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Original Article

Frequency of Hypomagnesemia in Patients with Type 2 Diabetes Mellitus

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Abstract

Objective: To determine the frequency of hypomagnesemia in type 2 diabetes mellitus in tertiary care hospital.

Methods: This was a descriptive cross-sectional study conducted at National hospital and medical center Lahore, Pakistan from January 2022 to December 2022. In this study a total of three hundred and fifty admitted and OPD patients with type 2 DM for at least one year irrespective of gender and in the age range of 18 to 75 years were included. Their serum magnesium level was recorded. Hypomagnesemia was labeled< 1.8 mg/dL.

Results: In this study 350 cases of DM were selected. Out of these 181 (51.71%) were males and 169 (48.29%) were females. The mean age of the subjects was 56.25±10.73 years and mean duration of DM was 7.20±5.35 years. HTN was seen in 99 (28.29%) of cases. Mean serum magnesium level was 1.83±0.29 mg/dl. Hypomagnesemia was observed in 103 (29.43%) of cases. Hypomagnesemia was seen in 51 (28.17%) males as compared to 52 (30.76%) females with p value of 0.63. Hypomagnesemia was seen in 55 (30.55%) cases with duration of DM up to 5 years as compared to 48 (28.23%) cases with duration more than this with p value= 0.64. Hypomagnesemia was observed in 28 (30.43%) cases with good glycemic control and 75(29.06%) cases with poor control with p= 0.79.

Conclusion: Hypomagnesemia is not uncommon and is seen in almost one third of the cases with DM and it has no significant association with any of the confounding variables examined within this study.

Keywords: Type 2 DM, HTN, Hypomagnesemia

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Introduction

Diabetes has become increasingly prevalent as a widespread non-communicable disease worldwide. Its frequency has been increasing rapidly within nations with moderate and lower economic statuses.[1] Type 2 diabetes mellitus comprises a variety of malfunctions marked by high blood sugar levels, arising from the combination of insensitivity to insulin, insufficient insulin production, and excessive or inappropriate release of glucagon. Inadequately controlled type 2 diabetes leads to a range of complications involving small blood vessels, large blood vessels, and nerve-related complications.[2]

Diabetes stands as a significant cause of blindness, renal dysfunction, cerebro-vascular accidents, myocardial infarctions, and lower extremity amputations. In 2012, diabetes was directly responsible for an approximate 1.5 million fatalities. Nearly half of all deaths attributed to elevated blood sugar levels occur prior to reaching 70 years of age. The World Health Organization's projects indicate that diabetes may become the seventh principal cause of mortality by the year 2030.[3,4] The global population with diabetes has reached 537 million, with 73 million of them located in the Middle East and North Africa region. This number is expected to surge by 86% to 136 million by 2045. Pakistan had over 32 million cases of diabetes in the year 2021.[5]

The role of magnesium in the body is widespread. It is a co-factor for all enzymatic reactions that require ATP and in various reactions that require kinases. Notably, it plays an important role in the regulation of blood glucose, acting as an essential component for insulin secretion, binding to its receptors and activity.[6] Hypomagnesaemia has been documented to be frequently associated with diabetes mellitus with prevalence of 11-47.7%.[7] One of the several studies has shown that low plasma magnesium concentration may contribute

to insulin resistance.8Corsonello et al reported a significant negative association between magnesium and glycated hemoglobin (HbA1C) in type 2 diabetes mellitus patients.[9] It is also proposed to be an indicative marker for the presence of diabetic retinopathy, neuropathy, cardiovascular and peripheral vascular disease and increased mortality.[7,10]

As indicated by the studies, there is a wide variation of low magnesium levels in type 2 diabetics among different populations. Hence, the aim of this study was to investigate the frequency of hypomagnesemia in type 2 diabetes mellitus in Pakistani population. This study can help predict glycemic control, prevent or delay complications of diabetes and alleviating the economic strain on our population.

Methods

Our research was a descriptive cross-sectional study carried out at National hospital and medical center Lahore, Pakistan, from January 2022 to December 2022. The study cohort comprised 350 individuals, using the WHO sample size calculator. We selected participants via a Non-Probability sampling method. Prior to their inclusion, patients provided informed consent to take part in the study. The data collection process was undertaken by house officers and postgraduate trainees in the Department of Internal Medicine. The variables of our study included MR numbers, age, gender, duration of diabetes, duration of hypertension, anthropometric measurements including height, weight, and BMI, blood pressure readings, magnesium levels, and diabetic medical records.

Measurement of fasting blood glucose and serum magnesium concentrations was conducted. Patients selected for testing were requested to be seated in a chair, and they were prompted to roll up their sleeves beyond the elbow. Venous blood samples were gathered using full aseptic measures. For HBA1c estimation samples were collected in EDTA bottles. Serum magnesium level estimation was done by timed end point method using calmagite dye while DXC 600 automated analyzer was used for blood sugar estimation. Our study adopted specific criteria for excluding certain patients. Those with chronic liver disease, ischemic heart disease, end-stage renal disease (ESRD), pregnancy, and those undergoing magnesium supplementation or taking loop diuretics, as confirmed by medical records, were excluded from participation. Throughout the study, ethical considerations were maintained, including the exclusion of handicapped and disabled patients from the participant pool.

Statistical Analysis

Statistical analysis was done using statistical package SPSS version 22. Descriptive statistics were calculated for study variables. Mean and standard deviation were calculated for age, serum magnesium level, duration of diabetes, HbA1C level, height, weight and BMI. Frequency and percentages were calculated for gender, hypertension, diabetes mellitus with good and poor glycemic control and outcome variable was hypomagnesemia. Effect modifiers like age, gender, duration of diabetes, status of diabetes mellitus (good or poor glycemic control) was dealt through stratification. Post stratification chi-square test was applied keeping p-value less than or equal to 0.05 as significant.

Results

In this study 350 cases of DM were selected. Out of these 181 (51.71%) were males and 169 (48.29%) were females. The mean age of the subjects was 56.25±10.73 years. Mean duration of DM was 7.20±5.35 years. HTN was seen in 99 (28.29%) of cases. Out of 350, only 92 (26.29%) cases had good control of DM. Mean serum magnesium level was 1.83±0.29 mg/dl.

Table 1: *Baseline characteristics and parameter of study participants (n=350)*

Characteristics	Hypomagnesemia	
	Present	Absent
Gender		
Male	51 (28.17%)	130 (71.83%)
Female	52 (30.76%)	117 (69.24%)
Age group		
18-49	32 (29.62%)	76 (70.38%)
50-75	71 (29.33%)	171 (70.67%)
Duration of Diabetes up to 5 years	55 (30.55%)	125 (69.45%)
Duration of Diabetes >5 years	48 (28.23%)	122 (71.77%)
Good Diabetes control	28 (30.43%)	64 (69.57%)
Poor Diabetes control	75(29.06%)	183 (70.94%)
Parameters	**Mean ± SD**	
Age (years)	56.25±10.73	
Duration of Diabetes (years)	7.20 ± 5.35	
Height (cm)	162.52±9.98	
Weight (kg)	68.72±15.66	
BMI	2.47 ± 3.67	
HbA1c	8.11 ± 2.37	
Serum magnesium (mg/dL)	1.83 ± 0.29	

Hypomagnesemia was observed in 103(29.43%) of cases. Hypomagnesemia was seen in 51(28.17%) males as compared to 52 (30.76%) females with p value of 0.63.

There was no significant difference of this in terms of age with p = 1.0. Hypomagnesemia was seen in 55 (30.55%) cases with duration of DM up to 5 years as compared to 48 (28.23%) cases with duration more than this with p= 0.64. Hypomagnesemia was observed in 28 (30.43%) cases with good glycemic control and 75(29.06%) cases with poor control with p= 0.79. The data is shown in table 1 and figure 1.

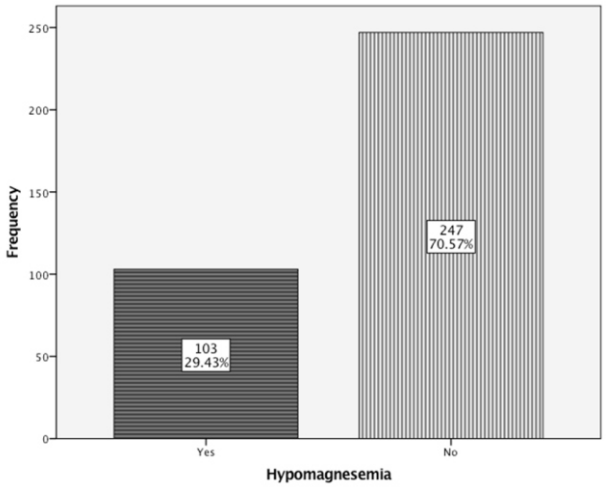

Figure 1: *Frequency of hypomagnesemia in study subjects*

Discussion

Type 2 diabetes mellitus (type 2 DM) represents a multifaceted metabolic disorder with complex interaction between genetic and environmental factors. It is characterized by abnormal glucose homeostasis due to insufficient insulin production or resistance resulting in long-term damage to several vital organs within the body. It is genetically diverse and comprises about 90% of cases worldwide. It has emerged as a prevailing global health challenge, with the World Health Organization (WHO) predicting an alarming increase to around 300 million cases by the year 2025.[11] The prevalence of magnesium deficiency in this condition ranges from 25% to 39%. Among the factors contributing to magnesium insufficiency, osmotic diuresis plays a notable role by contributing to the loss of magnesium within the body.[12]

Magnesium is the fourth most prevalent mineral in the human body and is one of the primary cations within our cells. It is involved in a multitude of processes, including carbohydrate oxidation, several enzymatic reactions, facilitation of glucose transport, promoting insulin secretion, and anchoring binding interactions.[13] A substantial portion of our body's magnesium, roughly 50%, is within our skeletal framework. The distribution of total body magnesium is predominantly concentrated in the bones, muscles, and non-muscular soft tissues, accounting for approximately 99% of its entirety. A significant portion, around 50-60%, is integrated as surface components of the hydroxyapatite mineral that constitutes bone.[14]

Maintaining magnesium equilibrium depends on several factors: dietary intake, the efficiency of absorption within the gastrointestinal tract, and the efficacy of excretion through the intestines and kidneys.[15]

In the present study, hypomagnesemia manifested in 103 cases accounting for 29.43% of the cases. These outcomes are comparable with the findings in previous research studies, revealing a spectrum of outcomes across different studies. As noted in a survey, the prevalence of hypomagnesemia displayed a range from 13.5% to 47.7%.[16] Another study revealed hypomagnesemia present in individuals with diabetes mellitus and a strong association was discovered between hypomagnesemia and insulin sensitivity as well.[17] These findings were further supported by nearly similar results in cases, where study was conducted among individuals with Type 2 DM. According to the studies conducted by Shaikh MK and Dasgupta et al, they concluded that type 2 Diabetes Mellitus is one of salient etiologies leading to magnesium deficiency; but this was only seen in cases with poor control of DM.[18,19]

This pattern was similarly observed in the current study where hypomagnesemia was observed in 28 (30.43%) cases with good glycemic control and 75(29.06%) cases with poor control with p= 0.79, which was higher in cases with poor control, though it was statistically insignificant. In the study by Masood et al, they found a near significance of hypomagnesemia in cases with DM.[20] It can be caused by multiple factors, the most important one being increased insulin resistance. Other influencing factors can be hyperosmolality, increased urinary output and urinary loss, reduced appetite and oral intake, malabsorption, and decreased reserves.[21] Intracellular shifts is another important factor to influence magnesium hemostasis.

There was no association of duration of DM and hypomagnesemia in the present study where Hypomagnesemia was seen in 55 (30.55%) cases with duration of DM up to 5 years as compared to 48 (28.23%) cases with duration more than this with p= 0.64. These numbers were almost equal to each other in both the groups. The data in the past has been variable with slight predominance in cases with longer duration of DM. There were no such cut off values of 5 years in previous studies, but few of them developed a linear correlation showing that higher the duration of DM the more likely it is for developing hypomagnesemia with a negative correlation; though there was no significant association seen.[22] According to a study done by Antin SS et al, they found hypomagnesemia in 35% of the cases which was closer to the present study. They also did not find any significant association of gender and various age groups.[23]

Moreover, it was seen that out of 350, only 92 (26.29%) cases had good control of DM and 73.71% of the cases had poor control. This was also seen by the study done by Pillay S et al where they found poor glycemic control in as high as 84.93% of the cases and hypomagnesemia was seen in 25% of the cases which was also closer to the data of our study. They further compared it with the controls and interesting results were seen that hypomagnesemia was seen in 85% of the cases with DM and only 15% of the general population with $p < 0.05.24$ Hypomagnesemia was seen in 51 (28.17%) males as compared to 52 (30.76%) females with p value of 0.63 with no significant association and was also observed in the results of previous studies. According to a study done by Pillay S et al and Seyoum et al and also by Schimatscheck et al, they also did not find any significant association of hypomagnesemia and gender ($p > 0.05$). However, a high degree of this prevalence was seen by the study of Seyoum et al as they observed hypomagnesemia in 65% of their gender-based cases.[24-26]

There were few limitations of this study, as this study did not look for other affecting electrolytes like potassium and also did not look for the type of treatment like oral hypoglycemic drugs or insulin therapy. However, there were many strengthening points as well as this study highlighted a very important concern which is almost always neglected and has a great impact due to its arrhythmogenic property.

Conclusion

Hypomagnesemia is not uncommon and is seen in almost one third of the cases with DM, particularly the individuals with poor glycemic control as evidenced by several studies. However, it has no significant association with any of the confounding variables examined within this study which were age, gender, duration of diabetes and status of glycemic control. Further interventional studies are required to understand the role of hypomagnesemia in DM among different nations as it may help in future prediction and prevention of DM related complications.

Conflict of Interest *None*

Funding Source *None*

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