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A Case Control Study of Levels of Serum Magnesium and HbA1c among Patients with Type 2 Diabetes

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ABSTRACT

Introduction: Magnesium (Mg) deficiency is a common problem in diabetic patients. Deficiency of Mg may increase the incidence of diabetes mellitus (DM) and occurrence of diabetic complications.

Objective: To assess the serum magnesium and HbA1c levels in type 2 diabetes patients.

Method: This is a case control study and the sample size was 60 (30 type 2 diabetic patients and 30 controls). Serum magnesium levels and HbA1c were measured . Statistical analysis was performed using SPSS 16.0 (SPSS Inc., Chicago, IL, USA)

Results: The serum magnesium levels are significantly lower in diabetic patients when compared to controls ($P<0.001$) . There was a significant correlation between the diabetic status and low serum magnesium levels. The values of HbA1C (%) were positively correlated with blood glucose level and negatively correlated with serum magnesium levels.

Conclusion: Hypomagnesaemia is associated with micro vascular complications and poor glycemic control. It is important to regularly monitor magnesium levels in all type 2 diabetic patients.

Keywords: *Type 2 Diabetes mellitus, Insulin resistance, Magnesium.*

INTRODUCTION

Diabetes is expected to distress about 170 million people worldwide and this represents about 2% of the world's population [1, 2] . Magnesium is the fourth most profuse cation in the human body and the second most abundant intracellular cation. It is a main cofactor in a number of key enzymatic reactions and appears to play an essential role in glucose metabolism and insulin homeostasis. It plays a vital role in carbohydrate metabolism. It can affect the release and activity of insulin [3]. Blood levels of magnesium are reduced in individuals with type-2 diabetes. Hypomagnesaemia may exacerbate insulin resistance.

The kidneys perhaps lose their ability to retain magnesium during periods of severe hyperglycemia (considerably elevated blood glucose). The increased excretion of magnesium in urine could then result in lower blood levels of magnesium[4]. Magnesium reduction and Insulin resistance result in a vicious cycle of decrease in intracellular Mg2+ and worsening insulin[5]. It is not known whether difference in trace elements status is a result of diabetes and hyperglycemia or instead their reduced levels contribute to the pathogenesis of the disease. However, different studies have given conflicting results[6,7]. In current years, increasing verification has appeared suggesting an association between magnesium deficiency and type 2 diabetes mellitus (T2DM) [8–12].

Because of increasing prevalence of DM in India, with the well-known biochemical parameters we

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decided to search the association of serum magnesium in Type 2 Diabetes. In the present study we evaluated the serum magnesium and HbA1c in type-2 diabetes cases & controls.

MATERIALS AND METHOD

Patients of type 2 diabetes mellitus of age 40-70 years, in the Department of Medicine, Chittoor Government district Hospital from December 2015 to April 2016 were taken for this study considering the inclusion and exclusion criteria. Informed written consent was taken from all subjects and the study was approved by the ethics committee. Controls were compared to cases by gender, age and BMI. None of the participants had a positive clinical history of chronic or acute renal failure, malignancy, chronic diarrhea, alcohol intake. Subjects receiving magnesium supplementation or treated with drugs known to modify magnesium metabolism (such as calcium antagonist, diuretics, thyroxin, and lithium) were excluded from the study. No patient with type 1 diabetes was included and none of the women were pregnant. Total of 60 subjects were included in this study 30 type 2 diabetic cases and 30 controls between age of 40- 70years . According to earlier studies, hypomagnesaemia was defined as a serum magnesium concentration #0.75 mmol/L [12, 13, 14]. T2DM was defined according to the criteria recommended by the Expert Committee on the Diagnosis and Classification of Diabetes.

Height, body weight and body mass index (BMI), which was calculated with the formula weight/ heightsquare(kg/m2), were recorded for each patient. A venous blood sample was collected from each subject in the morning after 12-hour fasting, to evaluate fasting glucose [hexokinase with enzymatic reference methods]; Serum magnesium [Colorimetric end point methods with ksilidil blue], HbA1c [HPLC-high performance liquid chromatography- Biorad Variant II Turbo].

Statistical analysis was performed using SPSS 16.0 (SPSS Inc., Chicago, IL, USA). Student `t' test /Chi-square test has been used to find the significance of homogeneity of study characteristics between both groups of patients. Analysis of variance has been used to find the significance of study parameters between the groups. Results were expressed as mean + SD. Probability values of P< 0.05 were considered to indicate statistical significance.

RESULTS

The cases and controls were group matched according to age and sex. The male/female ratio of both cases and controls is 13:12. The mean age group of cases is 58.4±9.46 and for controls is 59.12±6.90 (Table 1). The serum magnesium levels are significantly lower in diabetic patients when compared to controls (P<0.001). Whereas, HbA1C was significantly higher in diabetic patients when compared to controls (P<0.001) (Table 2).

Table 1 Showing age and BMI of Diabetic patients and controls .

Para-meter	Status	Mean ± Std. Deviation	t	P
Age	Controls	59.120±6.9000	-.307	0.76
	Cases	58.400±9.4648		
BMI	Controls	22.47±2.21	4.377	.0001*
	Cases	25.57±2.75981		

Table 2 Showing Serum Magnesium levels and HbA1C (%) in cases and controls

Parameter	Subjects N=25	Mean Std. Deviation	t	P
Serum Magnesium (mmol/L)	Controls	2.08±.407	-8.110	.0001***
	Cases	1.32±.231		
BMI (kg/m^2)	Controls	22.47±2.21	4.377	.0001*
	Cases	25.57±2.75981		
HbA1C (%)	Controls	4.93 ± 2.50	5.337	.0001*
	Cases	8.98 ± 2.26		

Table 3 Showing Linear regression of Serum Magnesium with Diabetic status

CONSTANT	Un-standardized Coefficients		Standardized Coefficients	t	P
	Beta	Std. Error	Beta		
Diabetic Status	.723	.114	.723	6.358	.0001

There is very highly significant correlation between the diabetic status and lower serum magnesium levels (P<0.001) (Table 3). The HbA1C (%) values were found to be significantly higher in diabetic group. The values of HbA1C (%) were positively correlated with blood glucose level and negatively correlated with serum magnesium levels.

DISCUSSION

Hypomagnesaemia may be an independent risk factor for type II diabetes. Defective tubular reabsorption, diarrhea, intestinal malabsorption, shift of magnesium from ECF to bone can result in hypomagnesaemia. Magnesium acts as cofactor for many enzymes involved in carbohydrate metabolism. Also, there is a strong relationship between magnesium and insulin action. A reduction of magnesium in the cells increases insulin resistance [15,16] . Tyrosine- kinase an intracellular enzyme requires magnesium to let insulin to exert its blood-sugar-lowering effects. In several studies, daily oral magnesium supplementation significantly improved insulin sensitivity by 10 percent and reduced blood sugar by 37 percent [17,18].

The mechanisms by which T2DM causes low serum magnesium levels remain to be fully understood. It has been suggested that insulin deficiency or resistance can promote magnesium wasting at thick ascending limb of the loop of Henle [19,20]. Secondly, lower serum magnesium in obese type 2 diabetic patients may be because of reduced intestinal magnesium absorption secondary to lower fiber in diet and higher fat intake [21,22] .Diabetic autonomic neuropathy may also reduce oral intake and gastrointestinal absorption [19,20].

Also, we found diabetics with micro vascular complications had poorer glycemic control than diabetics without micro vascular complications. Previous studies showed that higher level of HbA1C increases risk for development of micro angiopathy and macro angiopathy in diabetics [23].

There are some possible limitations that should be taken into consideration in interpreting the results of our study. First, we did not measure intracellular magnesium content, a more sensitive indicator of magnesium balance[24]. Although, approximately only 1% of whole-body magnesium is found extracellularly, there is a good correlation between extracellular and intracellular Magnesium is estimated by nuclear magnetic resonance spectroscopy. Second, we have not explicitly evaluated dietary magnesium daily intake. Finally, only a selected population of morbidly obese subjects was included

CONCLUSION

Diabetes is responsible for the low magnesium levels which are risk factors for various cardiovascular and other complications. The supplementation of magnesium and proper exercise to maintain the weight are advisable to prevent the diabetes associated complications in the future.

Conflict of Interest : Nil

Source of Funding : Nil

Ethical Clearance: Institutional ethics committee

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