



Study of Serum Magnesium Levels in Diabetic Foot Ulcers-A South Indian Experience

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Abstract

Hypomagnesaemia has been known to occur in patients with type 2 diabetes mellitus; it is often missed and undertreated. Hypomagnesemia has also been associated with diabetic foot ulcers. A total of one hundred and twenty subjects were included in this study and divided into three groups. The study group consisted of forty patients that are type 2 diabetes and foot ulcers; and the control groups consisted of forty patients with type 2 diabetes without foot ulcers and forty healthy subjects respectively. Biochemical parameters were estimated in all the three groups and compared. The present study was conducted with an objective to evaluate the serum magnesium, fasting blood glucose and glycosylated haemoglobin in type 2 Diabetes mellitus cases and compare them with healthy subjects. The present study also attempts to evaluate the probable association between diabetic foot ulcers and serum magnesium levels. There is significant difference between levels of serum magnesium levels among diabetics without complications and healthy subjects. The mean serum magnesium levels among the above groups are 1.79 ± 0.15 mg/dl and 2.25 ± 0.16 mg/dl respectively ($p < 0.001$). There is also significant difference between levels of serum magnesium levels among diabetic foot ulcer patients and diabetics without complications i.e. 1.60 ± 0.13 mg/dl and 1.79 ± 0.15 mg/dl respectively ($p < 0.001$). The serum magnesium levels were significantly lower in patients with diabetic foot ulcers compared to diabetics without complications.

Keywords: Diabetes mellitus, Diabetic foot ulcers, Hypomagnesaemia.

Introduction

Type 2 Diabetes Mellitus is an endocrine disease characterised by both insulin resistance and defective insulin secretion¹. Type 2 diabetes mellitus accounts for approximately (90-95) % of all diagnosed cases of diabetes². The number of people with diabetes worldwide was estimated to be 131 million in 2000; it is projected to increase to 366 million by 2030. India is fast emerging as the diabetes capital of the world. A study by the American Diabetes Association reports that India will see the greatest increase in people diagnosed with diabetes by 2030³.

Diabetic foot ulcers are major complication of diabetes resulting in significant morbidity associated with diabetes⁴. The aetiopathogenesis of diabetic foot ulcers is multifactorial^{5,6}. The major contributing factors are peripheral neuropathy and ischemia resulting from peripheral vascular disease⁷. Previous studies have shown that diabetic patients have up to a 25% life time risk of developing foot ulcer⁸.

Magnesium is an important intracellular cation and plays an important role in the carbohydrate metabolism⁹. It acts as a cofactor for every enzymatic reaction that requires kinases¹⁰. Previous studies have shown that magnesium levels are lower in patients with diabetes compared with non diabetic controls^{11,12}.

The association of hypomagnesaemia with poorly controlled diabetes and also various chronic complications of diabetes mellitus have been reported⁹.

The present study was conducted with an objective to estimate the serum magnesium, glycosylated haemoglobin and fasting blood glucose in type 2 Diabetes mellitus cases and compare them with healthy subjects. To the best of our knowledge no Indian study has evaluated the relationship between serum magnesium and diabetic foot ulcers. The present study also attempts to evaluate the probable association between serum magnesium levels and diabetic foot ulcers.

Material and Methods

The cross sectional observational study was carried out in the department of internal medicine and department of biochemistry of Basaveshwara Medical College Hospital and Research Centre. The study was conducted after obtaining permission from ethical committee and consent from the subjects.

A total of 120 subjects were included in this study and allotted into 3 groups. The study group consisted of 40 subjects that are type 2 diabetes and foot ulcers; and the control groups consisted of 40 subjects with type 2 diabetes without foot ulcers and 40

healthy individuals respectively. The three study groups were age and sex matched.

Patients with acute and chronic diarrhoea /malabsorption states, with thyroid and adrenal dysfunction, history of alcohol consumption, history of vitamin or mineral supplementation in the recent past, recent metabolic acidosis, pregnancy, lactating mothers, with serum creatinine ≥ 1.5 mg/dl and on medications known to alter magnesium levels were excluded from the study¹³.

The diagnosis of type 2 diabetes mellitus was confirmed by biochemical investigations in accordance with WHO criteria¹⁴.

Foot ulcer was defined as a full thickness skin defect that required ≥ 14 days for healing¹⁵. Biochemical investigations were done in the three groups. Fasting plasma glucose was estimated by using commercially available kit in automated analyzer. Magnesium was estimated by calmagite dye method¹⁶. HbA_{1c} was estimated using cation resin method.

Statistical Analysis: Data analysis was done using statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver. 2.11.1. Microsoft word and Excel have been used to generate graphs and tables. The significance of study parameters between three groups of subjects has been done by Analysis of variance (ANOVA). Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters.

Table-1
Serum Magnesium levels in three groups studied

Serum Mg	Controls	DM without complications	DM with foot ulcer
<1.5	0(0%)	0(0%)	5(12.5%)
1.5-2.0	0	32(80.0%)	35(87.5%)
2.0-2.5	40(100.0%)	8(20.0%)	0
Total	40(100%)	40(100%)	40(100%)

Lower levels of Serum Mg is significantly associated with DM patients with $P < 0.001$

Table-2
Comparison of mean levels FBS, HbA_{1c} and Serum Mg in three groups studied

	Controls	DM without complications	DM with foot ulcer	P value
FBS (mg/dl)	100.15 \pm 9.07	191.60 \pm 46.47	201.45 \pm 47.06	<0.001**
HbA _{1c}	6.01 \pm 0.24	7.71 \pm 0.49	7.94 \pm 0.48	<0.001**
Serum Mg	2.25 \pm 0.16	1.79 \pm 0.15	1.60 \pm 0.13	<0.001**

Results and Discussion

The comparative controlled study consisting of 40 diabetic foot ulcer patients, 40 diabetics without complications and 40 non diabetic healthy subjects was conducted to study the variability of serum magnesium in the above mentioned groups. The mean age of the subjects in the three groups in the above mentioned order was 53.63 \pm 7.98, 52.77 \pm 7.63 and 53.13 \pm 6.42 respectively. Among all the groups the sex distribution was the same i.e. 60% and 40% males and females respectively.

The mean FBS level in diabetic foot ulcer patients was 201.45 \pm 47.06 mg/dl. The mean levels among diabetics without complications and healthy subjects were 191.60 \pm 46.47 mg/dl and 100.15 \pm 9.07 mg/dl respectively.

The mean HbA_{1c} level in diabetic foot ulcer patients was 7.94 \pm 0.48%. The mean levels among diabetics without complications and healthy subjects were 7.71 \pm 0.49% and 6.01 \pm 0.24% respectively.

There is significant variability between levels of serum magnesium levels among diabetics without complications and healthy subjects. The mean serum magnesium levels among the above groups are 1.79 \pm 0.15 mg/dl and 2.25 \pm 0.16 mg/dl respectively ($p < 0.001$).

There is also significant variability between levels of serum magnesium levels among diabetic foot ulcer patients and diabetics without complications i.e. 1.60 \pm 0.13 mg/dl and 1.79 \pm 0.15 mg/dl respectively ($p < 0.001$).

In our study we found a strong association between low magnesium levels and diabetic foot ulcers. In a study by Rodriguez Moran and Guerrero Romero it was observed that 93.9% of 33 patients with diabetic foot ulcers had hypomagnesemia in contrast to 73.1% of 66 patients without diabetic foot ulcers. The possible mechanism suggested may be the association of hypomagnesaemia and risk factors for development of diabetic foot ulcers like polyneuropathy and platelet dysfunction¹⁷. In a similar study Keskek et al noted a strong correlation between hypomagnesemia and diabetic foot ulcers¹⁸.

Our study reinforced the already well known inverse correlation between serum magnesium levels and blood glucose levels as demonstrated in various other studies^{19,20,21}. The factors for hypomagnesemia in diabetes include decreased dietary intake, increased gastrointestinal loss as result of autonomic dysfunction, and osmotic diuresis due to glycosuria and reduced renal reabsorption⁹. Sometimes the more common use of antibiotics and antifungals in patients with diabetes may also contribute to renal magnesium wasting¹³.

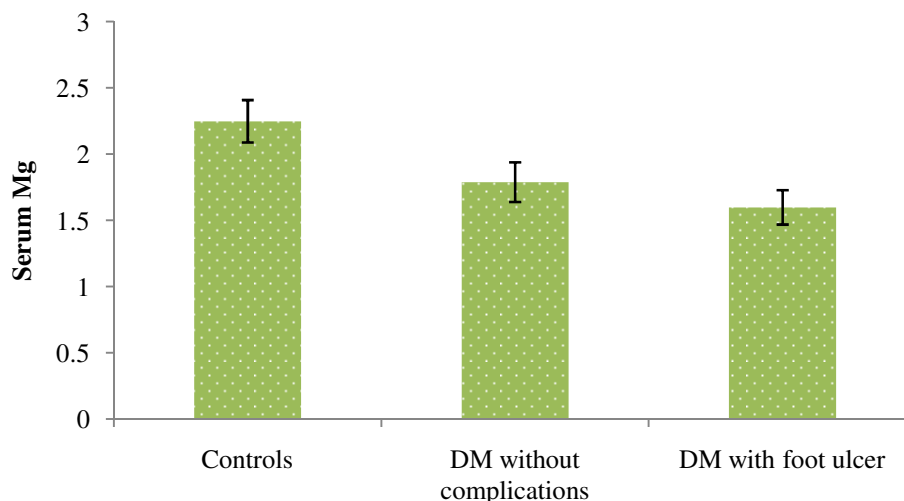


Figure-1
Serum magnesium levels in the three groups studied

Conclusion

Hypomagnesemia is common among type 2 diabetes mellitus patients. Hypomagnesemia may be a contributing factor for the long term complications of type 2 diabetes. As available information suggests that adverse outcomes are associated with hypomagnesaemia, it is prudent that magnesium levels are monitored in diabetic patients. Further studies on the role of magnesium supplementation in type 2 diabetes in Indian population are recommended.

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