

# Fasting Serum Magnesium Levels in Patients with Uncontrolled and Controlled T2DM in Relation to Its Complications

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## ABSTRACT

**Background:** Magnesium deficiency is proposed factor in pathogenesis of diabetic complications. Hypomagnesemia can be both a cause and consequence of diabetic complications. **Objective:** The aim of our study was to know the relationships between magnesium levels and diabetes its association with level of control of diabetes. **Study design:** This study was done in MVJ Medical College and Research Hospital, Hoskote, Bangalore. A total of 75 cases of type 2 diabetes mellitus (T2DM) were taken for study after satisfying the inclusion and exclusion criteria and also 35 nondiabetic patients admitted during this period were also included in this study under control group. All the patients were evaluated in detail including fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c) and fasting serum magnesium levels were estimated by using Calmagite method. **Results:** The serum magnesium among cases and controls are  $1.88 \pm 0.28$  mg/dL and  $2.10 \pm 0.29$  mg/dL, respectively. The mean serum magnesium levels in patients with controlled diabetes were 2.04 mg/dL, while they were 1.73 mg/dL in uncontrolled T2DM. Significant association was found between hypomagnesemia and diabetic retinopathy and nephropathy. **Conclusions:** There was significant reduction in serum magnesium levels in diabetics compared to controls. There was significant correlation between magnesium levels and levels of control in diabetics. Uncontrolled diabetics had low levels of serum magnesium. Duration of diabetes and high levels FBS also had an association with low magnesium levels. Low magnesium levels were mainly associated with diabetic retinopathy and nephropathy.

**Keywords:** Type 2 diabetes mellitus, magnesium, diabetic nephropathy, diabetic retinopathy

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Several distinct type of DM are caused by a complex interaction of genetics and environmental factors. Depending upon etiology of 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 such as microvascular (retinopathy, nephropathy, neuropathy) and macrovascular

(coronary heart disease, peripheral arterial disease, cerebrovascular disease).<sup>1</sup>

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.<sup>2</sup>

Magnesium deficiency has been found to be associated with microvascular disease in diabetes. Hypomagnesemia has been demonstrated in patients with diabetic retinopathy, lower levels of magnesium more is the risk for diabetic retinopathy. Magnesium depletion has also been associated with arrhythmogenesis, vasospasm, platelet activity and hypertension.<sup>3</sup>

The reason why magnesium deficiency occurs in diabetes are not clear but may include increased urinary loss, lower dietary intake or impaired absorption of magnesium compared to nondiabetic individuals.<sup>4</sup>

Low dietary intake can also contribute to hypomagnesemia in diabetics. Patients with type 2 diabetes

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are often overweight and may consume a diet higher in fat and lower in magnesium than nondiabetics.<sup>5,6</sup>

The present study was undertaken to know the relationships between magnesium levels and diabetes and association with level of control of diabetes.

## MATERIAL AND METHODS

Patients with type 2 diabetes admitted in MVJ Medical College and Research Hospital, Hoskote, Bangalore for a period of 1 year were included in the study. A total of 75 cases of T2DM were taken for study and also 35 nondiabetic patients admitted during this period were also included in this study under control group. All the patients were evaluated in detail including fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c) and fasting serum magnesium levels were estimated by using Calmagite method.

### Inclusion Criteria

All cases of T2DM and age- and sex-matched nondiabetic patients admitted to MVJ Medical College and Research Hospital, Hoskote, Bangalore.

### Exclusion Criteria

Patients with

- Chronic renal failure
- Acute myocardial infarction in last 6 months
- Malabsorption or chronic diarrhea
- History of alcohol abuse
- Hypertension, proteinuria, eclampsia
- History of epilepsy
- Patients on diuretics and receiving magnesium supplements or magnesium containing antacids.

### Statistical Method

T-test was used to find the significance of mean pattern of serum magnesium between cases/controls, controlled/uncontrolled. Analysis of variance (ANOVA) was used to find the mean pattern of serum magnesium in different complications in different range of FBS.

## RESULTS

A comparative study consisting of 75 diabetics and 35 controls was conducted to find serum magnesium in DM cases when compared to controls and magnesium levels in relation to complications.

The mean age of diabetics was  $59.56 \pm 9.70$  and  $58.66 \pm 1.026$  was that of controls (Table 1). The mean serum magnesium levels in cases and controls was 1.88 mg/dL and 2.1 mg/dL, respectively with p value of  $<0.003$ , which was statistically significant (Table 1). Hypomagnesemia was seen in 38.6% of the cases, whereas only 2.9% of controls had hypomagnesemia (Table 1).

Mean serum magnesium levels among uncontrolled DM were lower as compared to patients with controlled DM (Table 2).

Mean serum magnesium levels in patients with and without diabetic retinopathy was 1.77 mg/dL and 2.01 mg/dL, respectively, showing that patient with diabetic retinopathy had significantly lower levels of serum magnesium compared to those without retinopathy ( $p < 0.0006$ ) (Table 3). The mean serum magnesium levels in patients with and without diabetic neuropathy were 1.80 mg/dL and 2.09 mg/dL, respectively, which were statistically significant ( $p < 0.0002$ ) (Table 3).

The mean serum magnesium levels in patients with and without diabetic neuropathy were 1.92 mg/dL and 1.83 mg/dL, respectively, which were not statistically significant ( $p < 0.2120$ ) (Table 3). The mean serum magnesium levels in patients with and without ischemic heart disease (IHD) were 1.81 mg/dL and 1.92 mg/dL, respectively, which were not statistically significant ( $p < 0.139$ ) (Table 3).

**Table 1.** Age, Sex, Mean FBS, Mean Serum Magnesium Among Cases and Controls

	Cases (n = 75)	Controls (n = 35)	P value
Mean age	$59.56 \pm 9.70$	$58.66 \pm 10.26$	
Sex			
Male	57.33%	57.14%	
Female	42.67%	42.86%	
Mean FBS (mg/dL)	$206.33 \pm 14.89$	$94.86 \pm 11.78$	0.0001
Mean serum magnesium (mg/dL)	$1.88 \pm 0.28$	$2.1 \pm 0.29$	$<0.003$
Serum magnesium			
<1.8	29 (38.6%)	1 (2.9%)	
1.8-2.5	45 (60.0%)	32 (91.4%)	
>2.5	1 (1.4%)	2 (5.7%)	

**Table 2.** Effect of Level of Control of DM on Serum Magnesium

Serum magnesium (mg/dL)	Controlled diabetes (n = 37)	Uncontrolled diabetes (n = 38)
Range (min-max)	1.5-2.7	1.1-2.1
Mean ± SD	2.04 ± 0.29	1.73 ± 0.23

P < 0.001

**Table 3.** Serum Magnesium Levels in Patients With and Without Retinopathy, Nephropathy, Neuropathy and IHD

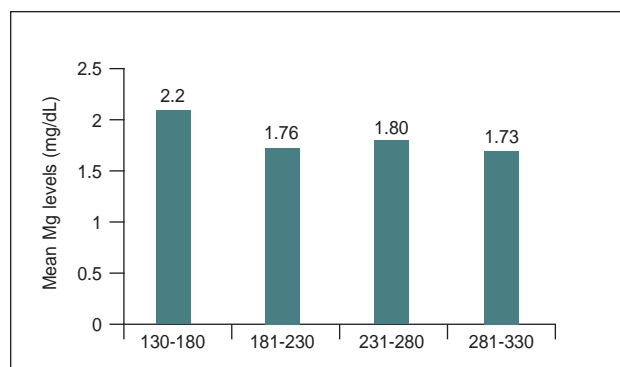
Serum magnesium (mg/dL)	Mean ± SD	P value
<b>Retinopathy</b>	1.77 ± 0.22	<0.0006
NPDR (n = 23)	1.86 ± 0.25	
PDR (n = 16)	1.63 ± 0.20	
No retinopathy	2.01 ± 0.31	
<b>Proteinuria (n = 53)</b>	1.80 ± 0.28	<0.0002
Microalbuminuria (n = 35)	1.86 ± 0.29	
Macroalbuminuria (n = 18)	1.67 ± 0.20	
No proteinuria (n = 22)	2.09 ± 0.27	
<b>Neuropathy</b>	1.92 ± 0.32	<0.212
No neuropathy	1.83 ± 0.27	
<b>IHD (n = 51)</b>	1.81 ± 0.28	<0.139
No IHD (n = 24)	1.92 ± 0.32	

NPDR = Nonproliferative diabetic retinopathy; PDR = Proliferative diabetic retinopathy; IHD = Ischemic heart disease.

Mean serum magnesium levels in patients with one complication, two complications and three complications was 2.07 mg/dL, 1.79 mg/dL and 1.74 mg/dL, respectively, which means that as the number of complications increase mean serum magnesium levels decrease (Table 4).

Mean serum magnesium levels in higher FBS range was low as compared to low FBS range i.e.: in range 130-180 mg/dL, 181-230 mg/dL, 231-280 mg/dL, 281-330 mg/dL, they were 2.2 mg/dL, 1.76 mg/dL, 1.80 mg/dL, 1.73 mg/dL, respectively (Fig. 1).

Serum magnesium levels were low when HbA1c was on higher side i.e.: When HbA1c was >9.80 then serum magnesium level was <1.7 mg/dL and when HbA1c was <7.20 then serum magnesium level was >1.7 mg/dL (Table 5).



**Figure 1.** Comparison of serum magnesium levels according to different ranges of FBS.

**Table 4.** Comparison of Serum Magnesium Levels According to the Number of Complications

Serum magnesium (mg/dL)	One complication (n = 25)	Two complications (n = 35)	All three (n = 13)
Mean ± SD	2.07 ± 0.30	1.79 ± 0.25	1.74 ± 0.29

**Table 5.** Comparison of Serum Magnesium Levels in Relation to HbA1c Levels

Serum magnesium (mg/dL)	<1.7	≥1.7
HbA1c	9.80 ± 1.75	7.20 ± 0.70

P < 0.001

**Table 6.** Comparison of Serum Magnesium Levels in Relation to Duration of Diabetes

Serum magnesium (mg/dL)	0-5 years (n = 17)	6-10 years (n = 39)	11-15 years (n = 12)	16-20 years (n = 7)
Mean ± SD	2.00 ± 0.36	1.90 ± 0.27	1.71 ± 0.29	1.78 ± 0.20

Mean serum magnesium levels according to the duration of diabetes i.e.: 0-5, 6-10, 11-15 and 16-20 years were 2.00, 1.90, 1.52 and 1.78 mg/dL, respectively (Table 6).

## DISCUSSION

The present study included 75 diabetics and 35 nondiabetics. Serum magnesium levels were determined in all the subjects.

The present study had diabetic patients whose ages ranged for 41-80 years, which was consistent with study done by Biradar et al.<sup>7</sup>

Mean age	Cases	Controls
Biradar et al	55.42 ± 12.65	55.58 ± 12.84
Present study	59.56 ± 9.70	58.66 ± 10.26

Male patients in cases and controls were 57.3% and 57.14%, respectively and females were 42.6% and 42.8%, respectively.

Mean serum magnesium	Cases	Controls	P value
Mean ± SD	1.88 ± 0.28	2.10 ± 0.29	<0.003

In this study, serum magnesium levels were more in controlled group as compared to uncontrolled group, which was consistent with the study done by Jain et al.<sup>8</sup>

Mean serum magnesium levels (Mean ± SD)	Controlled diabetes	Uncontrolled diabetes
Jain et al	1.85 ± 0.08	1.68 ± 0.12
Present study	2.04 ± 0.29	1.73 ± 0.23

In present study, there was no any significant association between age and sex but duration of diabetes had a relation with serum magnesium levels; patients with duration of diabetes more than 5 years had a lower serum magnesium levels as compared to those with a duration less than 5 years.

In our study also significantly lower levels of serum magnesium were observed in diabetics with microvascular complications.

Hypomagnesemia has been reported in patients with diabetic retinopathy. Lower the level of serum magnesium greater is the risk of severe diabetic retinopathy, which was consistent with study done by Kauser et al and Mirza Shariff et al.<sup>9,10</sup>

Mean serum magnesium levels (mg/dL)	Retinopathy	No retinopathy
Kauser et al	1.79 ± 0.15	2.25 ± 0.16
Mirza Shariff et al	1.28 ± 0.30	1.60 ± 0.40
Present study	1.76 ± 0.23	2.01 ± 0.31

The mechanism by which hypomagnesemia predisposes to retinopathy is unclear. Grafton et al<sup>11</sup> have proposed the inositol transport theory to explain this association. But exact reason remains obscure.

Mean serum magnesium (mg/dL)	Microalbuminuria	Macroalbuminuria
Rao et al	2.0 ± 0.24	1.80 ± 0.20
Present study	1.86 ± 0.29	1.67 ± 0.20

Above Box shows that patients with macroalbuminuria had a lower serum magnesium level as compared to patients with microalbuminuria.<sup>12</sup>

There was no association seen with magnesium levels in patients with neuropathy. There was a correlation between serum magnesium levels and number of complications.

Patients with only one complication had mean serum magnesium level of 2.07 ± 0.03 mg/dL and patient with two complications had a mean of 1.79 ± 0.25 mg/dL and those with three complications had a mean of 1.74 ± 0.29 mg/dL.

Patient with more than one complication had much lower serum magnesium levels, indicating more the complications, lesser the magnesium levels.

## CONCLUSION

- Serum magnesium levels were low in type 2 diabetics when compared to controls.
- Levels of serum magnesium were further lowered in uncontrolled type 2 diabetics than those in whom diabetes was controlled.
- Hypomagnesemia was associated with diabetic retinopathy and diabetic nephropathy.
- No correlation was found in respect to neuropathy and IHD.
- More the duration of diabetes and the levels of FBS, lower was the serum magnesium levels.
- Hypomagnesemia 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 T2DM and probably correlate their relationship with various complications.

## REFERENCES

1. Alvin CP. Harrison's Principle of Internal Medicine. 19th Edition, McGraw-Hill; 2012.
2. Nadler JL, Buchanan T, Natarajan R, Antonipillai I, Bergman R, Rude R. Magnesium deficiency produces insulin resistance and increased thromboxane synthesis. Hypertension. 1993;21(6 Pt 2):1024-9.
3. Sasaki S, Oshima T, Matsuura H, Ozono R, Higashi Y, Sasaki N, et al. Abnormal magnesium status in patients with

- cardiovascular diseases. Clin Sci (Lond). 2000;98(2): 175-81.
4. Wälti MK, Zimmermann MB, Spinaz GA, Hurrell RF. Low plasma magnesium in type 2 diabetes. Swiss Med Wkly. 2003;133(19-20):289-92.
  5. Ma J, Folsom AR, Melnick SL, Eckfeldt JH, Sharrett AR, Nabulsi AA, et al. Associations of serum and dietary magnesium with cardiovascular disease, hypertension, diabetes, insulin, and carotid arterial wall thickness: the ARIC study. Atherosclerosis Risk in Communities Study. J Clin Epidemiol. 1995;48(7):927-40.
  6. Schmidt LE, Arfken CL, Heins JM. Evaluation of nutrient intake in subjects with non-insulin-dependent diabetes mellitus. J Am Diet Assoc. 1994;94(7):773-4.
  7. Biradar S, Patil S, Kadeli D. Study of serum magnesium levels in type 2 diabetes mellitus. Int J Cur Res Rev. 2017;9(4):26-8.
  8. Jain AP, Gupta NN, Kumar A. Some metabolic facets of magnesium in diabetes mellitus. J Assoc Physicians India. 1976;24(12):827-31.
  9. Kausar MM, Afreen A, Kasi J. Study of serum magnesium levels in diabetic retinopathy. J Res Med Den Sci. 2014;2(3):19-22.
  10. Mirza Sharif Ahmed Baig, Mohd Siyadat Ali, Tejovathi B. Study of serum magnesium in diabetic retinopathy. Int J Biol Med Res. 2012;3(4):2480-2.
  11. Grafton G, Baxter MA. The role of magnesium in diabetes mellitus. A possible mechanism for the development of diabetic complications. J Diabetes Complications. 1992;6(2):143-9.
  12. Rao PP, Ghose M. Serum magnesium levels in type 2 DM with microalbuminuria and macroalbuminuria. IJSS. 2014.



## Dr Correct & Dr Incorrect

**SITUATION :** A patient being treated for *H. pylori* infection came with his family members for further management.



**Dr Incorrect**

THE ASYMPTOMATIC SPOUSE AND FAMILY MEMBERS, INCLUDING CHILDREN SHOULD ALSO BE TREATED



**Dr Correct**

TREATMENT OF THE SPOUSE AND FAMILY MEMBERS OF THE *H. PYLORI* INFECTED PATIENT (TREATED) IS NOT REQUIRED



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**LESSON :** It is unnecessary to attempt to eliminate the organism from asymptomatic family members with whom the treated patient will be in close contact.

Bacterial Infection

Inflammation

Mixed Skin Infection

Fungal Infection



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