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Original Research Article

A Study on Relationship between Vascular Complications of Diabetes Mellitus with Serum Magnesium Levels

M. Ramadevi MD[1], DC. Jaya Bhaskar MD[2], Shilpa Lenus [3]

[1]Associate professor of General Medicine, ACSR Government Medical College Nellore
[2]Rtd Professor, Department of General Medicine, S.V Medical College, Tirupati, AP
[3]Sree Narayana Institute of Medical Sciences, Chalakka, Ernakulam Dist, Kerala

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Corresponding author: Dr. M. Ramadevi
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Abstract:

Diabetes Mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Type 2 diabetes mellitus (T2DM) accounts for 90% of all DM cases and is characterized by progressive insulin secretory defect and insulin resistance1. It is a growing public health burden across the world, particularly in developing countries. India is almost in the grip of the diabetes epidemic and warrants immediate corrective measures.

Aim: To study the relationship between vascular complications of type 2 diabetes mellitus with serum magnesium levels.

Results: 101 patients of Type 2 Diabetes Mellitus who are fulfilling the inclusion and exclusion criteria are studied according to prestructured proforma. Results are analyzed.

Keywords: Diabetes Mellitus, hyperglycemia, Type 2 diabetes mellitus, Tirupati.

Introduction

Diabetes Mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Type 2 diabetes mellitus (T2DM) accounts for 90% of all DM cases and is characterized by progressive insulin secretory defect and insulin resistance [1]. It is a growing public health burden across the world, particularly in developing countries. India is almost in the grip of the diabetes epidemic and warrants immediate corrective measures.

Magnesium (Mg) is the fourth most abundant cation in the human body and plays a key role in many fundamental biological processes, including energy metabolism and DNA synthesis [2]. It also plays an important role in the phosphorylation reactions of glucose and its metabolism. Magnesium deficiency has been implicated in insulin resistance, carbohydrate intolerance, dyslipidemia, and complications of diabetes [3]. Magnesium deficiency is associated with microvascular complications in diabetes. Less magnesium levels has been demonstrated in patients with diabetic retinopathy, with lower levels of magnesium predicting a greater risk for diabetic retinopathy [1]. Magnesium deficiency has also been associated with arrhythmogenesis, vasospasm, platelet activity, and hypertension. The reasons why magnesium deficiency occurs in diabetes may include increased urinary loss, lower dietary intake and impaired absorption of magnesium compared to healthy individuals. Magnesium is also involved in insulin secretion, binding, and activity. A cellular deficiency of magnesium can alter the membrane-bound sodium-potassium-adenosine triphosphate which maintains the gradient of sodium and potassium and also in glucose transport [4].

AIM :

To study the relationship between vascular complications of type 2 diabetes mellitus with serum magnesium levels

Study design: A hospital-based prospective study.

Study subjects: 101 patients with type 2 diabetes mellitus fulfilling the inclusion criteria are included in the study.

Study settings: Patients admitted into Medical wards, Sri Venkateswara Ramnarain Ruia Government General Hospital, Tirupati.

Study period: One year from the date of Ethical Committee approval from 13-02-2020 to 12-

02-2021

Sample size: 101

Study methods: After completion of the selection of patients, written consent is taken from the patients or their attenders, a detailed history is taken, and a physical examination isdone. Subjects are investigated with routine blood tests like CBC, blood urea, serum creatinine, serum electrolytes, total protein, serum albumin, and serum magnesium levels. After the selection of patients, about 3 ml of blood sample is collected in a non- heparinized serum bottle and sent for serum magnesium levels measured by spectrophotometry.

Patients are also subjected to other investigations like ECG, Peripheral arterial Doppler, Carotid Doppler, ultrasound abdomen, 24-hour urinary protein estimation, and fundus examination.

Statistical analysis: The descriptive statistical analysis was performed to report the demographic variables. The data are reported as mean and standard deviation, as well as in percentage of the total population. One way Analysis of Variance (ANOVA) is performed to analyze the association between the variables. The significance is kept at 95%, and a p-value less than 0.05 shows statistical significance. Post-hoc analysis is used to identify the significance level between the groups in a one-way ANOVA analysis. Independent t-test analysis is performed to analyze the difference between the population having the problem under concern and those who do not. The data collected are analyzed using IBM SPSS statistics version 20.0 (IBM Corp. Released 2011.IBM SPSS Version 20.0. Armonk, NY).

Inclusion Criteria

1) Patients with type 2 diabetes mellitus

2) Patients who are willing to give informed written consent for this study

Exclusion Criteria

1) Patients with chronic renal failure of other cause

2) Acute myocardial infarction in the past 6 months

3) Malabsorption or chronic diarrhea

Results :

Results and Analysis

101 patients of Type 2 Diabetes Mellitus who are fulfilling the inclusion and exclusion criteria are studied according to prestructured proforma. Results are analyzed and discussed below.

1) Age distribution : The age group recruited in the present study is between 32 years to 80 years**.** In the present study, the majority of the patients are between 51 - 60 years of age (33.66%) followed by the age group of 41-50 years (25.74%).17.82% are in the age between 61-70 yrs and 11.88% are between 31-40 years. Only 10.89% of the study population belong to the age group above 70 years. The mean age of the study population is 55.77 +/- 11.624 years.

Table 1: Age distribution of the subjects

S.No	Age(years)	No of patients	Percentage (%)
1	**<30 yrs.**	0	0%
2	**31- 40 yrs.**	12	11.88%
3	**41- 50 yrs.**	26	25.74%
4	**51-60 yrs.**	34	33.66%
5	**61-70 yrs**	18	17.82%
6	**>70 yrs**	11	10.89%
7	**TOTAL**	101	100%

2). Gender Distribution

In the present study, the Male to Female ratio is 1.29:1 Out of the total subjects,56.43% are males and 43.56% are females.

Table 2: Gender Distribution of the subjects

S.No	Gender	No of patients (%)
1	**Male**	57 (56.43%)
2	**Female**	44 (43.56%)
3	**Total**	101(100%)

3. Duration of Diabetes Mellitus:

The majority of the patients are having the duration of diabetes for 1 to 5 years(41.58%) followed by 6 to 10 years(25.74%). Patients with more than 10 years of diabetes mellitus are 18.81% and 12.87% patients are having a duration of less than 1 year.

Table 3: Distribution of Duration of Diabetes mellitus

S. No.	Duration	No. of patients (%)
1	**<1 yr.**	14 (12.87%)
2	**1-5 yr.**	42 (41.58%)
3	**6-10 yr.**	26 (25.74%)
4	**>10 yr.**	19 (18.81%)

4). Serum Magnesium Levels in Study Subjects:

52.47% of study subjects are having normal magnesium levels (1.8-2.5 mg/dl). 24.75% have hypermagnesemia(>2.5 mg/dl) and 22.77% have hypomagnesemia (<1.8 mg/dl).The mean serum magnesium level in the study subjects is 2.205 mg/dl. The lowest level is0.93 mg/dl and the highest level is 4.19 mg/dl.

Table 4: Distribution of serum magnesium in study subjects

S. No	Serum Magnesium (mg/dl)	No. of patients	Percentage (%)
1	**<1.8**	23	22.77%
2	**1.8-2.5**	53	52.47%
3	**>2.5**	25	24.75%

5). SERUM MAGNESIUM LEVELS WITH GLYCEMIC CONTROL.

82.18% (n=83)of the study population has uncontrolled Diabetes and 17.8%(n=18) has controlled Diabetes.Out of 83 uncontrolled Diabetic patients, 32.53% have low Magnesium levels, 44.58% have normal Magnesium levels and 22.89% have high Magnesium levels.

In 18 controlled Diabetic patients,only 6 patients have high Magnesium levels.The remaining 12 patients have normal Magnesium levels and none of the patients have low Magnesium levels. Mean serum magnesium level in controlled Diabetes is higher(2.463 mg/dl) when compared to uncontrolled Diabetes(2.149 mg/dl).

Table 5: Serum Magnesium levels with glycemic control

S.No	Serum (mg/dl)	Controlled (FBS<126 AND PPBS<200)	Uncontrolled (FBS> 126 OR PPBS> 200)
1	**<1.8**	0	27
2	**1.8-2.5**	12	37
3	**>2.5**	6	19
4	**Total**	18(17.8%)	83(82.18%)

6). Serum Magnesium Levels with Duration of Diabetes Mellitus

Normal mean serum magnesium levels(2.04 mg/dl) are observed in patients with less than one-year duration of illness.Mean magnesium level is 2.289 mg/dl in patients with duration 1-5 yrs, 2.25 mg/dl in duration 6-10 years, and 2.07 mg/dl in duration more than 10 years. There is a gradual decline of mean serum magnesium levels as the duration of diabetes progresses for more than 1 year.

Table 6: Serum magnesium levels with the duration of diabetes mellitus

S. No	Duration of diabetes	Magnesium Level		
		Low	Normal	High
1	**<1 yr.**	6 (5.94%)	6 (5.94%)	2 (1.98%)
2	**1-5 yr.**	7 (6.93%)	25 (24.75%)	10 (9.90%)
3	**6-10 yr.**	7 (6.93%)	11 (10.89%)	8 (7.92%)
4	**>10 yr.**	7 (6.93%)	7(6.93%)	5 (4.95%)

Discussion

101 patients of Type 2 Diabetes Mellitus who are fulfilling the inclusion and exclusion criteria are studied according to pre-structured proforma. Results are analyzed and discussed below.

1) Age Distribution:

In the present study, the age group of subjects is in the range of 32-80 years. The maximum

number of patients are present is 51-60 years of age. The mean age in the present study is 55.77+/- 11.62 years. The mean age in the present study correlates with the studies done by Arpaci D et al [3], Sarah S Premraj et al [4],Misra et al[5] where the mean age was 55.6+/- 10.4, 56.92+/- 11.14, 54.04 +/- 12.12, 54.36+/- 11.25 and 57.32+/- 12.77 years respectively.

In another study by Y Zhang et al [6] the mean age was a little higher (60.54 +/- 0.36).The mean age was lower in the study of Yossef et al [7] (48.7+/- 6.25) as a large number of younger patients were enrolled in their study.

2. Gender Distribution:

In the present study, males constitute 56.44% of the study population, and 43.56% are females. The male to female ratio is 1.29:1. Arpaci et al [3] observed more or less equal distribution of both sexes in their studies with slight male preponderance, whereas a study by Shrabani Mohanty et al [9] had males twice more than females. In studies by Kumar et al[47] and Sarah S Premraj et al [4], there was more female preponderance with a lower male to female ratio.

Serum Magnesium Levels in Patients with Nephropathy

In the present study, 24-hour urine protein is used as indicator of diabetic nephropathy and it is observed that there is a significant correlation ($p<0.05$) between the serum magnesium levels and albuminuria. It is seen that patients with nephropathy have lower serum magnesium levels than those without nephropathy. The result is consistent with the studies of Arpaci et al [3]. Similarly, Sarah S Premraj et al [4] used UPCR in their study and found a significant correlation.

Serum Magnesium Levels in Patients with Diabetic Retinopathy

There is a progressive decrease in mean serum magnesium levels in those without retinopathy, NPDR, and PDR having 2.49, 2.08, and 1.73 mg/dl respectively. It is identified that a statistically significant difference is present ($p<0.05$) in the serum magnesium levels with retinopathy. There is a significant decrease in serum magnesium values in those with diabetic retinopathy compared to those without retinopathy. But there is no statistically significant difference in the serum magnesium values between NPDR and PDR. The results are consistent with other studies by Sarah S Premraj et al [4].

Summary

101 patients who fulfill the inclusion and exclusion criteria are included in the study, and results are statistically analyzed and discussed.

- The majority of patients are in the age group of 51-60 years of age. The mean age in the present study is 55.77 years.
- Male:Female ratio is almost equal (1.29:1) with a slight increase in the number of male subjects.
- Nephropathy is found to be the major complication in this population, followed by retinopathy and ischemic heart disease.
- The majority of the patients have diabetes duration of 1 to 5 years. Patients with long-duration diabetes of more than 10 years are only 18% in the present study.
- The majority of patients have normal Magnesium levels (52.47%). Hypomagnesemia is present in 22.77% of patients and hypermagnesemia in 24.75%.
- Magnesium is lower in uncontrolled diabetes compared to controlled diabetes and is statistically significant.
- There is no statistical significance between magnesium levels and the duration of diabetes in the present study.
- Lower magnesium levels are found in patients with complications like Diabetic Nephropathy, Diabetic Retinopathy, and Diabetic Neuropathy which are statistically significant.
- There is no significant difference between magnesium levels and ischemic heart disease even though lower magnesium levels are present in IHD patients.
- Significant relation is found between magnesium levels and macrovascular complications of diabetes like peripheral arterial disease and cerebrovascular disease.

Limitations of the study:

1. Small sample size.
2. Other comorbidities like hypertension, dyslipidemia are not considered.

Conclusion

Lower magnesium levels are associated with both macrovascular and microvascular complications of diabetes mellitus. Magnesium supplementation may be considered in diabetic patients irrespective of the duration of disease to prevent complications.

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