

## A Study of Fasting Serum Magnesium Levels in Patients with Type2 Diabetes Mellitus in Relation to its Complications

<sup>1</sup>Dr.KukatlaSadhashiv, <sup>2</sup>Dr.K.Pranay Reddy, <sup>3</sup>Dr.N.Pavani, <sup>4</sup>Dr.Danthuri Sharath Kumar

<sup>1</sup>Assistant Professor, Department of General Medicine, Government Medical College, Nizamabad, Telangana, India

<sup>2</sup>Assistant Professor, Department of General Medicine, Government Medical College, Nizamabad, Telangana, India

<sup>3</sup>Assistant Professor, Department of General Medicine, Government Medical College, Nizamabad, Telangana, India

<sup>4</sup>Assistant Professor, Department of General Medicine, Government Medical College, Nizamabad, Telangana, India.

Corresponding Author: Dr. Danthuri Sharath Kumar

E-mail: [drsharath1199@gmail.com](mailto:drsharath1199@gmail.com)

### Abstract

**Introduction:** Diabetes mellitus is a metabolic disorder with complications including micro & macrovascular. Hypomagnesaemia alters the glucose transport, and decreases the insulin secretion, affects the post receptor insulin signaling and interactions. The aim of our study was to know the relationship between magnesium levels and diabetes, association with level of control of diabetes and magnesium levels in relation to complications of diabetes.

**Methods:** It was a hospital based comparative study where a total of 110 patients were included in the study where 75 Patients with type 2 DM and 35 controls admitted to Gandhi hospital were selected. Basic demographic data was collected and patients were subjected to relevant investigations including serum magnesium levels.

**Results:** Infections were the most common cause for admission accounting for 61.3% of admissions among diabetics. The mean serum magnesium levels in cases and controls was 1.62 mg/dl and 2.31 mg/dl with a P value of <0.003, which was statistically significant. This could probably be explained on the basis of increase urinary loss, low dietary intake. Hypomagnesemia was seen in 44% of the cases where as only 2% of the controls had Hypomagnesemia. Hypomagnesaemia was associated with diabetic retinopathy and diabetic nephropathy. No correlation was found in respect to Neuropathy & IHD.

**Conclusions:** Hypomagnesaemia is a factor in type 2 diabetes and associated with various complications and duration of diabetes leading to various complications. Hence it is worth measuring serum magnesium levels in patients with type 2 DM and probably correlates their relationship with various complications.

**Key words:** serum magnesium, type 2 diabetes mellitus, complications

### **Introduction**

Diabetes mellitus is a metabolic disorder which results from defects in insulin secretion, action or both. With the changes in the lifestyle and other conditions, the prevalence of diabetes mellitus is on the rise globally and especially in India. According to the recent national family health survey 5 report, around 16.8% of male adult population and 14.6% of the female adult population are estimated to be diabetic.<sup>[1]</sup>

Majority of cases of diabetes fall into two broad categories either Type 1 or Type 2 Diabetes mellitus. Other types such as Gestational diabetes, malnutrition related diabetes are also evident. Type 2 Diabetes is the most common form accounting for approximately 90 to 95 percentage of all diagnosed cases of diabetes.<sup>[2]</sup> Complications associated with diabetes mellitus can be categorized into microvascular, macrovascular and others. Long term complications of diabetes include retinopathy, nephropathy and peripheral neuropathy and foot ulcers. Patients with diabetes have an increased risk of atherosclerotic, cardiovascular diseases. Hypertension and abnormalities of lipid metabolism are often found in diabetes.<sup>[3]</sup>

Magnesium deficiency is proposed as a factor in the pathogenesis of diabetic complications. Magnesium is the fourth most abundant cation in the human body and the second most abundant intracellular cation. Magnesium plays an essential role in carbohydrate metabolism and in the insulin action.<sup>[4]</sup> Magnesium acts as a cofactor in glucose transport mechanism of the cell membranes and various intra cellular enzymes involved in carbohydrate metabolism.<sup>[5,6]</sup> The concentrations of serum magnesium in healthy people are remarkably constant whereas 30 to 35% of diabetes have low serum magnesium concentration<sup>[7,8]</sup>. Magnesium deficiency has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes as well as the evaluation of the complications like retinopathy<sup>11</sup> cardiovascular diseases<sup>49</sup>, nephropathy and neuropathy. Moreover, low serum magnesium is a strong, independent predictor of development of type 2 diabetes.<sup>[9,10]</sup> Hence Hypomagnesemia can be both a cause and a consequence of diabetic complications.

The aim of our study was to know the relationship between magnesium levels and diabetes, association with level of control of diabetes and magnesium levels in relation to complications of diabetes.

### **Aim & Objectives:**

- To determine the relationship between magnesium levels and diabetes, association with level of control of diabetes and magnesium levels in relation to complication of diabetes.
- To estimate estimating fasting serum magnesium concentration in patients with type 2 Diabetes Mellitus.
- To correlate serum magnesium concentrations with micro and macrovascular complications of Type 2 Diabetes Mellitus – retinopathy, nephropathy, neuropathy, ischemic heart disease and peripheral vascular disease.

### **Material and Methods:**

It was a hospital based comparative study where study population were patients with type 2 diabetes admitted in Gandhi hospital. Also non diabetic patients admitted during this period were also included in the study under the control group to investigate the change pattern of serum magnesium in DM cases when compared to controls and magnesium levels in relation to complications of DM.

A total of 110 patients were included in the study where 75 Patients with type 2 DM and 35 controls admitted to Gandhi hospital were selected.

**Inclusion criteria:**

All cases of type 2 diabetes mellitus and age and sex matched non diabetic patients.

**Exclusion criteria:**

- Patients with chronic renal failure.
- Acute myocardial infarction in last 6 months
- Patients on diuretics.
- Patients receiving magnesium supplements or magnesium containing antacids
- Malabsorption or chronic diarrhoea.
- Patients with history of alcohol abuse.
- Pregnant women with hypertension, proteinuria and eclampsia.

Apart from basic demographic data, all 110 patients underwent the following investigations.

--Fasting Blood Sugar levels (FBS)

--Post Prandial Blood sugar (PPBS) ( measured two hours after a standard meal)

--Fasting serum magnesium levels (Calmagite dye method)

Normal level considered at 1.8-2.5mg/dl

-- 24 hours urinary protein and Routine Urine examination

-ECG

--Fundoscopy

--Renal Function Test (RFT)

-- HbA1C(HPLC METHOD)

**Data Analysis:**

Data entry was done in Microsoft Excel and analysis using Open Epi Info version 7. Data was summarized in percentages and proportions. Numerical data expressed in Mean and Standard deviation. 't' test was used for to determine the difference between the mean values between the two groups with  $p < 0.05$  considered to be statistically significant.

**Results:**

The mean age of the diabetics was  $58.56 \pm 8.92$  and  $56.96 \pm 9.32$  in controls with majority in both groups belonging to 51-60 years (38.67% & 40%) respectively in diabetic group and control group respectively. Gender distribution showed a slight male preponderance in both groups. Male and female population in diabetic group was 54.66% and 45.33% respectively and in control group was 54.28% & 45.71% respectively.

With regards to type of treatment in diabetics, 44% were on oral hypoglycemic drugs, 40% on both hypoglycemic drugs and Insulin and rest 16% only on insulin.

Infections were the most common cause for admission accounting for 61.3% of admissions among diabetics. The next most common cause was ischemic heart disease accounting for 13.3% of the admissions.

The mean FBS levels among cases and controls were 211 mg/dl and 92.76 mg/dl respectively. Among cases mean FBS was found to be high as compared to controls, probably

because of poor diabetic control . The mean serum creatinine levels among cases and controls were 0.92 mg/dl and 0.87 mg/dl respectively.

Serum magnesium levels in diabetics and controls:

The mean serum magnesium levels in cases and controls was 1.62 mg/dl and 2.31 mg/dl with a P value of <0.003, which was statistically significant. This could probably be explained on the basis of increase urinary loss, low dietary intake. Hypomagnesemia was seen in 44% of the cases where as only 2% of the controls had Hypomagnesemia.

**Table 1: Serum Magnesium levels in diabetics and controls**

Serum Magnesium (mg/dl)	Diabetic group (n=75)	Control group (n=35)
<1.8	33 (44%)	02 (5.71%)
1.8-2.5	41 (54.66%)	30 (85.71%)
>2.5	01 (1.33%)	03 (8.71%)
Mean±SD*	1.62±0.22	2.31±0.27

\* ‘t’ test applied, p=0.003 (statistically significant) SD-Standard deviation

**Table 2: Effect of level of control of Diabetes Mellitus on serum Magnesium**

Serum Magnesium (mg/dl)	Controlled (n=37)	Uncontrolled (n=38)
Mean±SD	2.13±0.27	1.69±0.22
Range (Min-Max)	1.6-2.7	1.0-2.2

‘t’ test applied, p=0.001 (statistically significant)

The mean serum magnesium levels among patients with uncontrolled diabetes were lower as compared to patients with controlled diabetes, which was statistically significant (P value <0.001. Hyperglycemia directly causes suppression of Magnesium).

Effect of type of treatment on serum Magnesium:

Of the 75 diabetic patients 33(44%) were on OHAs, 12(16%) were on insulin alone and 30(40%) were on both OHAs and insulin. The mean serum magnesium levels in the OHA group, insulin group and OHA+ insulin group were 1.98 mg/dl, 1.61mg/dl and 1.82 mg/dl respectively. The serum magnesium levels were significantly lower in the insulin treated group as compared to the OHA treated group.(P value <0.013) This may be because, Insulin causes shift of magnesium from extracellular to intracellular compartment causing low serum magnesium levels.

Mean serum magnesium levels according to the duration of diabetes i.e.0-5, 6- 10, 11-15, 16-20 years were 2.22, 1.83, 1.62 and 1.80 mg/dl respectively.

Comparison of Serum Magnesium levels in association with complications:

Diabetic retinopathy was seen in 39 patients of whom Non proliferative diabetic retinopathy was seen in 23 patients and proliferative in 16 patients. The mean serum magnesium levels in patients with Non proliferative diabetic retinopathy and proliferative diabetic retinopathy were 1.71 mg/dl and 1.53 mg/dl respectively and in patients without retinopathy was 2.21 mg/dl which was statistically significant (P value <0.0006).

The mean serum magnesium levels in patients with and without diabetic nephropathy were 1.72 mg/dl and 2.19mg/dl respectively which was statistically significant (P value <0.0002).

The mean serum magnesium levels in patients with diabetic neuropathy were 1.82 mg/dl and in those without neuropathy was 1.78 mg/dl which was statistically not significant (P value < 0.212).

Serum magnesium levels in comparing all the complications: Mean serum magnesium levels among patients with only one complication was 2.16 mg/dl and among them 7.2% had retinopathy, 8% had nephropathy and 0% had neuropathy. Mean serum magnesium levels among patients with two complications was 1.69 mg/dl and among them 28% had retinopathy with nephropathy and 17.3% had nephropathy with neuropathy. Among patients with all three complications the mean serum magnesium levels were 1.64 mg/dl and were seen in 17.3% of the patients.

Serum magnesium levels in patients with IHD: The mean serum magnesium levels in patients with IHD and those without IHD were 1.73 mg/dl and 1.88 mg/dl respectively which was statistically not significant.

### **Discussion:**

The Present hospital based comparative study on Serum Magnesium Levels in Patients with Type2 Diabetes Mellitus in Relation to its Complications found that the mean serum magnesium levels were 1.62 mg/dl and 2.31 mg/dl in cases and controls respectively. The mean serum magnesium levels in patients on insulin, OHAs and on OHAs plus insulin were 1.61 mg/dl, 1.98 mg/dl and 1.82 mg/dl respectively. The mean serum magnesium levels in patients with controlled diabetes were 2.13 mg/dl and 1.69 mg/dl in patients with uncontrolled diabetes.

These findings were in concurrence with findings by Wahid A et al (2017)<sup>[11]</sup> where there was significant difference in respect to serum magnesium levels between the cases and controls, with low value in the case group ( $1.59 \pm 0.187$  versus  $1.78 \pm 0.126$ ). Diabetic patients with hypomagnesemia did not differ from normomagnesemia diabetics in terms of age, sex, duration of diabetes and BMI. Diabetic patients with hypomagnesemia had higher values of fasting, post prandial glucose levels which was again similar to present study findings.

With regards to serum magnesium levels and diabetics with complications, present study observed that the mean serum magnesium levels in patients with and without diabetic retinopathy were 1.72 mg/dl and 2.21 mg/dl respectively. Whereas the mean serum magnesium levels in patients with diabetic nephropathy were 1.72 mg/dl and 2.19 mg/dl in those without nephropathy. In comparison to present study findings, study by Kundu et al (2013)<sup>[12]</sup> found that the mean values of serum magnesium was found to be lower in cases,  $1.38 \pm 0.39$  mg/dl with diabetic retinopathy (Group 3) compared with both the diabetic cases without retinopathy (Group 2),  $2.02 \pm 0.29$  mg/dl and healthy controls (Group 1),  $2.62 \pm 0.36$  mg/dl and was statistically significant. Mohan K et al (2014)<sup>[13]</sup> on magnesium levels in diabetic patients observed prevalence of hypomagnesemia is significantly higher in diabetics with microvascular complications compared to diabetics with no microvascular complications. Prevalence of hypomagnesemia is significantly higher in patients with diabetic retinopathy.

Another study by M. Manonmani, K. Manimekalai from Tamil Nadu found there was statistically significant difference in BMI, fasting blood sugar (FBS), Post Prandial Blood Sugar

(PPBS), lipid profile and Mg (in DM groups). HbA1c ( $P < 0.001$ ) levels were statistically significant with DM patients. Serum Mg levels were correlated showed negative correlation except High Density Lipoprotein (HDL) had positive correlation. The Serum Mg levels are significantly decreased along with the duration of the diabetes.<sup>[14]</sup>

### **Conclusions:**

Serum magnesium levels were low in type 2 diabetics when compared to controls. Levels of serum magnesium were further lower in uncontrolled type 2 diabetics than those in whom diabetes was controlled. Hypomagnesaemia was associated with diabetic retinopathy and diabetic nephropathy. No correlation was found in respect to Neuropathy & IHD. More the duration of diabetes and the levels of FBS, lower were the serum magnesium levels. Patients on insulin had lower levels of serum magnesium as compared to patients on OHAs. Hypomagnesaemia is a factor in type 2 diabetes and associated with various complications and duration of diabetes leading to various complications. Hence it is worth measuring serum magnesium levels in patients with type 2 DM and probably correlates their relationship with various complications.

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