

Serum magnesium among diabetics and non diabetics- A case control study

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Abstract

Background: Low serum magnesium level has long been known to be associated with diabetes mellitus invariably in all age groups, both types of diabetes and regardless of the type of therapy. Hence this study was planned to measure the levels of serum magnesium among diabetics and healthy individuals and to assess the link between magnesium levels and HbA1c value and microvascular complications of diabetes. **Methods:** This case control study was conducted among type 2 diabetes mellitus patients and non diabetic patients attending outpatient and inpatient department of general medicine in Sri Muthukumaran Medical College and Research Institute during November 2019. A total of eighty patients were included among them, forty known type 2 diabetes mellitus patients (cases) and forty non diabetic patients (controls), were included. Data was entered in Microsoft excel and data analysis was done using Statistical Package for Social Sciences (SPSS) version 17. **Results:** Mean of serum magnesium among diabetic cases and controls were 1.28±0.48 mg/dl and 2.23±0.21 mg/dl, respectively. The difference was found to be highly statistically significant. Also among the diabetic cases the mean serum magnesium levels were much low among cases with micro vascular complications of diabetes than the cases without micro vascular complications. **Conclusion:** Estimation of magnesium levels in all type 2 diabetes mellitus patients can be recommended, in order to diagnose and treat hypomagnesemia which in turn can prevent the complications of diabetes mellitus.

Key Words: serum magnesium, diabetes mellitus, non diabetic controls

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INTRODUCTION

Low serum magnesium is a common feature in patients with type 2 diabetes. Although diabetes can induce hypomagnesemia, magnesium deficiency has also been proposed as a risk factor for type 2 diabetes. Magnesium is a necessary cofactor for several enzymes that play an important role in glucose metabolism. Animal studies have shown that magnesium deficiency has a negative effect on the post-receptor signaling of insulin. on the

post-receptor signaling of insulin. Some short-term metabolic studies suggest that magnesium supplementation has a beneficial effect on insulin action and glucose metabolism.¹ Initially the cause of low serum magnesium was attributed to osmotic renal losses from glycosuria and decreased intestinal magnesium absorption and redistribution of magnesium from plasma into red blood cells caused by insulin effect. Recently a specific tubular magnesium defect in diabetes has been postulated. Hypermagnesuria results specifically from a reduction in tubular absorption of magnesium.² Magnesium is involved on multiple levels in insulin secretion and binding 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.³ In diabetics there is a direct relationship between serum magnesium level and cellular glucose disposal that is independent of insulin secretion. This change in glucose disposal has been shown to be related

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to increased sensitivity of the tissues to insulin in the presence of adequate magnesium levels.⁴ 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.⁵ Magnesium depletion has been associated with multiple cardiovascular implications like arrhythmogenesis, vasospasm, and hypertension and platelet activity.⁶ The persistent hypomagnesemia leads to raised serum glucose level, insulin resistance and the degree of magnesium depletion correlates positively with serum glucose concentration and the degree of glycosuria⁷. Glycosylated HbA1c level of more than 7.5% was considered as raised, and reflects poor glycemic control and was noted in 42% of type 2 diabetic patients.⁸ Intracellular Mg plays a key role in regulating insulin action, insulin-mediated-glucose uptake and vascular tone. Reduced intracellular magnesium concentrations result in a defective tyrosine-kinase activity, post-receptorial impairment in insulin action and worsening of insulin resistance in diabetic patients. Keeping in view the evidence linking hypomagnesemia with type-2 diabetes mellitus, limited locally available data and enormous burden of diabetics in our population, it was planned to measure the levels of serum magnesium among diabetics and healthy individuals and to assess the link between magnesium levels and HbA1c value and microvascular complications of diabetes.

MATERIALS AND METHODS

This case control study was conducted among type 2 diabetes mellitus patients (Cases) and non diabetic patients (Controls) attending outpatient and inpatient department of general medicine in Sri Muthukumaran Medical College and Research Institute during November 2019. All the patients aged more than 18 years of age in both the sexes were included in the study. Participants with Congestive heart failure, liver disease, cerebrovascular disorders, patients taking magnesium supplements or loop diuretics, impaired renal function and alcoholics were excluded from the study. A total of eighty patients were included in this study with forty known type 2 diabetes mellitus patients, who were considered as cases and another forty non diabetic patients, who were included as controls. Ethical committee approval was obtained before the commencement of the study. The principal investigator explained the purpose of the study to each participant and a written consent was obtained from the participants prior to the commencement of the study. The participants were

also informed that their participation was voluntary and that they could withdraw from the interview at any time without consequences. Every effort was made, to be sure that all information collected from the participants, remain confidential.

Two milliliters of venous blood was collected from all the study participants and sent for analysis of levels of serum magnesium, fasting blood sugars and HbA1C. Similarly post prandial blood sugars were also analyzed. The study was conducted using a proforma, covering particulars related to type 2 diabetes mellitus and the reports of all blood investigations were also noted in the same proforma. Data was entered in Microsoft excel and data analysis was done using Statistical Package for Social Sciences (SPSS) version 17.

OBSERVATIONS AND RESULTS

Among forty diabetic cases there were 8.8%, 17.5%, 13.8% and 10% were in the age group of ≤ 40 years, 41-50 years, 51-60 years and > 60 years respectively. Similarly there were 7.5%, 16.3%, 15% and 11.3% of participants in the age group of ≤ 40 years, 41-50 years, 51-60 years and > 60 years respectively, in the control group. The mean age in diabetic group was found to be 53.13 with standard deviation of 12.47 and in non diabetic group the mean age was found to be 55.13 with standard deviation of 14.16. In this current study there were 16(20%) females in diabetic group and 15(18.8%) females in control group and 24(30%) males in diabetic group and 25 (31.3%) males in control group.

Table 1: Proportion of participants in different age group and gender

Variables	Cases	Controls
Age group		
≤ 40 years	07 (8.8)	06 (7.5)
41-50 years	14 (17.5)	13 (16.3)
51-60 years	11 (13.8)	12 (15)
>60 years	08 (10)	09 (11.3)
Sex		
Female	16 (20)	15 (18.8)
Male	24 (30)	25 (31.3)

Among forty diabetic cases, 17(42.5%) patients had the duration of diabetes for less than 5 years and 23(57.5%) patients had diabetes more than 5 years duration. In this study majority 33(82.5%) participants were on oral hypoglycemic drugs and the rest 07(17.5%) patients were getting both oral hypoglycemic drugs and insulin for diabetes mellitus. Among forty diabetic cases micro vascular complications were not recognized in 30(75%) subjects. Diabetic neuropathy was seen in four (10%) cases, Diabetic nephropathy among 3(7.5%) cases and Diabetic retinopathy among 3(7.5%) diabetic patients.

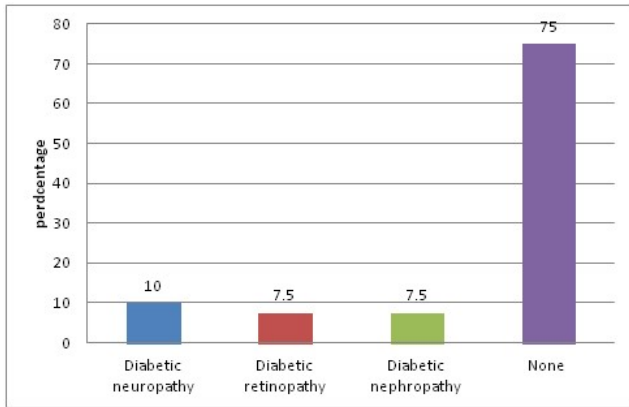


Figure 1: Proportion of Micro vascular complications among Diabetic cases

The mean fasting blood sugar (FBS) value among the diabetic cases and non diabetic controls was found to be 192.57±45.16 mg/dl and 96.23±19.14 mg/dl, respectively. The mean and SD of post prandial blood sugar (PPBS) values were 302.13±53.19 mg/dl and 113.36±32.01 mg/dl among cases and the controls respectively. The difference in FBS, PPBS values among cases and controls were found to be statistically significant. Among the diabetic cases the mean HbA1c was 7.1% with SD of 1.1% and among the non diabetics (controls) the mean HbA1c value was 5.7% with SD of 0.3%. The difference in HbA1C values among cases and controls was statistically significant. (p value 0.0001)

Table 2: Comparison of blood sugar levels among cases and controls

Parameters (Mean ± SD)	Cases	Controls	t value	p value
Fasting blood sugars (mg/dl)	192.57±45.16	96.23±19.14	12.423	0.000*
Post prandial blood sugars (mg/dl)	302.13±53.19	113.36±32.01	19.232	0.000*
HbA1c (%)	7.1±1.1	5.7±0.3	7.766	0.0001*

*Significant

The mean of serum magnesium among diabetic cases was found to be 1.28 and the standard deviation as 0.48 whereas in control group the mean serum magnesium was 2.23 and SD 0.24 and the difference between the diabetic cases and controls were found to be statistically significant.

Table 3: Comparison of serum magnesium levels among cases and controls

Parameter (Mean ± SD)	Cases	Controls	t value	p value
Serum Magnesium (mg/dl)	1.28±0.48	2.23±0.24	11.196	0.000*

*Significant

Among the diabetic patients in this study on whom micro vascular complications was detected the mean serum magnesium level was found to be 1.04 and Standard Deviation was 0.18. Among diabetic patients who do not have micro vascular complications the mean serum magnesium was 1.23 and SD 0.21. The difference in serum magnesium among patients with micro vascular complications was found to be statistically significant with p value 0.0146.

Table 4: Serum magnesium levels among cases with and without micro vascular complications

Parameter (Mean ± SD)	Microvascular complications		t value	p value
	Present	Absent		
Serum Magnesium (mg/dl)	1.04±0.18	1.23±0.21	2.560	0.0146*

*Significant

DISCUSSION

In the present study, the mean of serum magnesium among diabetic cases was found to be 1.28±0.48 mg/dl whereas in control group the mean serum magnesium was 2.23±0.21 mg/dl and the difference was found to be highly statistically significant. This is comparable with the studies done by A.P.Jain *et al*⁹, Nadler *et al*¹⁰ and Nagase *et al*¹¹. Nadler *et al*¹⁰ evaluated intracellular (erythrocytic) Mg²⁺ concentration in 20 type 2 diabetics. In addition, effects of intravenous or oral magnesium supplementation on intracellular Mg²⁺ concentration levels and platelet reactivity were also studied and the results showed intracellular Mg²⁺ concentration of diabetic patients was significantly reduced compared with values in non diabetic control subjects. In this study, among the diabetic patients in this study on whom micro vascular complications were detected the mean serum magnesium level was found to be 1.04±0.18 mg/dl. Also among diabetic patients who do not have micro vascular complications the mean serum magnesium was 1.23±0.21 mg/dl. The difference in serum magnesium among patients with micro vascular complications was found to be statistically significant. These findings were consistent with the findings of the study conducted by Kamat *et al*¹², Premraj *et al*¹³ and Kochar *et al*¹⁴ which reported that hypomagnesemia was associated with microvascular complications including diabetic retinopathy, diabetic nephropathy and diabetic neuropathy. Kochar *et al*¹⁴ added that, association was found between serum magnesium levels glycaemic control and duration of diabetes. Also they concluded that hypomagnesemia is widely prevalent in patients with type 2 diabetes mellitus and a major risk factor for the development microvascular complications that is, diabetic retinopathy, nephropathy

and neuropathy. Garland *et al*¹⁵ in his study speculated on a potential link between magnesium deficit of diabetes and several diabetic complications including cardiovascular problems and retinopathy. Rude *et al*¹⁶ suggested repletion of the deficiency or prophylactic supplementation with oral magnesium may help avoid or ameliorate such complications as arrhythmias, hypertension and sudden cardiac death and may improve the course of diabetic condition.

CONCLUSION

In this study we conclude that serum magnesium levels were comparatively lower in type 2 diabetic patients than controls. Also hypomagnesemia was commonly reported among patients with microvascular complications of diabetes mellitus and literature states that hypomagnesemia in turn could lead to development of early complications of diabetes. Hence it is worthwhile estimating magnesium levels in type 2 diabetes mellitus patients and take remedial measures to correct the same in order to prevent the complications of diabetes mellitus.

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