Original Article

Serum Magnesium in Patients of Type 2 Diabetes Mellitus

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Objective: Magnesium has a role in glucose homeostasis and insulin sensitivity in patients of diabetes mellitus. This study was conducted to compare the levels of serum magnesium in type-2 diabetic patients (controlled and uncontrolled) with non-diabetic controls.

Material and Methods: This cross-sectional comparative study was carried out in eighty patients with type-2 diabetes and forty healthy, age and sex matched controls. Diabetic patients were selected after taking detailed history from the outpatient Diabetic Clinic of Services Hospital, Lahore. They were analyzed for serum magnesium, fasting blood glucose and glycosylated hemoglobin (HbA1c) levels.

Results: Mean±SD serum magnesium levels of the type 2 diabetic uncontrolled cases were significantly lower ($p<0.01$) than in the non-diabetic control subjects (0.771±0.208 mmol/l and 0.901±0.128 mmol/l). These levels were non-significantly lower in controlled diabetic patients. There was inverse correlation ($r = - 0.084$) between the serum magnesium with fasting blood glucose and glycosylated hemoglobin in the type 2 controlled diabetic patients.

Conclusion: Hypomagnesemia is present in type 2 diabetic patients.

Key words: Serum magnesium, type 2 diabetes mellitus, glycosylated hemoglobin (HbA1c).

Introduction

Approximately 90-95% of all diagnosed cases of diabetes mellitus are of type 2.[1] Magnesium is the fourth most abundant cation in the human body and the second most abundant intracellular cation. It may exist as a protein bound, complexed or free cation.[2] Magnesium has long been known to be associated with diabetes mellitus. Several studies have shown low serum Mg^{++} concentrations in type 2 diabetics as compared to healthy controls.[4,5] Mather et al (1979) confirmed the presence of hypomagnesemia in nearly 25% of their diabetic patients. The association between diabetes mellitus and hypomagnesemia indicates its wide ranging impact on diabetes control and complications.[6] Mg^{++} depletion has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes.[7] Moreover, low serum Mg^{++} is a strong independent predictor of the development of type 2 diabetes.[8] In United States, 25 to 39% of outpatient diabetics have low concentration of serum Mg^{++}. In type 2 diabetic patients, hypomagnesemia can be both a consequence or a cause of increased insulin resistance.[9] Therefore, the aim of this study was to compare the serum Mg^{++} concentration of type 2 diabetics with healthy controls.

Subjects and Methods

A total of 120 subjects were included in the study. Eighty patients of type 2 diabetes mellitus were selected from outpatient Diabetic Clinic of Services Hospital, Lahore. Forty age and sex matched healthy subjects were taken as controls.

The objectives and methods of study were explained to the subjects and written consent was obtained. Eighty diabetics comprised of 40 controlled diabetic patients of type 2 diabetic mellitus with HbA1c < 8% and 40 uncontrolled type 2 diabetes with HbA1c >9%.

Five milliliter of venous blood was taken from each subject after 12 hours of fasting. 2 ml of blood sample was placed in a test tube containing fluoride and EDTA for glucose and glycosylated Hb estimations. The remaining 3 ml of blood was allowed to clot in a test tube. This blood sample was centrifuged and clear serum was stored in labeled plastic aliquots at 25°C until further analysis.[10] The serum magnesium was measured using Calmagite by Colorimetric method (Randox).[11] Fasting plasma glucose was measured by GOD-PAP Enzymatic Colorimetric method (Boehengir Mannheim).[12] The estimation of glycosylated hemoglobin (HbA1c) was measured by Ion Exchange method (Human).[13]

Statistical analysis of the data was done using Microsoft Excel 2002. Values were expressed as means ± SD. Differences between groups were evaluated using unpaired student's t-test and considered statistically significant at $p < 0.05$. Pearson's correlation coefficient were also

Results

Table 1 shows the basic and general characteristics of controls and patients with type 2 diabetes mellitus. Body mass index was significantly higher ($p > 0.05$) in type 2 diabetic patients as compared to that in non diabetic controls.

Table 2 shows that mean ± SD serum magnesium levels of the uncontrolled type 2 diabetic cases were significantly lower ($p< 0.01$) than the non diabetic control subjects (0.771±0.208 mmol/l versus 0.901±0.128 mmol/l respectively) and non significantly lower in type 2 controlled diabetic cases (0.831±0.251, p=0.18).

There was inverse correlation (r= -0.084) of the serum magnesium with fasting blood glucose and glycosylated hemoglobin in the type 2 uncontrolled diabetic patients **(Table 3).**

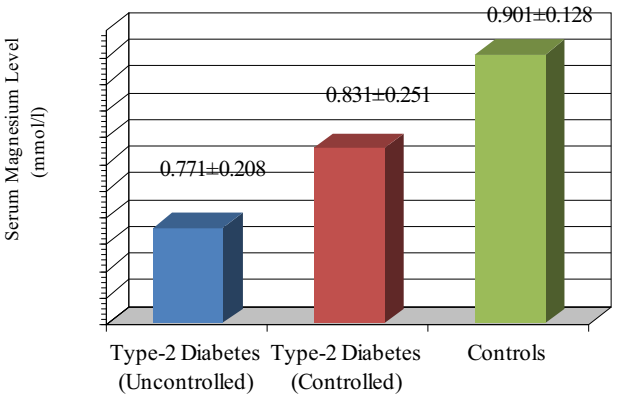

Fig:-1: Distribution of mean Serum Magnesium level in uncontrolled and controlled type-2 diabetics and control group.

Table-1: Characteristics of the subjects in the study groups.

Characteristics	Controls	Type 2 diabetes (controlled group)	Type 2 diabetes (Uncontrolled group)
Number	40	40	40
Gender M/F	20/20	20/20	20/20
Age (years)	49.3 ± 3.3	46.8 ± 3.4	50.0 ± 4.8
Body mass index (BMI)	23.0 ± 1.04	27.0 ± 1.04	27.70 ± 1.11
Duration of Diabetes (years)	-	5 ± 1.1	4.9 ± 1.2

Table-2: Serum magnesium, fasting blood glucose and glycosylated hemoglobin in non-diabetic controls and type 2 diabetics (controlled and uncontrolled) (Values are expressed as mean ±SD)

Parameters	Non-diabetic Controls (n=40)	Type II Diabetics Controlled (n=40)	p-value	Type II Diabetics Uncontrolled (n=40)	p-value
Serum magnesium (mmol/l)	0.901±0.128	0.831±0.251	0.18**	0.771±0.208	< 0.01*
Fasting plasma Glucose (mmol/l)	4.412±0.428	9.621± 4.380	< 0.01*	15.324±6.494	<0.01*
Glycosylated Hemoglobin (HbA1c)%	5.395±0.5318	7.406±0.583	< 0.01*	9.708±0.612	< 0.01*

**P = < 0.01 (highly significant), n = No. of subjects, **Non significant*

Table-3: Data showing correlation between Mg, HbA1c and fasting blood glucose in diabetic patients.

Correlation between	Type 2 diabetics controlled (n=40) r value	p value	Type 2 diabetics uncontrolled (n=40) r value	p value
Mg and glycosylated haemoglobin	0.284	0.076*	-0.084	0.606*
Mg and fasting plasma glucose	0.373	0.681	-0.145	0.067*

*r = correlation coefficient, *p = (Non significant)*

Discussion

Magnesium is an essential element. It is a cofactor in both glucose transporting mechanism of cell membrane and various enzymes involved in carbohydrate oxidation.[14] Previous studies have reported low serum and erythrocyte magnesium levels in type 2 diabetic patients.[15,16] Diabetes is frequently associated with extracellular and intracellular Mg^{++}

depletion.[17] Epidemiologic studies have found a high prevalence of hypomagnesaemia in subjects with type 2 diabetes, especially in those with poorly controlled glycemic control.[18,19] The present study showed that the mean values of serum magnesium were significantly lower ($p<0.01$) in type 2 diabetic patients than in controls. Serum Mg^{++} concentration of 35% of the diabetics was below the reference range. This prevalence of low magnesium status is similar to the studies reported previously.[20,21] The reasons for high prevalence of Mg^{++} deficiency in diabetics are not clear. These may include increased urinary loss, lower dietary intake or impaired absorption of Mg^{++} compared to healthy individuals.[22,23] Several studies have reported increased urinary Mg^{++} excretion in type 1 and 2 diabetes.[24,25] Increased urinary Mg^{++} excretion due to hypoglycemia and osmotic diuresis may contribute to hypomagnesaemia in diabetes.[26]

In diabetic subjects, serum Mg^{++} levels are inversely correlated to glycemic parameters.[27] The present study also shows the same results.

Conclusion

In conclusion, this study has demonstrated hypomagnesaemia in type 2 diabetics. Mg depletion reduces insulin sensitivity and may increase risk of secondary complications. It may therefore, be prudent in clinical practice to periodically monitor serum Mg^{++} concentrations in diabetic patients. If plasma Mg^{++} is low, dietary supplements of Mg^{++} may be beneficial.

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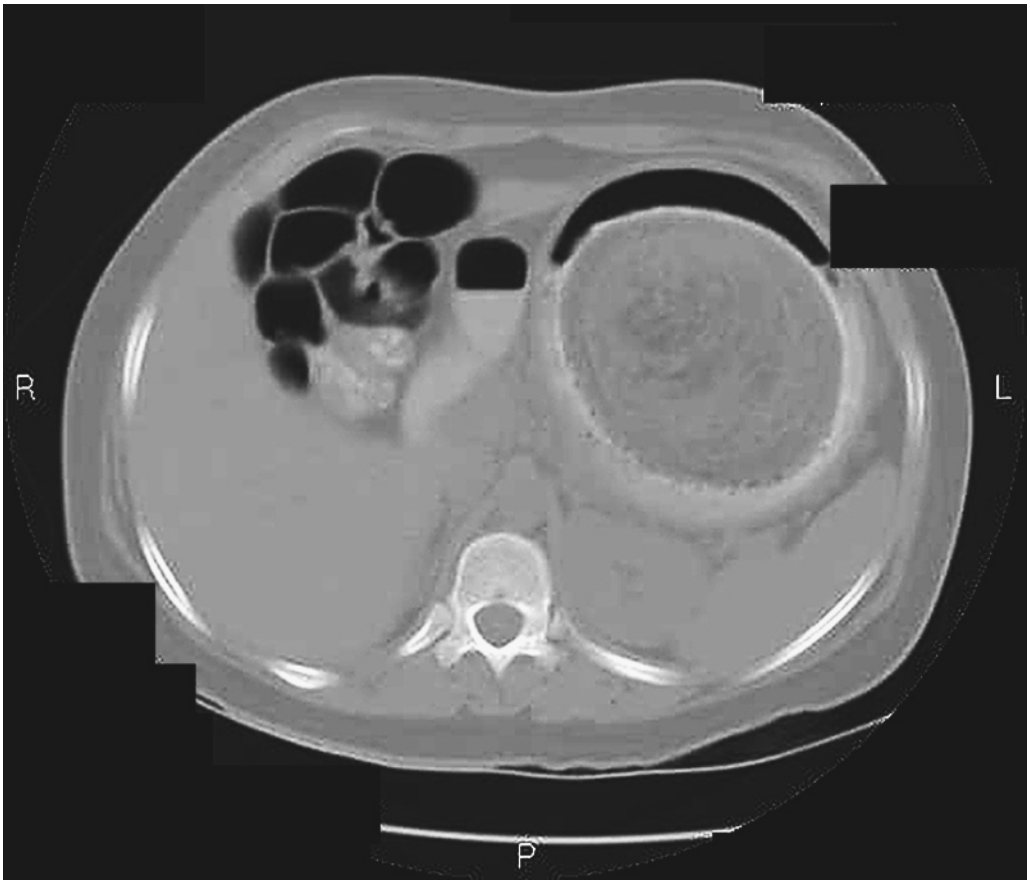
Picture Quiz

A 28-year-old lady presented with a 4-month history of pain in the left hypochondrium, abdominal distention, vomiting after meals, and weight loss of 10 kg. Physical examination revealed a firm epigastric mass. Computed tomography abdomen is shown below:

1. What is the diagnosis?
2. What is the next investigation?



See Answer on Page No. 29