

Research Article

Serum magnesium levels in type 2 diabetes

Yeluri Seshagiri Rao*, Dharma Rao V.

Department of General Medicine, Gayatri Vidya Parishad Institute of Health Care & Medical technology, Vishakapatnam, Andhra Pradesh, India

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***Correspondence:**

Dr. Yeluri Seshagiri Rao,

E-mail: vdrao.gm@gmail.com

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ABSTRACT

Background: Several studies undertaken in different parts of the world have shown that hypomagnesemia occur at an increased frequency among patients with type 2 diabetes compared with their counterparts without diabetes. As current data suggest adverse outcomes in association with hypomagnesemia, it is prudent to monitor magnesium routinely in this patient population and treat the condition whenever possible. Therefore, this study was undertaken to determine the serum magnesium levels in type 2 diabetes in this part of our country.

Methods: A cross-sectional study was conducted in 100 subjects, 50 diabetics without complications (group I), 50 diabetics with complications (group II) and 100 normal healthy controls (group III). Blood sugar levels, magnesium, HbA1C (%), cholesterol and triglyceride level were measured.

Results: Serum magnesium levels were found low in study group as compared to control group. A significant correlation between HbA1C and magnesium levels was seen. The patients with diabetic complications have significantly higher values of serum cholesterol and triglycerides.

Conclusions: Hypomagnesemia in type 2 diabetes was associated with poor glycemic control and with increased frequency of long term complications.

Keywords: Serum magnesium, Type 2 diabetes, Glycemic control, HbA1c

INTRODUCTION

Several vitamins and minerals act as cofactors in the enzyme reaction regulated by insulin. Deficiencies of certain vitamins and minerals such as vitamin E, potassium, magnesium, zinc and chromium may aggravate carbohydrate intolerance. Magnesium is involved on multiple levels in insulin secretion, binding and activity. Cellular magnesium deficiency can alter of the membrane bound sodium-potassium-adenosine triphosphatase which is involved in the maintenance of gradients of sodium and potassium and in glucose transport.¹

Magnesium deficiency has been found to be associated with diabetic micro vascular disease. Low serum

magnesium level correlated positively with the velocity of regaining basal vascular tone after hyperemia. Hypomagnesemia has been demonstrated in patients with diabetic retinopathy, with lower magnesium levels predicting a greater risk of severe diabetic retinopathy.² Magnesium depletion has been associated with multiple cardiovascular implications: arrhythmogenesis, vasospasm, and hypertension and platelet activity.³

The present study is undertaken to determine the clinical significance of serum magnesium levels.

METHODS

The present study was carried out in Gayatri Vidya Parishad Hospital, Vizag between February 2015 and January 2016. A total of 127 patients satisfying the

inclusion criteria were selected. The inclusion criteria were all the patients with type 2 Diabetes who fulfilled the inclusion and the exclusion criteria. Patients with chronic renal failure, patients on diuretics and/or alcohol abuse, patients receiving magnesium supplements or magnesium containing antacids, mal-absorption or chronic diarrhoea and other associated endocrine disorders were excluded from the study.

Diagnosis of Type 2 DM was based on the American Diabetes Association criteria and clinical history as following.⁴

1. FBS ≥ 126 mg/dl on 2 determinations,
2. symptoms of hyperglycemia and RBS ≥ 200 mg/dl,
3. 2-hour plasma glucose ≥ 200 mg/dl after a 75 grams oral glucose tolerance test (performed as described by the World Health Organization),
4. On oral hypoglycemic agents.

All the patients were screened for the presence of micro- or macrovascular complications like, retinopathy, peripheral vascular disease and coronary heart disease. On the basis of screening, 100 patients were divided into two groups: group I (50 diabetic patients without complications) and group II (50 patients with micro- or macrovascular complications). Group III include 100 normal healthy controls matched by age and gender with the patient groups. All the subjects were in the age group of 20 to 80 years.

Fasting plasma and serum sample of each subject were collected and serum magnesium, HbA1C and their lipid profiles were measured. Serum magnesium was measured by Calmagite endpoint method. Serum cholesterol was estimated by cholesterol oxidase method and serum triglyceride by glycerol peroxidase method on Medica Easyra auto analyser. HbA1C estimation was done by Medisys Labonacheck.

Statistical analysis was done by SPSS version 19.0.

RESULTS

One hundred and twenty seven patients of Type 2 DM patients consecutively seen at the out-patient department of General Medicine were screened for this study. Out of these patients, 27 were not enrolled because they have chronic renal failure (n= 19), alcohol abuse (n=5), diuretic use (n=2) and antacids containing magnesium (n=1).

The mean age of the diabetics was 54.92 ± 11.56 years whereas it was 53.58 ± 10.48 years in controls respectively. Both among the cases and controls the sex distribution was same i.e. 64% and 36% males and females respectively. The maximum number of patients was in the age group of 41-50 i.e. 39%.

The baseline characteristics of both the groups are shown in Table 1.

Table 1: The baseline characteristics of both the groups.

	Study Group		Control Group
	Group I	Group II	Group III
Age	54.92 ± 11.56	55.86 ± 9.87	53.58 ± 10.48
Time since diagnosis of diabetes (years)	8.7 ± 4.62	9.2 ± 5.1	Not applicable
BMI (kg/m ²)	27.6 ± 9.1	28.7 ± 8.7	28.9 ± 4.7
Waist-to-hip ratio	0.97 ± 0.05	0.98 ± 0.03	0.95 ± 0.07
Systolic blood pressure (mmHg)	140.2 ± 28.1	143.3 ± 24.6	135 ± 19.6
Diastolic blood pressure (mmHg)	82.7 ± 16.4	86.5 ± 14.2	79.1 ± 13.5
FBS	230.34 ± 88.42	240.71 ± 76.57	99.42 ± 10.32
HbA1c	7.3 ± 1.53	7.7 ± 1.87	5.2 ± 0.73
Total cholesterol (mg/dl)	196.91 ± 56.37	206.96 ± 28.19	173.75 ± 28.18
HDL cholesterol (mg/dl)	40.15 ± 10.42	35.91 ± 18.53	45.17 ± 11.97
LDL cholesterol (mg/dl)	111.53 ± 40.15	119.69 ± 11.19	106.94 ± 32.43
Triglycerides (mg/dl)	130.08 ± 37.89	144.24 ± 40.71	125.56 ± 76.99
Magnesium (mg/dl)	1.67 ± 0.37	1.32 ± 0.23	2.07 ± 0.27

The average serum magnesium level were below normal range in group I and group II and were measured as 1.67 ± 0.37 and 1.32 ± 0.23 respectively. Hypomagnesemia was more in group II patients in comparison to group I. In control group (group III), the serum magnesium level was within normal range and was measured as 2.07 ± 0.27 .

The average HbA1C (%) values were measured as 7.97 ± 0.76 , 9.60 ± 1.10 and 5.69 ± 0.43 in group I, group II and group III, respectively. The average HbA1C (%) values in group II were found to be significantly higher than the group I and the values of HbA1C (%) were positively correlated with blood glucose level.

The lipid profile was deranged in the study groups. The average serum cholesterol levels were measured as 221.38 ± 15.90 , 290.92 ± 21.82 and 144.13 ± 13.98 in group I, group II and group III, respectively. The serum cholesterol values were significantly higher in group II ($p < 0.001$) and group I ($p < 0.01$) as compared to group III. The average serum triglyceride levels were 163.17 ± 7.83 , 189.34 ± 14.87 and 109.76 ± 12.19 in group I, group II and group III, respectively. The serum triglyceride values were significantly higher in group II ($p < 0.001$) and group I ($p < 0.01$) as compared to group III.

Of the total of 100 diabetic patients 49% were on insulin alone, 33% were on OHA'S and 18% were on combination of OHA'S and insulin. The mean serum magnesium levels in the OHA group, insulin group and the insulin+ OHA group were 1.95 mg/dl, 1.59 mg/dl and 1.25 mg/dl respectively. The serum magnesium levels were significantly lower in the insulin treated group compared to the OHA treated group, $p < 0.001$.

DISCUSSION

Marked magnesium deficiency has been reported in the previous studies in patients with type-2 diabetes.⁵ However, some workers have also reported normal and even high levels.⁶ Prevalence of hypomagnesemia in type-2 diabetics was reported by Nadler et al. in type 2 diabetics attending outpatient clinics in the US.⁷ Walti MK et al. also reported a prevalence of hypomagnesemia in type 2 diabetics at 37.6% versus 10.9% in nondiabetic controls in a study conducted in Zurich, Switzerland.

The reasons for the high prevalence of magnesium deficiency in diabetes are not clear, but may include increased urinary loss, lower dietary intake, or impaired absorption of magnesium compared to healthy individuals. Several studies have reported increased urinary magnesium excretion in type 1 and type 2 diabetes.^{5,7} Recently a specific tubular defect in magnesium reabsorption in thick ascending loop of Henle is postulated. This defect results in reduction in tubular reabsorption of magnesium and consequently hypomagnesemia. The reason for this tubular defect in diabetics is unclear. Insulin treatment has been shown to correct renal magnesium loss in diabetics. Low dietary intake is an unlikely cause of impaired magnesium status in diabetes. A dietary assessment conducted in Europe showed that only 5.4% of the diabetic group and 9.1% of the control group had intakes of magnesium below their individual requirements. In addition, recently it has been shown that type 2 diabetics in reasonable metabolic control absorb dietary magnesium to a similar extent as healthy controls. Increased urinary magnesium excretion due to hyperglycemia and osmotic diuresis may contribute to hypomagnesemia in diabetes.

Hypomagnesemia is reported to be both a cause and result of poor glycemic control. Magnesium is a cofactor in both glucose transporting mechanisms of cell

membrane and various enzymes important in carbohydrate oxidation.⁸ In addition; magnesium deficiency has been shown to promote insulin resistance in multiple studies. Nadler, et al has reported that insulin sensitivity decreases even in non-diabetic individuals after induction of magnesium deficiency.⁹ Likewise, elderly subjects were shown to have improved glucose tolerance when they received magnesium supplements.

The present study had diabetic patients ranging from 20-80 years. The average age of controls in the present study was 53.58 years while in the study of Yajnik CS et al was 46.5 years.¹⁰ The mean age of diabetics in the present study was 54.9 years as against 54.7 in study of Yajnik CS et al.

Schlienger et al studied the influence of glycemic control (glycemic control evaluated by HbA1C) on various trace elements and reported significantly reduced plasma magnesium levels in patients with poor control of diabetes.¹¹

On establishing the relationship between magnesium levels and the state of control of diabetes, it was observed that in poorly controlled diabetic's serum and urinary magnesium levels were respectively lower and higher than that of poorly controlled (1.75 ± 0.34 versus 1.85 ± 0.08 in fairly controlled and 1.25 ± 0.19 versus 1.68 ± 0.12 in poorly controlled) with no significant difference in erythrocytic magnesium levels.

Nagase N found that serum magnesium levels of diabetes mellitus (1.90 ± 0.37) was significantly lower than that of normal controls (2.30 ± 0.32).¹² They also concluded that serum magnesium level of poorly controlled diabetic patients is lower than that of well controlled diabetic patients. These results suggested that magnesium deficient state is one of the causes of insulin resistance. However, he included the patients with hypertension, ischemic heart disease and diabetes mellitus. We did not evaluate the interrelationship between these entities.

CONCLUSION

Serum magnesium levels were lower in type 2 diabetic patients when compared to controls. Levels of serum magnesium levels were further lower in uncontrolled type 2 diabetic patients than those in whom diabetes was under control. Further studies are required to know whether magnesium supplementation is helpful in management of diabetes and prevention of complications.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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