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Comparative Study of Serum Magnesium Levels in Diabetic Patients with And Without Microvascular Complications In A Tertiary Care Centre

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ABSTRACT

Background: It has been shown in several research that type 2 diabetes mellitus (DM) and its consequences with hypomagnesemia are related. Given that retinopathy, neuropathy, and nephropathy have been linked to hypomagnesemia in recent studies, it is advisable to routinely evaluate magnesium in this patient group and treat hypomagnesemia whenever possible. To compare type 2 diabetics' blood magnesium levels with microvascular problems was the goal of this study.

Methods: This research is a cross-sectional analytical study. About 114 diabetic patients from outpatient clinics, wards and intensive care unit were recruited from Department of General Medicine, Sri Balaji Medical College and Hospital, Crumpet, Chennai. The study population are further divided into two groups. Fifty-seven people with diabetes with microvascular complications (group I) have diabetes with no microvascular complications (group II). Clinical and physical examinations were done on all patients.

Results: Most diabetic patients (37%) aged 51 to 60 years, 54% male and 46% female. Approximately 26% of recruited patients had diabetes < 5 years, 44% were on insulin treatments, and 56% were oral hypoglycaemic agents. 57 diabetic people that have microvascular issues. Magnesium levels in the blood are noticeably greater in diabetics with microvascular difficulties than in those without issues. Between these two groups, no notable biochemical differences were discovered. Diabetic neuropathy is more likely to occur in patients who have had diabetes for a longer length of time.

Conclusions: We conclude that level of serum magnesium levels was found to be abnormally low with increasing diabetes duration along with microvascular complications. Type 2 diabetes patients who had hypomagnesemia were more likely to have long-term and microvascular problems.

Keywords: *Serum magnesium, Type 2 diabetes, Microvascular complications, HbA1c, Diabetes duration, Neuropathy*

INTRODUCTION

Most of the minerals and vitamins are found to regulate enzyme reactions involved in different metabolism. Magnesium (Mg) is the fourth important cofactor involved in various metabolism.[1] Both extracellularly and intracellularly, Mg deficiency is likely linked with diabetes complications. According to epidemiological studies, people with type 2 diabetes, particularly those with poor glycemic control, are at expanded chance of developing hypomagnesemia.[2] Blood Mg concentrations were shown to be lower in diabetes individuals contrasted with non-diabetic patients in a cross-sectional examination. Impedance of glucose homeostasis and insulin responsiveness, as well as the onset and progression of diabetes-related complications such as ischemic heart disease, atherosclerosis, elevated cholesterol and triglyceride levels, hypertension, diabetic retinopathy, neuropathy and nephropathy, have been linked. For magnesium deficiency in patients with type 2 diabetes, one more solid and autonomous indicator of type 2 diabetes is low blood magnesium levels.[3,4] Type 2 diabetics are at higher gamble for both prompt and long-term consequences that might ultimately prove fatal. Retinopathy, neuropathy, and nephropathy are the most common microvascular problems, whereas cardiovascular disease and strokes are the most common macrovascular issues.[5] Many research has shown a relationship between hypomagnesemia and the onset of diabetes-related microvascular problems in Caucasian diabetics.[6,7]

Researchers have shown that diabetes mellitus (DM) and its complications are more likely correlated with hypomagnesemia. Low retinal magnesium levels are associated with an increased incidence of diabetic retinopathy.[8] Hypomagnesemia may increase the incidence of diabetic foot ulcers because of its association with polyneuropathy, platelet dysfunction, and diabetic foot ulcers. Compared to individuals without the illness, those with diabetic foot ulcers had a greater frequency of hypomagnesemia. [9] In diabetic nephropathy, the serum is ionised, and Mg levels were significantly lower in the microalbuminuria. This implies that people with diabetes with low blood Mg levels have a far more rapid decline in renal function.[10] In light of this, the current study analyses magnesium levels in the blood of diabetic individuals with and without microvascular problems.

MATERIALS AND METHODS

This quantitative CT research was conducted between March 2021 and September 2022 at the Department of General Medicine, Sri Balaji Medical College and Hospital, Crumpet, Chennai. One hundred fourteen diabetic patients from OPD, Wards and ICU were recruited for this study. The study population are further divided into two groups. Fifty-seven diabetic subjects had microvascular complications (group one) and 57 diabetic subjects without microvascular inconveniences (group two).

Inclusion criteria

Patients over the age of 30 who met the World Health Organization's criteria for type 2 diabetes mellitus were included, as were those with and without microvascular problems as determined by tests for diabetic nephropathy, diabetic retinopathy, and diabetic neuropathy.

Exclusion criteria

Patients less than 30 years and also have CAD or peripheral arterial disease are excluded.

The Institutional Review Board gave their written permission. We have the medical department's and the associated department's written okay for this. All cases with a checked determination of type 2 DM were incorporated after informed verbal agreement was obtained from the patients.

Clinical and physical examinations were performed on participants, and their medical histories were recorded. Diabetic nephropathy is diagnosed based on the measurement of urinary albumin excretion levels. Normoalbuminuria (<30mg/24hr), Microalbuminuria (30–299 mg/24h), Clinical (overt) albuminuria (≥300 mg/24h). Diabetic retinopathy is diagnosed based on tests like visual acuity test and ophthalmoscopy-slit lamp/indirect ophthalmoscopy/handheld ophthalmoscopy. Diabetic neuropathy is diagnosed based on a clinical examination of a sensory system, cranial nerve examination. Each subject's fasting plasma and serum samples were collected, Medisys Labonacheck did HbA1C estimation, and serum

magnesium was measured by Calmagite endpoint.

Statistical analysis

All of the obtained data was imported into Excel and analysed using SPSS 24. The chi-square test and the t-test were used to identify relationships and associations between categorical variables.

RESULTS

The majority of diabetic patients (37%) age were gone from 51 to 60 years (mean ± SD, 56.67 ± 12.97 years) and there were 54% male and 46% female. Approximately 26% of recruited patients had diabetes < 5 years, 44% were on insulin treatments, and 56% were oral hypoglycaemic agents. About 74.5% of diabetic patients were obese, with a mean BMI of 25.37. There were 57 diabetic patients diagnosed with microvascular problems; 28 had diabetic nephropathy, 22 had diabetic retinopathy, and 7 had diabetic neuropathy (Table 1).

TABLE 1: Distribution of baseline parameters

Variable		**Frequency (n=114)**	**Percentage**
Gender	Male	62	54
	Female	52	46
Age (Years)	≤40	12	10.5
	41-50	30	26.3
	51-60	42	36.8
	>60	30	26.4
Duration of DM(Years)	≤5	30	26
	≥5	74	74
Treatment	Insulin	50	44
	OHA	64	56
BMI	<18.5	2	1.75
	18.5-22.99	2	1.75
	23.0-24.99	25	22
	≥25.0	85	74.5
Microvascular complications (n=57)	Diabetic Retinopathy	22	38.6
	Diabetic Nephropathy	28	49.1
	Diabetic Neuropathy	7	12.3

These two groups have no significant differences in HbA1C, fasting blood sugar, or postprandial sugar levels (Table 2).

TABLE 2: Baseline characteristics of diabetic patients with and without microvascular complications

Variables	**Microvascular complications**		**No Microvascular complications**		**P value**
	Mean	**SD**	**Mean**	**SD**	
Age	59.66	10.23	53.66	13.55	0.42
HbA1C	9.86	2.39	9.47	2.46	0.43
FBS	201.13	62.6	188.85	60.08	0.32
PPBS	256.68	104.69	273.8	150.49	0.53

Diabetic patients with the microvascular complication group have a mean level of 1.21 ± 0.26, and those without microvascular complications showed a mean level of 1.89 ± 0.32, which is statistically significant (p=0.01) (Table 3).

TABLE 3: Level of serum magnesium in Diabetics patients with and without microvascular complication

Complications	Magnesium		P value
	Mean	SD	
Microvascular complications	1.21	0.26	0.01
No Microvascular complications	1.89	0.32	

Magnesium level in MV complications

Diabetic retinopathy patients had magnesium levels of 1.16 ± 0.28 mg/dL, diabetic nephropathy had 1.02 ± 0.22 mg/dL, and diabetic neuropathy had 1.14 ± 0.26 mg/dL. Microvascular problems in diabetes were associated with considerably reduced magnesium levels. This finding provides direct evidence for a statistically significant correlation ($p<0.05$) between microvascular problems and serum magnesium.

Duration of DM in MV complications

Diabetic retinopathy patients had 7.8 ± 1.2 years, diabetic nephropathy had 9.4 ± 2.2 years, and diabetic neuropathy was 10.2 ± 1.8 years. Diabetic neuropathy is more prevalent in those who have had the disease for a longer period of time.

TABLE 4: Comparative changes between DM patients with and without microvascular complications.

	Magnesium level in MV complications	Duration of DM in MV complications
Diabetic retinopathy	1.16 ± 0.28	7.8 ± 1.2
Diabetic nephropathy	1.02 ± 0.22	9.4 ± 2.2
Diabetic neuropathy	1.14 ± 0.26	10.2 ± 1.8

All values are communicated as Mean ± SD. P values demonstrate huge contrasts. n= number of patients; MV denotes Microvascular; DM denotes Diabetes Mellitus; FBS denotes Fasting blood sugar; PPBS denotes Postprandial Blood sugar

DISCUSSION

Hypomagnesemia is a clinical condition where blood magnesium levels are less than 1.6 mg/dl. The microvascular disease was found to be linked to magnesium deficiency and also with type 2 diabetic patients. Patients with diabetes mellitus endure microvascular entanglements leading to retinopathy, nephropathy and neuropathy. Patients with diabetic retinopathy have been demonstrated to have hypomagnesemia, with lower magnesium levels being connected to a higher gamble of diabetic retinopathy severity in scientific studies.[11-14] Meanwhile, impaired insulin synthesis, insulin resistance, and increased vascular issues are related to magnesium deficiency and diabetes. A multidisciplinary approach is a need to treat diabetic patients with microvascular complications.

Diabetes patients with low magnesium levels are not always due to a lack of magnesium in their diet. A three-month course of oral Magnesium supplementation substantially increased plasma magnesium concentration and urine magnesium excretion 6-8h in insulin-dependent individuals with type 2 DM, as documented in a paper by De Valk et al. However, it did not affect either glycemic management or lipid levels in the blood plasma.[15] A study reported that type 2 diabetes with low blood magnesium levels (serum magnesium levels mmol/l) were randomized, twofold visually impaired, fake treatment controlled clinical preliminaries and received 50 ml of MgCl2 solution. Researchers observed that giving patients with type 2 diabetes low serum magnesium levels an oral supplement of MgCl2 solution resulted in substantial increases in blood

magnesium levels, as well as enhancements in insulin awareness and metabolic control.[16]

In this study, the diabetic patient's age ranged from 35 to 85. In this analysis, the median age was 56.67. We also found that men were more likely to be diagnosed with Type 2 Diabetes Mellitus than females (54% vs. 46%). According to one of the independent research, the heterogeneity of the chose patient populace probably adds to the significant contrast in the revealed frequency of hypomagnesemia. Notably, there is a 2:1 ratio between the occurrence of hypomagnesemia in women and males. Studies have shown that men with diabetes may also have greater Mg ionised levels.[17]

We found that people with diabetes with microvascular complications had lower serum magnesium levels than those without. Indeed, our findings mirror those of several other research which also found low blood magnesium levels in type 2 diabetics.[1,18] Because magnesium aids glucose transit and metabolises carbohydrates, it is an essential mineral. There is a firm link between hypomagnesemia and hyperglycemia. Two different studies by Alzaid et al. and White JR showed that type 2 DM patients' insulin resistance affected their ability for insulin to promote both glucose and magnesium absorption and whether this impairment was exacerbated by acute hyperglycemia, which indicates the association of hypomagnesemia to the type 2 diabetes. [19,20] Apart from microvascular, we execute that there may be a connection between hypomagnesaemia and the macrovascular problems of diabetes, and this might be our future research.

CONCLUSIONS

As the duration of diabetes and the resulting microvascular problems increased, so did the unusually low levels of magnesium in the blood. More patients from a wider range of socioeconomic backgrounds are needed to confirm these findings over a longer time period. In futuristic, we can conduct a trial of magnesium supplementation to evaluate whether fasting blood sugar, HbA1c levels and microvascular complications are improving after taking a supplement.

Limitations

This study's drawbacks include its cross-sectional and observational design and its very small sample size.

CONFLICT OF INTEREST

No conflicts of interest

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