with HbA1c of DM patients. Table-1 shows the baseline parameters of the study population. There was no significant difference of age, sex, systolic blood pressure (BP), diastolic BP and body mass index (BMI) between Group-A and B cases. Out of 50 Group-A cases, 43 (86%) had serum magnesium below the normal reference range (< 1.8 mg/dl) while all the Group A cases were within the normal range.

Table-2 shows the serum magnesium and HbA1c levels of the study subjects of both groups. Fasting plasma glucose and HbA1c levels were significantly ($p < 0.001$) higher in DM patients (Group-A) than healthy individuals (Group-B) while serum magnesium

Table-1: *Baseline parameters of the Group-A and B study population (N = 100)*

Parameters	Group A (n = 50)	Group B (n = 50)	p value
Age (years; Mean ± SD)	50.5 ± 6.0	50.4 ± 5.1	0.943
Male (n, %)	32 (64.0)	30 (60.0)	0.680
Female (n, %)	18 (36.0)	20 (40.0)	
Systolic BP (mmHg; Mean ± SD)	115.4 ± 5.8	115.0 ± 6.1	0.736
Diastolic BP (mmHg; Mean ± SD)	75.5 ± 5.7	75.5 ± 5.3	1.000
BMI (kg/m^2; Mean ± SD)	19.9 ± 2.8	19.0 ± 4.0	0.219
Fasting plasma glucose (mmol/l; Mean ± SD)	8.8 ± 1.7	5.2 ± 0.9	<0.001
S. Mg (mg/dl; n, %)			
1.8 – 3.6	7 (14)	50 (100)	-
<1.8	43 (86)	0	

Note: Group-A: DM cases, Group-B: Healthy individuals, BP: Blood pressure, BMI: Body mass index, Mg: Magnesium.

Table-2: *Serum magnesium and HbA1c levels of the study population (N = 100)*

Test	Group A (n = 50) Mean ± SD	Group B (n = 50) Mean ± SD	p value
HbA1c (%)	**7.1 ± 1.1**	**4.9 ± 0.6**	**< 0.001**
S. Magnesium (mg/dl)	**1.5 ± 0.6**	**2.3 ± 0.5**	**< 0.001**

Note: p value calculated by Student's t test.

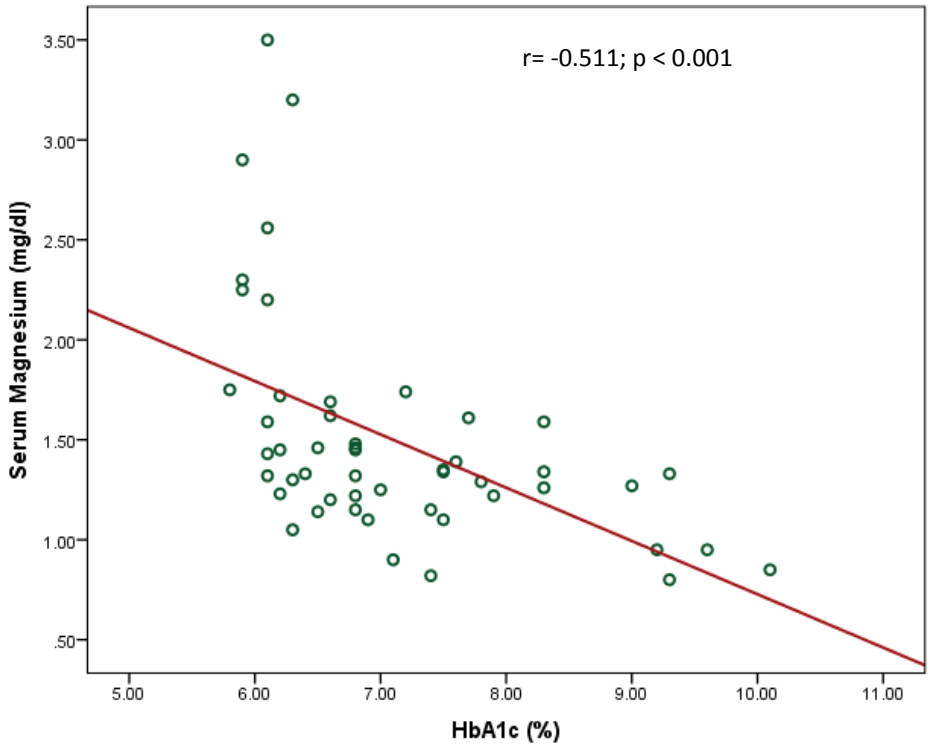

Figure-1: *Correlation of HbA1c with serum magnesium in Group A*

levels were significantly ($p < 0.001$) low in DM patients compared to healthy individuals.

Pearson's correlation coefficient test revealed that there was significant negative correlation between serum magnesium with HbA1c ($r= -0.511$, $p<0.001$; Figure-1).

Discussion

This cross sectional study investigated the level of serum magnesium in DM patients and in age and sex matched healthy individuals. We also evaluated the correlation of serum magnesium with HbA1c. Serum magnesium concentration was significantly lower in DM patients ($p < 0.001$) compared to healthy individuals. The finding of our study is in agreement with other reported studies [9,17] who also found significantly decreased level of serum magnesium in diabetic patients. The possible explanation of such hypomagnesaemia in DM cases could be due to higher urinary losses or impaired absorption of magnesium [9,10].

Correlation of serum magnesium with HbA1c was done. In the present study, we found negative correlation of serum magnesium levels with HbA1C ($r = -0.511$ and $p < 0.001$) in DM cases. Similar negative correlation of serum magnesium with HbA1c in diabetic cases has been reported by other studies [18]. The findings indicate that uncontrolled glycemia is associated with low serum magnesium status in DM cases. Therefore, it is concluded that regular assessment of serum magnesium would be helpful to prevent the complications related to hypomagnesaemia among DM patients.

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Conflict of interest

The authors declare no conflict of interest.

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