

# Study of Serum Magnesium and HbA1c in Type 2 Diabetes Mellitus Patients

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**Abstract:** ***Aim:** To compare the serum magnesium levels in type 2 diabetes mellitus patients with and without micro vascular complications. **Materials and methods:** Comparative study done on 50 diabetic subjects (25 without micro vascular complications, 25 with micro vascular complications).serum magnesium was compared between the two groups and its relation with HbA1c assessed. **Results:** The average serum magnesium levels were measured as  $1.92 \pm 0.25$  and  $1.46 \pm 0.32$  in Group I and Group II respectively. The HbA1C (%) values were found to be significantly higher in group II. 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:** serum magnesium, diabetes mellitus, micro vascular complications, HbA1c

## 1. Introduction

Studies have shown that magnesium levels are lower in patients with diabetes compared with non diabetic controls [1]. The interrelationships between magnesium and carbohydrate metabolism have regained considerable interest over the last few years. The association between diabetes mellitus and hypomagnesaemia is compelling for its wide ranging impact on diabetic control and micro vascular complications [2].

Hypomagnesaemia has been related as a cause of insulin resistance, also being a consequence of hyperglycemia, and when it is chronic leads to the installation of macro and micro vascular complications of diabetes, worsening the deficiency of Mg [3]. The etiology of hypomagnesaemia cannot be clearly explained and serum magnesium levels have been shown to be inversely related to the severity of diabetes [2].

Hypomagnesaemia is contributed by:

- a)Hyperglycemia which leads to decreased cellular Mg Levels, independent of insulin levels
- b)Osmotic diuresis leads to increased urinary Mg losses and
- c)Concomitant use of diuretics and hypolipidemic agents also increase urinary Mg loss [4].

Hypomagnesaemia has been linked to poor glycemic control, diabetic nephropathy, retinopathy and diabetic neuropathy [2]. Magnesium is essential for insulin secretion, insulin receptor interaction; post receptor events (involving tyrosine kinase mediated phosphorylation) and normal carbohydrate utilization (by Mg dependent enzymes) [4]. A compromise in these functions leads to insulin resistance in hypomagnesaemia [4]. Oral magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects [5]. Hence this work was undertaken to evaluate the relationship between serum magnesium, HbA1c and diabetes mellitus without and with micro vascular complications.

## 2. Aims and Objectives

**Aim:** To compare the serum magnesium levels in type 2 diabetes mellitus (T2DM) patients with and without micro vascular complications.

**Objectives:**

- 1)To estimate serum magnesium levels in type 2 Diabetes mellitus.
- 2)To correlate serum magnesium level in type 2 diabetics with and without micro vascular complications
- 3)To correlate serum magnesium with HbA1c.

## 3. Materials and methods

### 3.1 Source of Data

Patients of type 2 diabetes mellitus of age 40-70 years, in the Department of General Medicine, Kempegowda Institute of Medical Sciences, Bangalore from November 2014 to March 2015 were taken for study considering the inclusion and exclusion criteria.

### 3.2 Methods of Collection of Data

The diagnosis of type 2 diabetes mellitus was established with the recommended criteria's of American diabetes Association. Informed consent was taken from all subjects. A pre-structured and pretested pro forma was used to collect the data. Baseline data including age and sex, detailed medical history including conventional risk factors were collected; clinical examination and relevant investigations were done.

Retinopathy was assessed by Direct Ophthalmoscopy. Nephropathy was determined based on dipstick test for urine micro albumin and renal function tests. Neuropathy was determined by clinical examination and monofilament test. Blood and urine samples were collected for relevant investigations.

### 3.3 Sample Size

Total: 50, 25 cases and 25 controls between age of 40-70years

Group I: 25 patients of type2 diabetes mellitus without micro vascular complications.

Group II: 25 patients of type2 diabetes mellitus with micro vascular complications.

#### Inclusion criteria

- Group I: Patients willing to participate in the study, in the age group of 40–70 years with type 2 diabetes without proven micro vascular complications
- Group II: Patients willing to participate in the study, in the age group of 40–70 years with type 2 diabetes with proven micro vascular complications, like nephropathy, neuropathy and/or retinopathy were selected.

#### Exclusion criteria

Patients with diabetic keto acidosis,coronary artery disease,stroke,peripheral vascular disease,immunological disorder, taking diuretics and magnesium supplements or containing antacids,malabsorption syndrome,chronic diarrhea,chronic renal failure due to factors other than type 2 Diabetes Mellitus,pancreatitis,alcoholism and liver diseases were excluded from the study .

### 3.4 Statistical analysis:

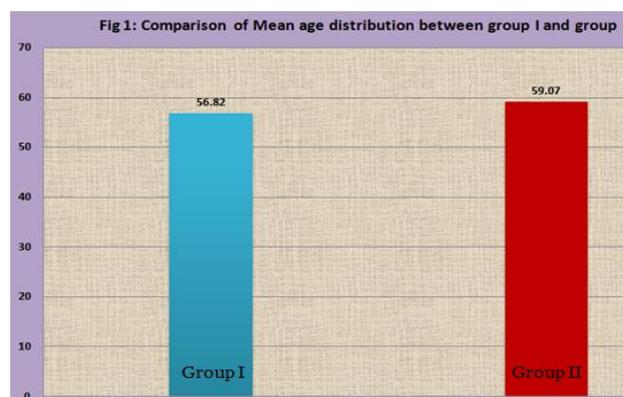
Student 't' test /Chi-square test has been used to find the significance of homogeneity of study characteristics between both groups of patients. Analysis of variance has been used to find the significance of study parameters between the groups. Results were expressed as mean + SD. Probability values of P< 0.05 were considered to indicate statistical significance.

## 4. Results

**Table 1: Patient demography**

	Group I(n=25)	Group II(n=25)
Age (years)	56.82±10.07	59.07±9.52
Sex Males	16	15
females	9	10
BMI	26.06±2.95	27.45±6.60
Duration of diabetes(yrs)	3.58±3.406	10.15±5.977
Treatment- none	6	2
OHA	16	11
Insulin	2	8
Both	1	4
FBS(mg/dl)	180.30	180.77
PPBS(mg/dl)	255.92	264.90
HbA1c %	8.98±2.26	9.93±2.50
Hypertension	9	19

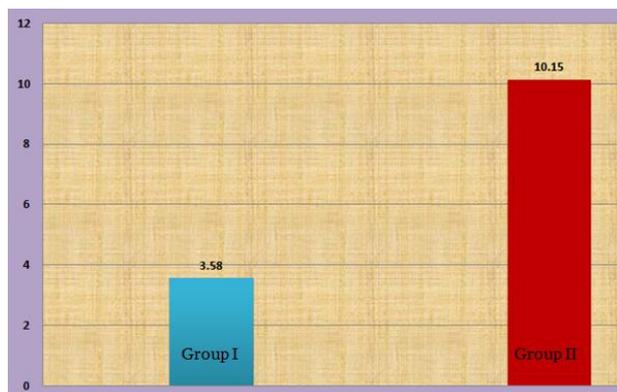
The average serum magnesium levels were measured as 1.92 ±0.25 and 1.46±0.32 in Group I and Group II respectively. Patients in Group II showed significant hypomagnesaemia as compared to Group I. The average HbA1C (%) values were measured as 8.98 ± 2.26 and 9.93 ± 2.50 in Group I and Group II respectively. The HbA1C (%) values were found to be significantly higher in group II. The values of HbA1C (%) were positively correlated with blood glucose level and negatively correlated with serum magnesium levels.



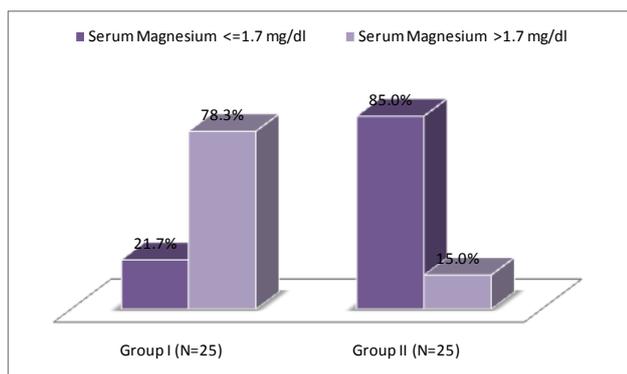
**Figure 1: Mean age distribution**

**Table 2: FBS, PPBS, HbA1c, S. Magnesium**

FBS,PPBS, HbA1c and serum magnesium levels in study population								
		N	Mean	SD	Min.	Max.	t' value	p' value
FBS (mg/dl)	Group I (N=25)	25	180.3	84.178	65	524	0.001	0.973
	Group II (N=25)	25	180.77	67.205	59	414		
PPBS (mg/dl)	Group I (N=25)	25	255.92	109.417	125	564	0.231	0.632
	Group II (N=25)	25	264.9	94.78	86	566		
Glycated HbA1c(%)	Group I (N=25)	25	8.985	2.2662	6.1	14	4.781	0.031
	Group II (N=25)	25	9.938	2.5039	6.8	16.3		
Serum Magnesium	Group I (N=25)	25	1.922	0.2512	1.4	2.4	74.451	<0.001
	Group II (N=25)	25	1.468	0.3202	0.9	2.2		



**Figure 2:** Mean duration of diabetes



**Figure 3:** Hypomagnesaemia in group I and II

## 5. Discussion

Mg is the second predominant component in the intracellular compartment, an important regulator of the cellular processes, co-factor of more than 300 essential metabolic reactions, including the ones that produce or use the MgATP complex [3].

However, its functionality is related to the synthesis of tissue constituents, growth and thermo genesis, and with the activity of tyrosine kinase, in the metabolism of glucose [3]. The almost universal involvement of magnesium in a wide variety of cellular processes critical to glucose metabolism, insulin action and cardiovascular functions has been well-appreciated [6]. The incidence of subclinical magnesium deficiency is common in diabetes and cardiovascular disorders [6].

**Table 3:** Comparison of previous studies

Study	Sample	Mean s.Mg in microvascular complications	Observation
Mirza Sharif Ahmed Baig (2012)	90	1.29±0.31	Low levels of serum magnesium were found in patients with diabetic complications when compared with diabetic patients without complications.
Asha S Khubchandani (2013)	75	1.32 ±0.28	Low S.Mg in T2DM with complications and significant correlation between HbA1C and magnesium levels.
Arundhati Dasgupta (2013)	150	1.02±0.31	Hypomagnesemia in diabetes was associated with poorer glyceemic control, retinopathy, nephropathy, and foot ulcers.
Present study	50	1.46±0.32	Low s.Mg and poor glyceemic control in T2DM with microvascular complications.

In our study we found that diabetics with micro vascular complications had significantly lower level of serum magnesium ( $1.46 \pm 0.32$ ) compared to diabetics without micro vascular complications ( $1.92 \pm 0.25$ ). Studies have shown that although the binding of insulin to its receptor does not appear to be altered by magnesium status, the ability of insulin once bound to receptor to activate tyrosine kinase is reduced in hypomagnesaemia states [2][7]. As a result reduced peripheral glucose uptake and oxidation are often noted in subjects with hypomagnesaemia [2][8]. Thus hypomagnesaemia may be a possible risk factor in development and progress of diabetic complications. The precise mechanism for development of micro vascular changes is not fully understood, it is possible that hypomagnesaemia inhibits prostacyclin receptor function producing an imbalance between prostacyclin and thromboxane effect which has marked atherogenic potential which is responsible for micro vascular complications [2]. Some studies have shown that oral supplementation with MgCl<sub>2</sub> solution restores serum magnesium levels improving insulin sensitivity and metabolic control in type 2 diabetic patients with decreased serum magnesium levels [5].

Also, we found diabetics with micro vascular complications had poorer glyceemic control than diabetics without micro vascular complications. Previous studies showed that higher level of HbA1C increases risk for development of micro angiopathy [9] and macro angiopathy [10] in diabetics [6].

## 6. Conclusion

- Hypomagnesaemia is associated with micro vascular complications and poor glyceemic control.
- It is important to regularly monitor magnesium levels in all type 2 diabetic patients.
- Further studies on the role of magnesium supplementation in T2DM in the Indian population are necessary.

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