e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(12); 985-989

Original Research Article

A Retrospective Study Determining Serum Magnesium Levels and its Correlation with Glycaemic Status in Type II Diabetics

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Received: 05-10-2023 / Revised: 22-11-2023 / Accepted: 25-12-2023
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Conflict of interest: Nil

Abstract

Aim: The aim pf the present study was to find the status of S. Mg in patients of type 2 diabetes mellitus (type 2 DM).

Material & Methods: This was a retrospective, carried out in ESICMCH, Bihta, Patna, Bihar, India from February 2022 to January 2023. All already diagnosed cases of type 2 diabetes mellitus (type 2 DM) and who were diagnosed at admission was enrolled. The study consisted of 50 consenting patients who came for routine blood investigations.

Results: 32 (64%) were in the age group of 41–60 years, 10 (20%) were in age group of 19–40 years, whereas 8 (16%) were between 61 and 80 years. There were 46% male and 54% females. 24 (48%) were diabetic since 11–20 years, 16 (32%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 2 (4%) were diabetic since >30 years. Laboratory reports revealed that there was significant difference in mean total leukocyte count, Serum glutamic pyruvic transaminase (SGPT), serum glutamic‐ oxaloacetic transaminase (SGOT), K+, Randon blood sugar (RBS), and HbA1c between hypomagnesemia patients compared to normomagnesemia patients ($P < 0.05$) There was no significant difference in other laboratory values between the two groups. The difference of S. Mg level in relation to HbA1c was statistically highly significant.

Conclusion: The present study concluded that hypomagnesemia has been linked to a lack of glycaemic regulation which can lead to diabetic complications. Early detection with oral magnesium supplementation as a therapeutic approach can avoid this; nonetheless, the prospective effect of magnesium therapy in avoiding the emergence of diabetes complications deserves further research.

Keywords: Complications, glycaemic control, serum magnesium, type 2 diabetes mellitus

Introduction

Type 2 diabetes makes 90% of diabetes cases. [1] Its worldwide prevalence may be 439 million by 2030. [2] According to the International Diabetes Federation and WHO, its prevalence is 10% [3] and over 19% of world's diabetics are Indians. [4] Being a major public health problem it is characterized by chronic hyperglycaemia which produces microvascular complications such as retinopathy, nephropathy, coronary artery disease , stroke etc. [5]

Magnesium is the second most abundant intracellular cation in the body. It plays a significant role in many metabolic pathways, especially in glucose metabolism, by acting as a cofactor for several enzymes. It plays a vital role in insulin secretion, insulin binding and homeostasis. [6] Low levels of magnesium have shown to damage tyrosine kinase activity and receptors involved in signaling. [7] Both intracellular and extracellular magnesium deficits are associated with type 2 diabetes mellitus. [8]

Hypomagnesemia has been reported in 25%–38% of type 2 diabetics [9] and to be associated with increased morbidity and mortality. [10,11] Hypomagnesemia has been implicated in carbohydrate intolerance, hyperglycaemia, insulin resistance, complications of diabetes and hyperlipidaemia. [12] Hypomagnesemia is common among diabetic patients which is frequently underdiagnosed. It is now established that diabetes can by itself induce hypomagnesemia and hypomagnesemia can in turn induce onset or worsen diabetes mellitus. [12]

Hypomagnesaemia alters the activity of Na+ K+ ATPase which is required for insulin dependent glucose transport, post-preceptorial insulin action and worsening of insulin resistance. Magnesium

deficiency may be due to increased urinary loss, less dietary intake or impaired absorption of magnesium Compared to Healthy Adults. [13] It was found that poor glycemic control, insulin resistance and low Mg level were strongly associated with increased the prevalence of microalbuminuria. [14]

Systemic inflammation and insulin resistance are the important reasons for the inverse relationship of magnesium intake and diabetes mellitus. Hence the aim was to find the status of S. Mg in patients of type 2 diabetes mellitus (type 2 DM).

Material & Methods

This was a retrospective study, carried out in ESICMCH, Bihta, Patna, Bihar, India from February 2022 to January 2023. All already diagnosed cases of type 2 diabetes mellitus (type 2 DM) and who were diagnosed at admission was enrolled. The study consisted of 50 consenting patients who came for routine blood investigations.

Inclusion Criteria

- Patients with type 2 DM of age 18 years and above, who gave written informed consent, were included in the study.

Exclusion Criteria

- Patients receiving diuretics, those with chronic diarrhoea, malabsorption syndrome, sepsis and those who were not willing to participate in the study were excluded.

Methods

Type 2 DM was diagnosed based on the diagnostic criteria given by the American Diabetes Association. [15] Diabetic retinopathy (DR) was diagnosed based on fundus Examination. [16] Diabetic nephropathy (DN) was diagnosed based on the presence of macroalbuminuria or microalbuminuria. Microalbuminuria was defined as an Albumin to creatinine ratio (ACR) between 30 and 300 mg/g. Macroalbuminuria was defined as an ACR >300 mg/g. [17] Diabetic neuropathy was diagnosed based on the presence of clinical features such as tingling and numbness. Xylidyl blue colorimetric method was used to estimate serum magnesium (S. Mg) level. [18] It was considered to be normal if in the range of 1.8–2.6 mg/dl. Less than 1.8 mg/dl was considered as hypomagnesemia.

Detailed history was taken from the subjects and examination was done to diagnose micro vascular complications of diabetes. Laboratory investigations were done to support the findings of examination. All patients were examined for complete blood count, urine routine and for microalbuminuria, fasting blood glucose, post prandial blood glucose, haemoglobin A1c (HbA1c), blood urea, serum creatinine, S. Mg, ultrasonography abdomen, and fundus examination. Other examinations such as electrocardiography, 2D echocardiography, serum sodium, and potassium were done as per the indication.

Statistical Analysis

Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 24.0, IBM. Pearson correlation coefficient was used to find correlation of S. Mg level with diabetic control. Odds ratio was calculated to find association of S. Mg level with DR and also to find association of S. Mg level with diabetic nephropathy.

Results

Table 1: Demographic characteristics of the study participants

Variables	Sub-groups	n	%
Gender	Male	23	46
	Female	27	54
Age groups	19-40 years	10	20
	41-60 years	32	64
	61-80 years	8	16
Duration of diabetes	0-10 years	16	32
	11-20 years	24	48
	21-30 years	8	16
	>30 years	2	4
Age (Mean ± SD)		53.27 ± 12.118	

32 (64%) were in the age group of 41–60 years, 10 (20%) were in age group of 19–40 years, whereas 8 (16%) were between 61 and 80 years. There were 46% male and 54% females. 24 (48%) were diabetic since 11–20 years, 16 (32%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 2 (4%) were diabetic since >30 years.

Table 2: Laboratory reports of the study population

Laboratoryreport	Mean±SD		*P*
	Normo-magnesemia	Hypo-magnesemia	
Hemoglobin	10.34±2.38	10.28±1.96	0.935
Total count	7542.78±2380.12	8426.14±2574.96	0.048
Platelets	2.04±0.86	2.12±0.84	0.512
Urea	36.82±16.54	43.08±25.75	0.64
Creatinine	1.26±0.94	1.56±1.34	0.150
SGPT	34.46±27.93	44.07±33.67	0.036
SGOT	32.28±21.43	45.43±28.63	0.001
Total bilirubin	1.12±0.83	1.23±0.68	0.412
Na+	135.32±3.77	135.74±2.86	0.432
K+	3.97±0.53	4.16±0.32	0.007
Cl-	98.22±3.06	98.42±1.68	0.090
RBG	232.88±62.06	258.82±71.69	0.007
HemoglobinA1C	7.32±1.22	8.72±1.58	<0.001

Laboratory reports revealed that there was significant difference in mean total leukocyte count, Serum glutamic pyruvic transaminase (SGPT), serum glutamic- oxaloacetic transaminase (SGOT), K+, Randon blood sugar (RBS), and HbA1c between hypomagnesemia patients compared to normomagnesemia patients ($P < 0.05$) There was no significant difference in other laboratory values between the two groups.

Table 3: Status of magnesium level according to hemoglobinA1C

HbA1c	Normo-magnesia	Hypo-magnesia,
Optimal (<7%)	18	4
Uncontrolled (>7%)	12	16
Total	30	20
P Value	<0.001	

The difference of S. Mg level in relation to HbA1c was statistically highly significant.

Discussion

Magnesium (Mg) is the second most abundant intracellular cation after potassium present in living cells and may influence the regulation of blood glucose metabolism by modulation of insulin secretion and insulin action. [8] Therefore, alterations in the metabolism of this mineral may influence these functions, contributing to the pathogenesis of obesity and insulin resistance. [19,20] Studies and knowledge on the relationship between diabetes and Mg status are expanding. Hypomagnesemia is a common finding in type 2 diabetic patients (T2DM). [21]

Diabetes mellitus is an endocrinological disease having high metabolic stress as well as high oxidative stress. Many trace elements and minerals are important for normal functioning of our body. Studies have already mentioned the importance of serum magnesium and zinc in pathogenesis and development of magnesium levels in diabetes and carbohydrate metabolism. [22] 32 (64%) were in the age group of 41–60 years, 10 (20%) were in age group of 19–40 years, whereas 8 (16%) were between 61 and 80 years. There were 46% male and 54% females. 24 (48%) were diabetic since 11–20 years, 16 (32%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 2 (4%) were diabetic since >30 years. Magnesium plays an important role in the carbohydrate metabolism, it regulates rate-limiting enzymes involved in glycolysis, glucose homeostasis, and insulin action including both insulin receptor responses (tyrosine kinases) and the insulin-signaling cascade. Magnesium also regulates cellular glucose metabolism and insulin secretion. Other metabolic processes involving magnesium as a cofactor or directly are lipid metabolism, and protein and nucleic acid synthesis. Magnesium also has a stabilizing role for proteins, nucleic acids, and biological membranes. [23] Due to involvement in multiple metabolic functions, Mg may be an important factor in occurrence of complications. The high prevalence of hypomagnesemia in their study population may be because they had included patients with type 2 diabetes of at least 5 years' duration. Another study by Saeed et al [24] done in Iraq reported only 5% prevalence of hypomagnesemia in diabetics. This very low prevalence as compared to other studies may probably be due to race or dietary differences.

Laboratory reports revealed that there was significant difference in mean total leukocyte count, Serum glutamic pyruvic transaminase (SGPT), serum glutamic- oxaloacetic transaminase (SGOT),

K+, Randon blood sugar (RBS), and HbA1c between hypomagnesemia patients compared to normomagnesemia patients ($P < 0.05$) There was no significant difference in other laboratory values between the two groups. The difference of S. Mg level in relation to HbA1c was statistically highly significant. In addition, there was a significant negative correlation between S. Mg and HbA1c level ($r = -0.499$, $P = 0.001$), which is similar to study by Aksit et al [25] ($r = 0.332$, $P < 0.001$ respectively) and Yossef et al [26] ($r = 0.569$, $P < 0.0001$ respectively).

Studies conducted by Siddique et al and Al-Osali et al also demonstrated the negative correlation between the same. [27,28] Hypomagnesemia disrupts glycaemic control through altering cellular glucose transfer, lowering pancreatic insulin release, disrupting post-receptor signalling, and changing the insulin-insulin receptor contact. [29] It also plays a part in the pathogenesis of microvascular complications of diabetes like advanced retinopathy, foot ulcers and nephropathy. According to a study conducted by Marhelle et al [30], dyslipidaemia and hypertension were also inversely related with serum magnesium levels. Although a large number of potential cohort research and meta-analyses have indicated that magnesium consumption lowers the incidence of diabetes, the findings are still mixed, and additional research is needed to confirm this. [31]

Conclusion

The present study concluded that hypomagnesemia has been linked to a lack of glycaemic regulation which can lead to diabetic complications. Early detection with oral magnesium supplementation as a therapeutic approach can avoid this; nonetheless, the prospective effect of magnesium therapy in avoiding the emergence of diabetes complications deserves further research.

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