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Serum Magnesium Levels in Type 2 Diabetes Patients and its Relation with Diabetic Nephropathy

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ABSTRACT

Introduction: *Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Low magnesium status has repeatedly been demonstrated in patients with type 2 diabetes. Magnesium deficiency appears to have a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes. The present study was undertaken with an aim to correlate serum magnesium levels with diabetic nephropathy.* ***Materials and methods:*** *Total 100 patients with type 2 diabetes of 5 years of duration and above, admitted in Dr. Pinnamaneni Siddhartha Institute of Medical Sciences and Research Foundation from November 2015 to April 2017 were included in the study.* ***Results:*** *The mean serum magnesium value in the normal group was 1.78, the microalbuminuria group was 1.61, and in macroalbuminuria, the group was 1.52.* ***Discussion:*** *One of the possible mechanisms explaining the relation between diabetic nephropathy and magnesium deficiency is insulin resistance. Deficiency of magnesium can reduce tyrosine-kinase activity, post-receptor activity and eventually it may contribute to the development of insulin resistance. Hypomagnesemia independently predicts the progression to ESRD in patients with advanced type 2 diabetic nephropathy.*

Keywords: Diabetes mellitus, Hypomagnesemia, Serum, Diabetic nephropathy

INTRODUCTION

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Depending upon the etiology of the DM, factors contributing to hyperglycemia include reduced insulin secretion, decreased glucose utilization, and increased glucose production. The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multiple organ systems, leading to microvascular and macrovascular complications [1].

Magnesium appears to have a role in glucose homeostasis and insulin sensitivity in patients with type 2 diabetes [2]. Low magnesium status has repeatedly been demonstrated in patients with type 2 diabetes. Hypomagnesemia has been demonstrated in patients with diabetic nephropathy, lower levels of magnesium predicting a greater risk.

In type 2 diabetes, patients with microalbuminuria or clinical proteinuria showed a significant decrease in serum ionized magnesium levels. A significant negative correlation between serum ionized magnesium and HbA1c and triglycerides, in both microalbuminuria and clinical proteinuria groups, was observed [3]. The present study was undertaken with an aim to correlate serum magnesium levels with diabetic nephropathy.

Objectives

The study is aimed at:

- Estimating serum magnesium concentration in patients with type 2 diabetes mellitus.
- Correlating serum magnesium concentration with diabetic nephropathy.

Inclusion Criteria

Total 100 cases of type 2 diabetes mellitus of 5 years of duration and above admitted to Dr. Pinnamaneni Siddhartha Institute of Medical Sciences& Research, during the study period were included in the study.

Exclusion Criteria

- Patients with chronic renal failure caused due to factors other than type 2 DM.
- Acute myocardial infarction in the last 6 months.
- Patients on diuretics.
- Patients receiving magnesium supplements or magnesium-containing antacids.
- Malabsorption or chronic diarrhea.

Statistical Method

The t-test was used to find the significance of the mean pattern of serum magnesium among the subjects.

RESULTS

Total 100 patients were involved in the study and were distributed among groups which included age, gender, serum magnesium levels, and neuropathy. The relations were studied by the chi-square test.

In the age group, patients ranged from ≤40 to >80 years with a mean age of 62 years, which comprised of ≤40 years (9%), 41-50 years (19%), 51-60 years (22%), 61-70 years (24%), 71-80 years (23%), >80 years (3%). Out of the 100 patients, 57% were males and 43% were females (Figure 1,2).

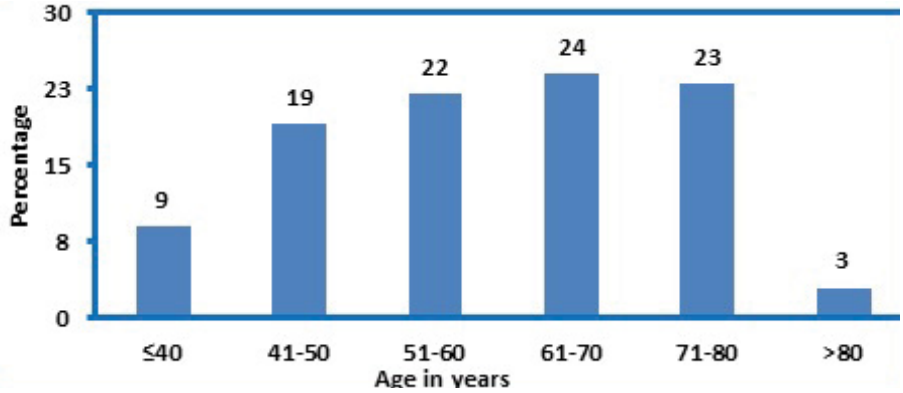

Figure 1 Age distribution in the study

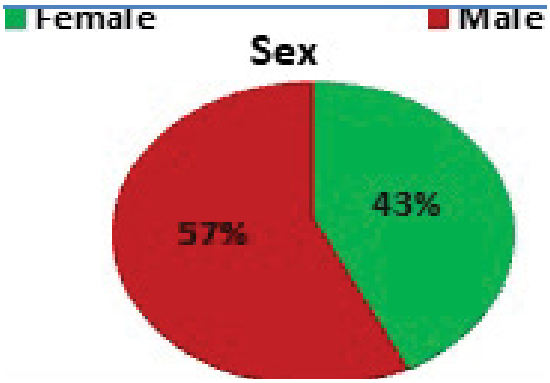

Figure 2 Gender distributions in study

The mean magnesium values in normal vs. microalbuminuria vs. macroalbuminuria were 1.78, 1.61, 1.52 respectively (Figures 3 and 4) (Tables 1 and 2).

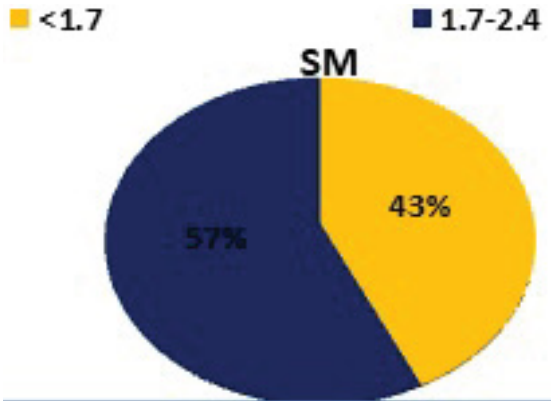

Figure 3 Distribution of serum magnesium levels

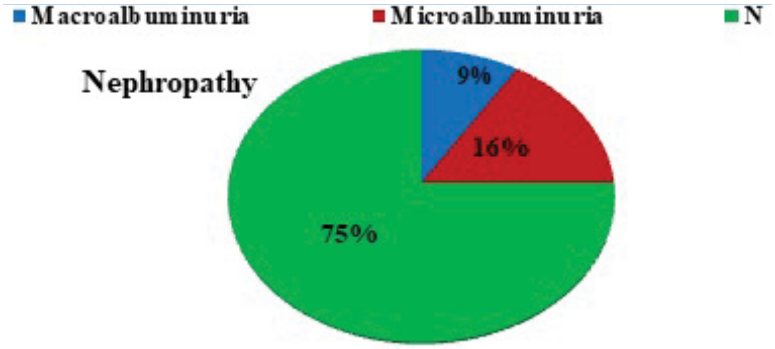

Figure 4 Nephropathy in the study

Table 1 Incidence of nephropathy in the study

Nephropathy	Serum Magnesium			
	<1.7		1.7-2.4	
	Count	%	Count	%
Macroalbuminuria	8	18.60%	1	1.80%
Microalbuminuria	9	20.90%	7	12.30%
N	26	60.50%	49	86.00%
Total	43	100.00%	57	100.00%
Chi-square value=11.0; p=0.004				

Table 2 Incidence of nephropathy in comparison to microalbuminuria versus macroalbuminuria

Nephropathy	Serum magnesium				
	N	Minimum	Maximum	Mean	SD
Macroalbuminuria	9	1.4	1.7	1.52	0.1
Microalbuminuria	16	1.1	2	1.61	0.29
N	75	1	2.3	1.78	0.31
F=4.64					

DISCUSSION

The kidney is the organ that most closely regulates magnesium homeostasis. About 80% of the total plasma magnesium is filtered through the glomerular membrane (ionized and complex fractions). The major sites of magnesium reabsorption in the nephron are the proximal tubule (5-15%), the thick ascending limb of the loop of Henle (70-80%) and the distal convoluted tubule (5-10%).

Experimental researches have shown that patients with diabetes have a low concentration of plasma magnesium level [4]. In a study by Corsonello, et al., type 2 diabetic patients with microalbuminuria or clinical proteinuria had significantly low ionized magnesium [3].

The intracellular depletion of myo-inositol due to disruption of its paracellular transport mechanisms is a major factor in the development of diabetes complications in magnesium deficiency [5].

Therefore, magnesium deficiency has specific pathogenic significance in diabetic nephropathy. Magnesium chloride supplementation lowers HbA1c, improves the Insulin sensitivity in type 2 diabetics and higher magnesium intake is associated with lower risk of diabetes in the general population [6,7].

The present study included 100 diabetic patients. Serum magnesium levels were determined in all the subjects and were correlated with nephropathy.

Most of the subjects i.e. 69% were between 50- 80 years of age with only 28% below 50 years and 3% above 80 years. The mean age of patients was 59.8 years which compares with the study of Arpaci, et al., where the mean age was 55.6 ± 10.4 years [8].

In this study there was a female preponderance, 57% of subjects were female and 43% male. This in contrast to the studies done by Arpaci, et al., and Dasgupta, et al., where only 42.1% and 38% of subjects were females [8,9].

Among the study subjects, 43% had serum magnesium level below the reference range of 1.7 mg/dL and thus were hypomagnesemic. This is in sharp contrast to the studies of Arpaci, et al., and Dasgupta, et al., where 9.6% and 11% were found to have low magnesium levels respectively [8,9].

The possible explanation for this may be the rural set up in which the study was done where the general nutrition status and health awareness of the subjects was below par.

Among 25 patients with nephropathy, 17 were hypomagnesemic as compared to 26 out of 75 patients without nephropathy with a significant value of p=0.004 (Table 1). The mean magnesium levels in normal vs. microalbuminuria vs. macroalbuminuria group were 1.78, 1.61, 1.52, respectively. These findings correlate well with the study of Arpaci, et al., where they found a significant association between microalbuminuria and hypomagnesemia regardless of age and duration of diabetes [8].

Insulin resistance probably explains the relation between diabetic nephropathy and hypomagnesemia; magnesium deficiency reduces tyrosine kinase activity, post-receptor activity, and insulin-dependent glucose uptake, thereby leading to insulin resistance. In addition, increased intracellular calcium in magnesium deficiency interrupts skeletal muscle and adipocyte response to Insulin.

On the other hand, Insulin deficiency and resistance lead to reduced tubular reabsorption of magnesium and ensuing hypomagnesemia favor the onset and progression of diabetic microangiopathy, via a reduction in activity of Na+/K+ ATPase pump.

A Recent study by Yusuke, et al., concluded that hypomagnesemia independently predicts the progression to end-stage renal disease in patients with advanced diabetic nephropathy [10].

CONCLUSION

It would be prudent to screen for hypomagnesemia in patients with diabetes mellitus and provide necessary magnesium supplementation which could delay the onset or progression of diabetic nephropathy.

LIMITATIONS

- The sample size was small and hence may not represent the entire population.
- The rural population attending the hospital was the subject of the study and therefore may account for the high incidence of hypomagnesemia.

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