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ORIGINAL RESEARCH

Serum magnesium level in type 2 Diabetes mellitus and its relationship with glycemic control and diabetic complications

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ABSTRACT

Background: Several studies undertaken in different parts of the world have shown that hypomagnesemia occur at an increased frequency among patients with type 2 diabetes compared with their counterparts without diabetes. As current data suggest adverse outcomes in association with hypomagnesemia, it is prudent to monitor magnesium routinely in this patient population and treat the condition whenever possible. Therefore, this study was undertaken to determine the serum magnesium levels in type 2 diabetes in this part of our country. Aim & Objective: 1. Serum magnesium level in type 2 Diabetes mellitus and its relationship with glycemic control and diabetic complications.2. To study Clinical profile of type 2 DM. 3. Correlation of Serum magnesium level in type 2 DM with glycemic control and complications. Method: Study design: Case control study. Study setting: Department of Medicine at tertiary care centre. Study duration: January 2021 to December 2021. Study population: The study population included 50 diabetics without complications (group I), 50 diabetics with complications (group II) and 100 normal healthy controls (group III). Sample size: 100. Results: Serum magnesium levels were found low in study group as compared to control group. A significant correlation between HbA1C and magnesium levels was seen. The patients with diabetic complications have significantly higher values of serum cholesterol and triglycerides. Conclusions: Hypomagnesemia in type 2 diabetes was associated with poor glycemic control and with increased frequency of long-term complications.

Keywords: Serum magnesium, Type 2 diabetes, Glycemic control, HbA1c

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INTRODUCTION

Several vitamins and minerals act as cofactors in the enzyme reaction regulated by insulin. Deficiencies of certain vitamins and minerals such as vitamin E, potassium, magnesium, zinc and chromium may aggravate carbohydrate intolerance. Magnesium is involved on multiple levels in insulin secretion, binding and activity. Cellular magnesium deficiency can alter of the membrane bound sodium-potassium-adenosine triphosphatase which is involved in the maintenance of gradients of sodium and potassium and in glucose transport.[1]

Magnesium deficiency has been found to be associated with diabetic micro vascular disease. Low serum magnesium level correlated positively with the velocity of regaining basal vascular tone after hyperemia. Hypomagnesemia has been demonstrated in patients with

diabetic retinopathy, with lower magnesium levels predicting a greater risk of severe diabetic retinopathy.[2]

Magnesium depletion has been associated with multiple cardiovascular implications: arrythmogenesis, vasospasm, and hypertension and platelet activity.[3] The present study is undertaken to determine the clinical significance of serum magnesium levels.

AIM AND OBJECTIVES:

1. Serum magnesium level in type 2 Diabetes mellitus and its relationship with glycemic control and diabetic complications.
2. To study Clinical profile of type 2 DM
3. Correlation of Serum magnesium level in type 2 DM with glycemic control and complications.

MATERIAL AND METHODS

Study design: Cross Sectional study

Study setting: Department of Medicine at tertiary care centre

Study duration: January 2021 to December 2021.

Study population: The study population included 50 diabetics without complications (group I), 50 diabetics with complications (group II) and 100 normal healthy controls (group III).

Inclusion criteria:

1. 50 diabetics without complications (group I), 50 diabetics with complications (group II) and 100 normal healthy controls (group III).

Exclusion criteria:

1. Patients with chronic renal failure,
2. patients on diuretics and/or alcohol abuse
3. patients receiving magnesium supplements or magnesium containing antacids
4. mal-absorption or chronic diarrhoea and other associated endocrine disorders
5. Not willing to participate in study
6. Incomplete Questioners

Approval for the study:

Written approval from Institutional Ethics committee was obtained beforehand. Written approval of medicine department and related department was obtained. After obtaining informed verbal consent from all cases with confirmed diagnosis of type 2 DM such cases were included in the study

Sample Size: 100

Sampling technique: Using purposive sampling technique a total of 100 cases with confirmed diagnosis of type 2 DM such cases were included in the study.

Methods of Data Collection and Questionnaire:

Predesigned and pretested questionnaire was used to record the necessary information. Questionnaires included general information, such as age, sex, residential address,

STUDY PROCEDURE:

This study was conducted in Medicine Department of tertiary care center, in who satisfied the above said inclusion and exclusion criteria and this study conducted from ……..

Diagnosis of Type 2 DM was based on the American Diabetes Association criteria and clinical history as following.[4]

1. FBS≥ 126mg/dl on 2 determinations,
2. symptoms of hyperglycemia and RBS ≥200mg/dl,

3. 2-hour plasma glucose ≥200mg/dl after a 75 grams oral glucose tolerance test (performed as described by the World Health Organization),
4. On oral hypoglycemic agents.

All the patients were screened for the presence of microor macrovascular complications like, retinopathy, peripheral vascular disease and coronary heart disease. On the basis of screening, 100 patients were divided into two groups: group I (50 diabetic patients without complications) and group II (50 patients with micro- or macrovascular complications). Group III include 100 normal healthy controls matched by age and gender with the patient groups.

All the subjects were in the age group of 20 to 80 years. Fasting plasma and serum sample of each subject were collected and serum magnesium, HbA1C and their lipid profiles were measured. Serum magnesium was measured by Calmagite endpoint method. Serum cholesterol was estimated by cholesterol oxidase method and serum triglyceride by glycerol peroxidase method on Medica Easyra auto analyser. HbA1C estimation was done by Medisys Labonacheck.

Data entry and analysis

The data were entered in Microsoft Excel and data analysis was done by using SPSS demo version no 21 for windows. The analysis was performed by using percentages in frequency tables, $p<0.05$ was considered as level of significance using the Chi-square test.

RESULTS AND OBSERVATIONS

One hundred and twenty seven patients of Type 2 DM patients consecutively seen at the out-patient department of General Medicine were screened for this study. Out of these patients, 27 were not enrolled because they have chronic renal failure (n= 19), alcohol abuse (n=5), diuretic use (n=2) and antacids containing magnesium (n=1). The mean age of the diabetics was 54.92±11.56 years whereas it was 53.58±10.48 years in controls respectively. Both among the cases and controls the sex distribution was same i.e. 64% and 36% males and females respectively. The maximum number of patients was in the age group of 41-50 i.e. 39%.

Table 1: The baseline characteristics of both the groups.

	Study Group		**Control Group**
	Group I	**Group II**	**Group III**
Age	54.92±11.56	55.86±9.87	53.58±10.48
Time since diagnosis of diabetes (years)	8.7±4.62	9.2±5.1	Not applicable
BMI (kg/m2)	27.6±9.1	28.7±8.7	28.9±4.7
Waist-to-hip ratio	0.97±0.05	0.98±0.03	0.95±0.07
Systolic blood pressure (mmHg)	140.2±28.1	143.3±24.6	135±19.6
Diastolic blood pressure (mmHg)	82.7±16.4	86.5±14.2	79.1±13.5
FBS	230.34±88.42	240.71±76.57	99.42±10.32
HbA1c	7.3±1.53	7.7±1.87	5.2±0.73
Total cholesterol (mg/dl)	196.91±56.37	206.96±28.19	173.75±28.18
HDL cholesterol (mg/dl)	40.15±10.42	35.91±18.53	45.17±11.97
LDL cholesterol (mg/dl)	111.53±40.15	119.69±11.19	106.94±32.43
Triglycerides (mg/dl)	130.08±37.89	144.24±40.71	125.56±76.99
Magnesium (mg/dl)	1.67±0.37	1.32±0.23	2.07±0.27

The average serum magnesium level were below normal range in group I and group II and were measured as 1.67±0.37 and 1.32±0.23 respectively. Hypomagnesemia was more in group II patients in comparison to group I. In control group (group III), the serum magnesium level was within normal range and was measured as 2.07±0.27. The average HbA1C (%) values were measured as 7.97±0.76, 9.60±1.10 and 5.69±0.43 in group I, group II and group III, respectively. The average HbA1C (%) values in group II were found to be significantly higher than the group I and the values of HbA1C (%) were positively correlated with blood glucose level.

The lipid profile was deranged in the study groups. The average serum cholesterol levels were measured as 221.38±15.90, 290.92±21.82 and 144.13±13.98 in group I, group II and group III, respectively. The serum cholesterol values were significantly higher in group II ($p<0.001$.)

DISCUSSION

Marked magnesium deficiency has been reported in the previous studies in patients with type-2 diabetes.[5] However, some workers have also reported normal and even high levels.[6] Prevalence of hypomagnesemia in type-2 diabetics was reported by Nadler et al. in type 2 diabetics attending outpatient clinics in the US.[7] Walti MK et al. also reported a prevalence of hypomagnesemia in type 2 diabetics at 37.6% versus 10.9% in nondiabetic controls in a study conducted in Zurich, Switzerland.

The reasons for the high prevalence of magnesium deficiency in diabetes are not clear, but may include increased urinary loss, lower dietary intake, or impaired absorption of magnesium compared to healthy individuals. Several studies have reported increased urinary magnesium excretion in type 1 and type 2 diabetes.[5,7] Recently a specific tubular defect in magnesium reabsorption in thick ascending loop of Henle is postulated.

This defect results in reduction in tubular reabsorption of magnesium and consequently hypomagnesemia. The reason for this tubular defect in diabetics is unclear. Insulin treatment has been shown to correct renal magnesium loss in diabetics. Low dietary intake is an unlikely cause of impaired magnesium status in diabetes. A dietary assessment conducted in Europe showed that only 5.4% of the diabetic group and 9.1% of the control group had intakes of magnesium below their individual requirements.

In addition, recently it has been shown that type 2 diabetics in reasonable metabolic control absorb dietary magnesium to a similar extent as healthy controls. Increased urinary magnesium excretion due to hyperglycemia and osmotic diuresis may contribute to hypomagnesemia in diabetes. Hypomagnesemia is reported to be both a cause and result of poor glycemic control.

Magnesium is a cofactor in both glucose transporting mechanisms of cellmembrane and various enzymes important in carbohydrate oxidation.[8] In addition; magnesium deficiency has been shown to promote insulin resistance in multiple studies. Nadler, et al has reported that insulin sensitivity decreases even in non-diabetic individuals after induction of magnesium deficiency.[9] Likewise, elderly subjects were shown to have improved glucose tolerance when they received magnesium supplements. The present study had diabetic patients ranging from 20- 80 years.

The average age of controls in the present study was 53.58 years while in the study of Yajnik CS et al was 46.5 years.[10] The mean age of diabetics in the present study was 54.9 years as against 54.7 in study of Yajnik CS et al. Schlienger et al studied the influence of glycemic control (glycemic control evaluated by HbA1C) on various trace elements and reported significantly reduced plasma magnesium levels in patients with poor control of diabetes.[11]

On establishing the relationship between magnesium levels and the state of control of diabetes, it was observed that in poorly controlled diabetic's serum and urinary magnesium

levels were respectively lower and higher than that of poorly controlled (1.75±0.34 versus 1.85±0.08 in fairly controlled and 1.25±0.19 versus 1.68±0.[12]
in poorly controlled) with no significant difference in erythrocytic magnesium levels. Nagase N found that serum magnesium levels of diabetes mellitus (1.90±0.37) was significantly lower than that of normal controls (2.30±0.32).[12] They also concluded that serum magnesium level of poorly controlled diabetic patients is lower than that of well controlled diabetic patients. These results suggested that magnesium deficient state is one of the causes of insulin resistance. However, he included the patients with hypertension, ischemic heart disease and diabetes mellitus. We did not evaluate the interrelationship between these entities.

CONCLUSION

Serum magnesium levels were lower in type 2 diabetic patients when compared to controls. Levels of serum magnesium levels were further lower in uncontrolled type 2 diabetic patients than those in whom diabetes was under control. Further studies are required to know whether magnesium supplementation is helpful in management of diabetes and prevention of complications.

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