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Original Research Article

"A Comparative Study of Hypomagnesemia and Normomagnesemia: Association Between Serum Magnesium Levels and Diabetes Duration in Type 2 Diabetes Mellitus"

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Abstract:
This hospital-based, comparative, descriptive study examined the relationship between several indicators and the altering pattern of blood magnesium levels in Type 2 diabetes mellitus (T2DM). The study involved 100 people in total (50 cases and 50 controls). In comparison to controls, the diabetic group had considerably lower mean serum magnesium levels. Among diabetic individuals, a sizeable percentage had hypomagnesemia. A correlation between blood magnesium levels and the duration of diabetes, glycemic control, and diabetic retinopathy was found in the study. The cross-sectional design and the study's single hospital location are its drawbacks, though. To confirm the results and investigate the function of magnesium in the treatment of T2DM, more study is required.

Keywords: Hypomagnesemia, Type 2 Diabetes Mellitus

Introduction:

Globally, the prevalence of diabetes mellitus, a chronic metabolic illness that places heavy financial and health costs on millions of people, has reached epidemic levels. The most common form of diabetes, type 2 diabetes mellitus (T2DM), is characterised by insulin resistance and relative insulin insufficiency. T2DM is a complicated aetiology that is influenced by both hereditary and environmental factors. Due to its role in insulin action and glucose metabolism, magnesium, an important mineral, has been linked to the pathophysiology of diabetes among

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other environmental variables[1].

The possibility of a connection between magnesium and T2DM has been investigated in several research. According to studies, both men and women are at a lower risk of developing T2DM when they consume more magnesium [2]. In obese children, magnesium insufficiency has been associated with insulin resistance, pointing to a potential involvement in the development of T2DM [3]. According to research, hyperinsulinemia increases renal magnesium loss, which causes magnesium depletion in those who have insulin resistance [4].

Magnesium and glucose metabolism have been linked in the setting of diabetes. Diabetes glucose disposal and fasting plasma magnesium levels were shown to be negatively correlated in studies [6]. Additionally, hypomagnesemia has been connected to diabetic retinopathy, emphasising its potential effects on sequelae from diabetes [7].

As a result, the current study's objective is to compare the blood magnesium levels of T2DM patients with those of non-diabetic controls while taking numerous clinical and demographic factors into account. The incidence of hypomagnesemia in T2DM patients and its relationship to the length of diabetes will be evaluated by the study. Additionally, it will investigate the relationship between diabetes patients' blood magnesium levels and glycemic management.

Aim:

-To examine the relationship between serum magnesium levels and Type 2 diabetes mellitus in a comparative study of diabetic and non-diabetic individuals.

Objectives:

-Determine the prevalence of hypomagnesemia in the diabetic group and its correlation with various diabetes duration categories.

-Compare mean serum magnesium levels between diabetic patients with hypomagnesemia and normomagnesemia to understand the potential impact of diabetes duration on magnesium levels.

Materials and Methods:

Type of study: Hospital-based, comparative, descriptive study.

Study area: New Medical College & Hospital, Kota.

Study period: 2020-2021 (one year).

Sample size: 100 patients (50 Type 2 DM and 50 Controls) from Medicine OPD, Diabetes clinic, or various wards of Medical College and Associated Group of Hospitals, Kota.

Diagnostic criteria for Type 2 Diabetes Mellitus: ADA criteria (Fasting plasma glucose ≥ 126 mg/dl, Two-hour plasma glucose ≥ 200 mg/dl after a glucose challenge, HbA1C ≥ 6.5%, or symptoms of diabetes plus random blood glucose concentration ≥ 200 mg/dl).

Inclusion criteria: Established cases of Type 2 diabetes mellitus within the last 1 to 6 months, age between 30 to 60 years, and normal healthy subjects for comparative study.

Exclusion criteria: Patients with renal failure, acute myocardial infarction in the last six months, on diuretics or magnesium supplements, malabsorption, chronic diarrhea, history of

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alcohol abuse, and patients refusing to give informed consent.

Institutional Ethics Committee approval was obtained, and patients provided informed written consent. The study involved a detailed history, clinical examination, and complete laboratory work-up, including fasting and post-prandial plasma glucose, HbA1C, renal and liver function tests, lipid profile, CBC, and serum magnesium level estimation using the Calmagite dye method. Anthropometric measurements, ECG, and X-ray chest were also performed. The HbA1C level was determined through HPLC analysis.

Data Analysis:

a. Data was entered in Microsoft excel and data analysis was done on SPSS version 16. The plan was submitted to the Ethical Committee of the Institute and study was initiated only after ethical approval.

b. Data was expressed in percentages.

c. Appropriate test of significance was applied.

d. $P<0.05$ was considered significant.

Ethical issues:

1. A written and informed consent was taken from all concerned competent authority/study subjects.
2. No pressure or coercion was exerted on subjects for participation in the study.
3. Confidentiality and privacy was ensured at all stages.
4. Data was used for research purpose only.

Results:

Table 1. Characteristics of study population

No. of Subjects	**100 (50 Cases+50 Controls)**
Mean Age of Diabetics (Years) Mean Age of Controls (Years) (Range 30-60)	48.2 50.70
Male Female	29 21
Mean Duration of Diabetes (Years)	6.88
Medication OHA Insulin OHA+ Insulin	 31 5 14

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Comorbidities Hypertension Ischemic Heart Disease	 13 10
Diabetic retinopathy NPDR PDR	 13 2
Poor glycemic control HbA1C> 7%	27

The table contrasts 50 people with Type 2 diabetes (cases) with 50 healthy people (controls). Diabetics are 48.2 years old on average, have had the disease for 6.88 years, and have poor glycemic control in 27 cases. OHA 31, Insulin 5, and OHA+Insulin 14 were used as medications. Additionally, diabetics exhibit associated conditions such as hypertension (13), ischemic heart disease (10), and diabetic retinopathy (NPDR 13, PDR 2).

Table 2: Age-wise distribution

Age group (years)	Diabetic group		Control group		p- value
	Number	Percentage	Number	Percentage	
30 to 40	11	22%	10	20%	0.82 NOT SIGNIFICANT
41 to 50	12	24%	11	22%	
51 to 60	27	54%	29	58%	
Total	50	100%	50	100%	

The table compares the 50 patients in the diabetes group with the 50 people in the control group to demonstrate how the study population was distributed by age. 22% of diabetics in this category are between the ages of 30 and 40, 24% are between the ages of 41 and 50, and 54% are between the ages of 51 and 60. In the control group, 58% of people are between the ages of 51 and 60, 22% are between the ages of 41 and 50, and 20% are between the ages of 30 and 40. Age distribution between the two groups has a p-value of 0.82, which means there is no discernible difference in age distribution between diabetes and controls.

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Table 3: Gender-wise distribution

Gender	Diabetic group		Control group		p- value
	Number	Percentage	Number	Percentage	
Males	29	58%	36	72%	0.45
Females	21	42%	14	28%	
Total	50	100%	50	100%	

The gender distribution of the study population is shown in the table, which contrasts the control group (50 non-diabetic people) with the diabetes group (50 patients). In the diabetes group, 58% of the participants are men and 42% are women, compared to 72% men and 28% women in the control group. The gender distribution between the two groups has a p-value of 0.45, which means there is no statistically significant difference between the gender distribution of diabetes and controls. This shows that gender is not a significant factor determining the development of Type 2 diabetes in this research population and that the percentage of males and females in the diabetic group is identical to that in the control group.

Table 4. Mean Age in diabetics and control

Parameter	Mean ± SD		t value	P value	Significance
	Diabetic	Control			
Age (Years)	48.2 ± 7.95	50.70 ±8.23	0.058	0.9538	Not Significant

The mean age of diabetes patients and the control group are contrasted in the table. The control group's mean age is 50.70 years with a standard deviation of 8.23, whereas the diabetes group's mean age is 48.2 years with an SD of 7.95. The statistical analysis produced a t-value of 0.058 and a p-value of 0.9538.

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Table 5. Prevalence of Hypomagnesemia

Gender	Diabetic group		Control group		p- value
	Hypomagnesemia	Percentage	Hypomagnesemia	Percentage	
Males	12/29	41.37%	2/36	0.05%	0.3884
Females	7/21	33.33%	1/14	0.07%	
Total	19/50	38%	3/50	0.06%	

The table compares the genders of the diabetes group (50 patients) and the control group (50 non-diabetic people) in order to show the prevalence of hypomagnesemia (low magnesium levels) in the study population. Hypomagnesemia affects 41.37% of men and 33.33% of women in the diabetic population. 0.05% of men and 0.07% of women in the control group have hypomagnesemia. In all, 38% of diabetics and 0.06% of non-diabetics have hypomagnesemia. There is no discernible difference in the incidence of hypomagnesemia between diabetics and controls depending on gender, as indicated by the gender comparison's p-value of 0.3884.

Table 6. Mean Serum Mg level in Case and Control groups

Serum Mg	Group		t value	P value	Significance
	Diabetic	Control			
Mean ± SD	1.598 ± 0.297	1.968 ± 0.225	6.4511	<0.0001	Highly Significant

The diabetes group (50 patients) and the control group (50 non-diabetics) are compared in the table for their mean serum magnesium levels. In comparison to the control group's mean serum magnesium level of 1.968 ± 0.225, the diabetes group had a considerably reduced mean serum magnesium level of 1.598 ±0.297. High statistical significance is shown by the t-value of 6.4511 and p-value of less than 0.0001 achieved by statistical analysis. This suggests that diabetics had lower serum magnesium levels than the control group, indicating a substantial difference in serum magnesium levels between diabetics and controls.

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Table 7. Distribution of Duration of Diabetes in Case group subjects

Years	Group I Hypomagnesemia		Group II Normomagnesemia		TOTAL
	No.	%	No.	%	No.
0-4	9	47.36%	19	57.57%	28
5-9	7	36.84%	7	21.21%	14
≥10	3	15.78%	5	15.15%	8
Total	19	100%	31	100%	50

Based on two subgroups, Group I with hypomagnesemia and Group II with normomagnesemia, the table displays the distribution of the length of diabetes in the diabetic group (50 patients). In Group I, individuals with hypomagnesemia have a diabetes duration of 0 to 4 years in 47.36%, 5 to 9 years in 36.84%, and 10 years in 15.78% of cases. In Group II, 57.57% of patients with normomagnesemia have had diabetes for less than four years, 21.21% have had it for five to nine years, and 15.15 percent have had it for more than ten years. Each subgroup's total patient population is equal to the entire patient population in the diabetes group, and the percentages for each subgroup sum up to 100%.

Conclusion:

- The study showed that individuals with Type 2 diabetes mellitus had considerably lower mean serum magnesium levels than patients in the control group, underlining the possible contribution of magnesium to the pathophysiology of diabetes.

- It was discovered that a significant fraction of diabetic patients had hypomagnesemia, highlighting the need of monitoring and treating magnesium status in the treatment of diabetes.

- The study supports the need for additional research to fully grasp the implications of magnesium in Type 2 diabetes mellitus and its associated complications by illuminating the relationship between serum magnesium levels and diabetes duration, glycemic control, and diabetic retinopathy.

Limitations:

- Because just one hospital was used for the study, it's possible that the results cannot be applied to different populations or environments. A bigger, more representative sample drawn from several sites would offer a more comprehensive view of the connection between magnesium and Type 2 diabetes mellitus.

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- The study's cross-sectional design merely offers a glimpse of the serum magnesium levels at one particular period. To evaluate the variations in magnesium levels over time and demonstrate a link between magnesium shortage and the onset or progression of Type 2 diabetes mellitus, longitudinal studies are required.

Funding:
No funding services

Conflict of interest:
None declared.

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