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Materials and Methods: A total of 50 patients with type 2 Diabetes Mellitus were recruited from the institute's medicine department. Fifty age and sex matched apparently healthy individuals with normal plasma glucose and with no symptoms suggestive of Diabetes mellitus were taken as controls. Both cases and controls were subjected to estimation of biochemical parameters.

Objectives: The present study was conducted with an objective to evaluate the serum magnesium and fasting blood glucose in type 2 Diabetes mellitus cases and compare them with controls. The present study also attempts to evaluate the possible relationship between the modality of treatment and serum magnesium levels.

Results: There is significant difference between levels of serum magnesium levels among diabetics and controls. The mean serum magnesium levels in cases and controls are 1.67 mg/dl and 2.03 mg/dl respectively ($p < 0.001$). The mean serum magnesium levels in the OHA group, insulin group and the insulin+ OHA group were 2.02 mg/dl, 1.59mg/dl and 1.25 mg/dl respectively.

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Conclusion: The serum magnesium levels were significantly lower in the insulin treated group compared to the OHA treated group. The serum magnesium levels were also significantly lower in insulin treated group compared to the OHA group.

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I. INTRODUCTION

Type 2 diabetes mellitus is metabolic and endocrinological disease characterised by hyperglycemia associated with both insulin resistance and defective insulin secretion¹. Type 2 Diabetes mellitus accounts for approximately 90-95% of all diagnosed cases of diabetes². In addition to hyperosmolar coma and ketoacidosis, patients with type 2 diabetes mellitus may have cardiovascular disease, nephropathy, retinopathy and polyneuropathy³.

Magnesium is the fourth most abundant cation in the human body and the second most abundant intracellular cation⁴. It plays an important role in the

carbohydrate metabolism. It serves as a cofactor for all enzymatic reactions that require kinases⁵. It is also an essential enzyme activator for neuromuscular excitability and cell permeability, a regulator of ion channels and mitochondrial function, a critical element in cellular proliferation and apoptosis, and an important factor in both cellular and humoral functions⁶.

The treatment of the patients of type 2 diabetes mellitus requires a multidisciplinary approach whereby every potential complicating factor must be closely monitored and treated. In particular although hypomagnesaemia has been reported to occur with increased frequency in patients with type 2 diabetes mellitus, it is frequently overlooked and undertreated⁷.

The present study was conducted with an objective to evaluate the serum magnesium and fasting blood glucose in type 2 Diabetes mellitus cases and compare them with controls. Very few studies have evaluated the relationship between serum magnesium and modality of treatment in type 2 diabetes mellitus. The present study also attempts to evaluate the possible relationship between the modality of treatment and serum magnesium levels.

II. MATERIALS AND METHODS

The study was approved by the Ethics committee; a written informed consent was obtained from all participants in this study. A total of 50 patients with type 2 diabetes mellitus were recruited from the institute's medicine department. The diagnosis of type 2 diabetes mellitus was confirmed by biochemical investigations as per WHO criteria⁸. Fifty age and sex matched apparently healthy individuals with normal plasma glucose and with no symptoms suggestive of DM were taken as controls.

Patients with acute or chronic diarrheal/malabsorption states, with thyroid or adrenal dysfunction, history of alcohol intake, history of vitamin or mineral supplements in the recent past, recent metabolic acidosis, pregnancy, lactation, with serum creatinine > 1.5 mg/dl and on drugs known to affect magnesium levels were excluded from the study⁹.

Both cases and controls were subjected to estimation of biochemical parameters. Fasting plasma glucose was estimated by using commercially available

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kit in automated analyzer. Magnesium was estimated by a kit that uses calmagite dye method¹⁰. The reference serum magnesium level by this method is 1.6-2.5 mg/dl.

III. STATISTICAL ANALYSIS

Statistical analysis of data was performed using SPSS (Version 15.0). Chi-square and Fisher Exact test has been used to find the significance of proportion of serum magnesium levels between cases and controls. Student t test has been used to find the significance of mean pattern of serum magnesium between cases/controls and Insulin/OHA.

IV. RESULTS

A Comparative study consisting of 50 Diabetic Mellitus patients and 50 controls was undertaken to investigate the change pattern of serum magnesium in DM cases when compared to controls. The mean age of the diabetics was 55.42±12.65 years whereas it was 55.58±12.84 years respectively. Both among the cases and controls the sex distribution was same i.e. 62% and 38% males and females respectively. The maximum number of patients was in the age group of 41-50 i.e. 42%.

The mean FBS levels among cases and controls were 230.1 mg/dl and 99.42 mg/dl respectively. There is significant difference between levels of serum magnesium levels among diabetics and controls. The mean serum magnesium levels in cases and controls are 1.67 mg/dl and 2.03 mg/dl respectively ($p < 0.001$).

Of the total of 50 diabetic patients 25(50%) were on insulin alone, 16(32%) were on OHA'S and 9(18%) were on combination of OHA'S and insulin. The mean serum magnesium levels in the OHA group, insulin group and the insulin+ OHA group were 2.02 mg/dl, 1.59 mg/dl and 1.25 mg/dl respectively. The serum magnesium levels were significantly lower in the insulin treated group compared to the OHA treated group.

Infections were the most common cause for admission accounting for 54% of the admissions among diabetics. The next commonest cause for admission was cardiovascular disease which accounted for 16% of the admissions. Of these 50% were on insulin, 37.5% on OHA's and 12.5% on OHA's and insulin both. Of the cardiovascular disease 3 patients were admitted for stable angina, 3 for unstable angina and 2 for myocardial infarction. Neurological problems accounted for 12% of admissions. 4 patients admitted for stroke, 1 for cranial nerve palsy and 1 for peripheral neuropathy. Peripheral vascular disease accounted 12% of admissions. 4 patients had ischemic signs in the limbs and 2 patients had gangrene. 6% of patients were admitted exclusively for poorly controlled diabetes.

V. DISCUSSION

Of all the endocrine and metabolic disorders associated with magnesium deficiency, diabetes mellitus is the most common. Many studies have shown that plasma levels are lower in patients with type 1 and type 2 diabetes mellitus compared with non diabetic control subjects. Inverse correlations between magnesium and fasting plasma glucose, HbA1C, HOMA-IR have been observed.^{11, 12}

Factors implicated in hypomagnesemia in diabetics include diets low in magnesium¹³, osmotic diuresis causing high renal excretion of magnesium, insensitivity to insulin affecting intracellular magnesium transport and thereby causing increased loss of the extracellular magnesium¹⁴ rampant use of loop and thiazides diuretics promoting magnesium wasting,^{15, 16} diabetic autonomic neuropathies⁴ and reduced tubular reabsorption due to insulin resistance¹⁷. Sometimes the more common use of antibiotics and antifungals such as aminoglycosides and amphotericin in patients with diabetes may also contribute to renal magnesium wasting¹⁸.

Hypomagnesemia may be a contributing factor for the long term complications particularly ischemic heart disease¹⁹, retinopathy^{20, 21}, foot ulcer²² and peripheral neuropathy²³. In our study there was significant decrease in serum magnesium level in type 2 DM as compared to controls. Similar such decreased in serum magnesium level in diabetic patients as compared to controls has been reported in other studies.^{24, 25}

Our study also demonstrated that serum magnesium levels were significantly lower in patients on insulin treatment compared to patients who were on oral hypoglycaemic agents alone.

VI. CONCLUSION

Hypomagnesemia, defined herein as having low serum magnesium concentrations, is common among patients with type 2 diabetes. Contributory mechanisms most likely are multifactorial. Because available data suggest that adverse outcomes are associated with hypomagnesemia, it is prudent that routine surveillance for hypomagnesemia is done and the condition be treated whenever possible.

A magnesium rich diet consisting of whole grains legumes, fruits and vegetables such as spinach, okra, dry apricots may be recommended. Further studies on the role of magnesium supplementation in type 2 DM in the Indian population are recommended.

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Table 1 : Effect of DM on Serum magnesium

Serum Magnesium	Cases	Controls
Range (Min-Max)	1.0-2.50	1.50-2.60
Mean ± SD	1.67±0.37	2.03±0.25
95% CI	0.052-1.56	0.04-1.96
Significance	Student t=5.649, P<0.001	

Table 2 : Comparison of serum Magnesium levels between cases and Controls

Serum Magnesium	Cases (n=50)		Controls (n=50)	
	Number	%	Number	%
≤ 1.0	1	2.0	-	-
1.0-1.50	19	38.0	1	2.0
1.50-2.00	21	42.0	31	62.0
2.00-2.50	9	18.0	16	32.0
>2.50	-	-	2	4.0
Inference	Cases are significantly more likely to have less Serum magnesium (<1.50 mg/dl) when compared to Controls with P<0.001			

Table 3 : Effect of type of treatment on Serum magnesium

Serum Magnesium	Insulin (n=34)	OHA (n=16)
Range (Min-Max)	1.0-2.20	1.60-2.50
Mean ± SD	1.50±0.27	2.02±0.29
95% CI	1.41-1.60	1.86-2.18
Significance	Student t=5.988, P<0.001	

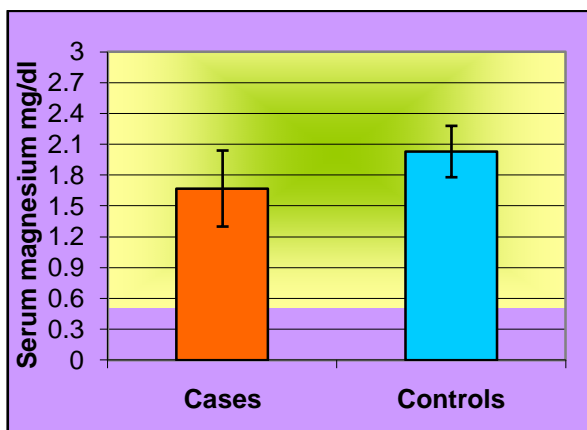


Figure 1

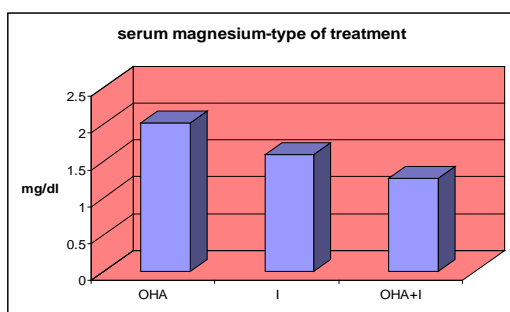


Figure 2

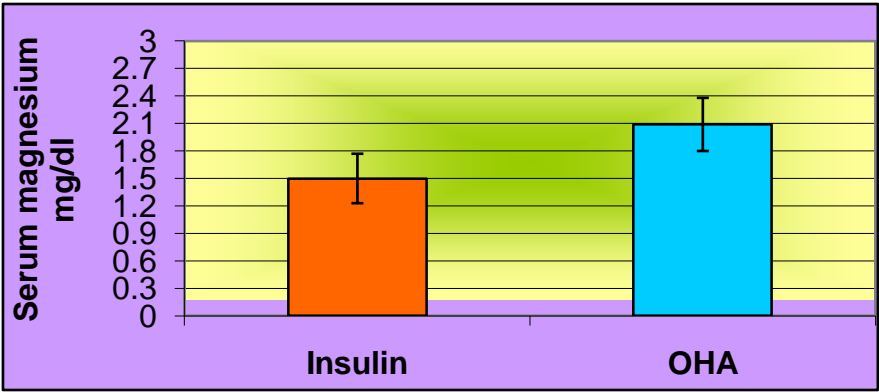


Figure 3

