



Serum Magnesium Levels: A Key Issue For Diabetes Mellitus

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Abstract

The global burden of diabetes mellitus is expected to increase by 42% (from 51 million in year 1995 to 72 million by 2025) and by 172% (from 84 to 288 million) in the developed countries. The disease leads to many complications and one of them is electrolyte imbalance which has been an ignored subject. Amongst the electrolytes, magnesium merits special attention. The aim of the present study was to assess serum magnesium levels in Type 2 diabetics. A hospital based cross-sectional study was performed on 50 diabetic patients attending the OPD of medicine department from January 2011 to July 2011, M.M. Institute of Medical Sciences and Research, Mullana (Ambala). Thirty age-matched healthy controls were also selected for the sake of comparison. Blood was withdrawn and serum magnesium levels were estimated by colorimetric method using Xylidyl blue dye. The results were analyzed using Student's unpaired 't' test. Serum magnesium levels among normal healthy controls (n=30) ranged between 1.8-3.0 mg/dl (mean \pm SD = 2.33 \pm 0.37 mg/dl), while the levels of serum magnesium in diabetic patients (n=50) ranged between 0.2-2.25 mg/dl (mean \pm SD = 1.62 \pm 0.47). The difference was statistically significant (p<0.001). Levels of serum magnesium were significantly lower in diabetic patients as compared to normal healthy controls. Therefore, hypomagnesaemia is a key issue in diabetes which, if corrected, is expected to result in a better management of the disease.

Key Words

Diabetes Mellitus, Serum Magnesium Levels, Xylidyl Blue Method

Introduction

Micronutrients have been investigated as potential, preventive and therapeutic agents for type 2 diabetes mellitus and their complications (1). In particular, diabetes has shown to be associated with abnormalities in the metabolism of zinc, chromium, copper, magnesium and manganese (2). Out of these magnesium has been investigated as a clinically significant electrolyte, for a long term global policy to lower the burden of diabetes mellitus, with new findings and researches (3). Even the international expert committee has given new recommendations for the diagnosis and treatment of diabetes mellitus in this respect (4). Magnesium is essential for insulin secretion, insulin receptor interaction, post receptor events (involving tyrosine kinase mediated phosphorylation) and normal carbohydrate utilization (by Mg dependent enzymes). A compromise in these functions leads to insulin resistance in hypomagnesaemia; the latter is contributed by: (a) Hyperglycemia which leads to decreased cellular Mg Levels, independent of insulin

levels (4), (b) Osmotic diuresis leads to increased urinary Mg losses (5); and (c) Concomitant use of diuretics and hypolipidemic agents also increase urinary Mg loss. The prevalence of diabetes is higher in the developing countries (6.2% in 2000) as compared to that in developed countries (3.5% in 2000)(6). In China, for instance, diabetes has reached epidemic proportions, affecting 92.4 million people aged < 20 years (9.7% of the adult population) (7). Out of 13 prospective studies of magnesium in 51 peoples of Brazil by Sales CH (8) type 2 is the primary outcome (9) Magnesium intake was inversely associated with incidence of diabetes in young American adults (10). This inverse association may be explained, at least in part, by the inverse correlation of magnesium with their complications like diabetic retinopathy, diabetic nephropathy and diabetic neuropathy (11).

Clinically, hypomagnesaemia may be defined as a serum Mg concentration <1.6 mg/dl or SD \pm 2 below the

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mean of the general population (normal serum Mg concentration is 1.5- 2.5 mg/dl)(12), which can be corrected by magnesium supplements.(13). Because hypomagnesaemia has been linked to various micro- and macro vascular complications, a better understanding of Mg metabolism and efforts to minimize hypomagnesaemia in the routine management of diabetes are warranted(14).

Material and Methods

A hospital based cross- sectional study was performed in 50 diabetic patients attending the outpatient department of medicine from January 2011 to July 2011 at M.M. Institute of Medical Sciences and Research, Mullana (Ambala). Thirty age-matched healthy controls were also selected for the sake of comparison. Inclusion criteria were Individuals willing to participate in the study, either sex (male and female) and age 30 years and above. Cases suffering from diabetic Ketoacidosis, hyperthyroidism, Hyperpituitarism, pancreatitis, carcinoma of pancreas, and Cushing's disease were excluded . Patient taking any medicine which may alter the blood glucose levels like phenothiazines, caffeine, nicotine, levodopa, morphine, steroids, oral contraceptives, alpha-interferon etc were not included in this study. Informed and written consent was obtained from each diabetic subjects. Samples were collected 5 ml of venous blood aseptically collected from antecubital vein and the whole blood was put in a vial with no anticoagulant and allowed to stand for some time so that serum was separated for estimation of magnesium levels by Xylidyl blue method where magnesium forms blue violet complex whose intensity is proportional to magnesium concentration in specimen measured at 546 nm.

Results

The results were analyzed using Student's unpaired 't'test. Serum magnesium levels among normal healthy controls (n=30) ranged between 1.8-3.0 mg /dl (mean \pm SD = 2.33 \pm 0.37 mg/dl), while the levels of serum magnesium in diabetic patients (n=50) ranged between 0.2-2.25 mg/dl (mean \pm SD = 1.62 \pm 0.47). The difference was statistically significant (p<0.001). Levels of serum magnesium were significantly lower in diabetic patients as compared to normal healthy controls. *Table (1-3)*

Discussion

The serum magnesium levels among normal healthy controls (n=30) ranged between 1.8-3.0 mg /dl (mean = 2.33 \pm 0.37 mg/dl), A similar finding was reported by LAL, et al with the normal reference value of serum magnesium i.e. 1.8-3.0 mg/dl.(12) the levels of serum magnesium amongst diabetic subjects (n=50) ranged between 0.2-

2.25 mg/dl with mean \pm S.D 1.62 \pm 0.47. It was observed that the difference between controls and patients was statistically highly significant (p<0.001) with levels of serum magnesium significantly lower in patients as compared to normal healthy individuals. Thus, the present study confirms the finding that the patients with type 2

Table1. Serum Magnesium Levels in Normal Healthy Controls and Type 2 Diabetics

Group	Serum Magnesium (mg/dl)	
	Range (mg/dl)	Mean \pm S.D(S.E)
Control, n=30	1.8- 3.0	2.33 \pm 0.37 [*] (0.05)
Patients, n=50	0.2- 2.25	1.62 \pm 0.47 [*] (0.06)

Table 2. Distribution of Type 2 Diabetics as per Magnesium Levels

No of individuals	Serum Magnesium(mg/dl)	
	Range (mg/dl)	Mean (mg/dl)
Group A (n=8)	0.1- 1.0	0.9 \pm 0.27(0.009)
Group B(n=35)	1.1- 2.0	1.7 \pm 0.16(0.027)
Group C (n=7)	2.1- 2.25	2.2 \pm 0.12(0.045)

diabetes mellitus have significantly lower levels of magnesium as compared to controls as reported by several workers in the previous studies(10). The diabetics subjects under study were distributed into 3 groups A, B & C on the basis of serum magnesium levels .Group A included subjects having serum magnesium levels between 0.1-1.0 while Groups B &C included having serum magnesium levels between 1.1-2.0 and >2.1 mg/dl (*Table2*)

In group A (n=8) serum magnesium levels ranged between 0.1-1.0mg/dl with mean \pm S.D of 0.93 \pm 0.27 mg/dl and S.E of 0.009. In Group B (n=35) serum magnesium levels ranged between 1.1-2.0 mg/dl with mean \pm S.D of 1.71 \pm 0.16. The Group C (n=7) serum magnesium levels ranged between 2.1-2.25 mg/dl with mean \pm S.D of 2.23 \pm 0.12 mg/dl. The difference between magnesium levels of Group A, B & C was highly significant (p<0.001). It was observed that maximum number of diabetics were in the range of 1.1 to 2.0 mg/dl and most prevalent levels of serum magnesium encountered amongst type 2 diabetics to be 1.7mg/dl. A similar finding was reported by Young D S *et al.*(15)

All the patients and control subjects were distributed into three Groups, group 1, 2 & 3 (*Table3*).Group 1 included subjects in age group of 30-45 years , while Group 2 & 3 contained subjects of age group 46-60 & >60 years respectively. In group 1, serum magnesium levels amongst healthy individuals (n=13) range between 1.4-3 mg/dl with mean \pm S D of 2.1 \pm 0.38 mg/dl. The

Table 3. Comparison of Serum Magnesium Levels in Different Age Groups of Type 2 Diabetics and Healthy Controls

Age in Years	Control			Patients		
	No of Cases	Range of serum magnesium	Mean \pm S.D.	No of Cases	Range of serum magnesium	Mean \pm S.D.
30- 45	13	1.4- 3	2.1 \pm 0.38	17	0.8- 2.2	1.5 \pm 0.37
46- 60	13	1.6- 2.9	2.1 \pm 0.38	26	0.6- 2.5	1.7 \pm 0.40
61- 75	4	1.5- 2.6	2.0 \pm 0.36	7	0.8-1.9	1.4 \pm 0.66

corresponding levels amongst patients (n=17) ranged between 0.8-2.2 mg/dl with mean \pm SD 1.5 \pm 0.37 mg/dl .The difference between the two, i.e. controls and patients was statistically significant (p<0.001) Similarly in group 2 (n=13) the serum magnesium levels amongst controls ranged between 1.6-2.9 mg/dl with a mean \pm SD 2.1-0.38mg/dl The corresponding levels amongst patients (n=26) ranged between 0.6-2.5 mg/dl with a mean \pm S D 1.7 \pm 0.40 mg/dl .The difference between the two, i.e. controls and patients was statistically significant (p<0.001) Similarly in group 3 (n=4) the serum magnesium levels amongst controls ranged between 1.5-2.6 mg/dl with a mean \pm S D 2.0-0.36 mg/dl .The corresponding levels amongst patients (n=7) ranged between 0.8-1.9 mg/dl with mean \pm S D 1.4 \pm 0.66 mg/dl The difference between the two i.e. control and patient was statistically significant (p<0.05) Thus, it was observed that maximum number of subjects were found in the groups 1 & 2 in case of controls but in case of patients it was in group 2 i.e. 46-60 years .

The treatment of the patients with diabetes requires a multidisciplinary approach whereby every potential complicating factor must be monitored closely and treated . Serum magnesium levels are not investigated in routine clinical practice despite its significance. In particular, although hypomagnesaemia has been reported to occur with increased frequency among patients with type 2 diabetes mellitus, it is often overlooked and undertreated. Oral magnesium restores serum magnesium levels, improving insulin sensitivity and has the potential to partly ameliorate some of the diabetic complications.(13) Magnesium pidolate at 4.5 g per day (15.8 mmol/day) for 4 weeks significantly improved insulin action and oxidative glucose metabolism, increased erythrocyte magnesium concentration, and decreased erythrocyte membrane micro viscosity (16). It is therefore advisable to include serum magnesium in the routine electrolyte panel for the better management of diabetes mellitus.

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