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Original Research Article

A Hospital-Based Study Assessing Serum Magnesium Levels and its Correlation with Glycemic Status in Type II Diabetes Patients: An Analytical Study

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Abstract

Aim: The aim of the present study was to assess the level of serum magnesium in diagnosed Type II diabetics without microvascular and macrovascular complications and correlate with glycemic status.

Methods: A cross-sectional study was conducted in the Department of Biochemistry. The data was collected for finding out correlation between the glycemic index and serum magnesium was analysed and the results were obtained. The estimated sample size was 50. The sampling type was purposive sample.

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. 32 (64%) were male and 18 (36%) were female. Thus, there was male preponderance. 24 (48%) were diabetic since 11–20 years, 15 (30%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 3 (6%) 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 prevalence of hypomagnesemia in patient with HbA1c <7% was 20% as compared to that of normomagnesemia (60%), while the prevalence of hypomagnesemia in patient with HbA1c >7% was 80% as compared to that of normomagnesemia (40%). This difference of S. Mg level in relation to HbA1c was statistically highly significant.

Conclusion: The study concluded that that low S. Mg level in type 2 diabetes patients may be associated with higher HbA1c level, higher incidence of retinopathy and nephropathy. Routine monitoring and correcting S. Mg levels in type 2 diabetes patients may help in better control of HbA1c and delaying progression to retinopathy and nephropathy.

Keywords: Magnesium, HbA1c, Diabetes.

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] Magnesium is an essential mineral found in dietary fibers, non-starchy vegetables, fruits, nuts, and dairy products. [5] Hypomagnesemia has been reported in 25%–38% of type 2 diabetics [6] and to be associated with increased morbidity and mortality. [7,8]

In spite of innovative methods in the management of diabetes mellitus, the morbidity and mortality continue to be high.4 The deleterious effect of diabetes in these patients is related to complications, including both macrovascular and microvascular complications. [5,6]

Diet is widely believed to play an important role in the development of type 2 diabetes (T2D) and the associated complications. [9,10] The glycated haemoglobin (HbA1c) is widely used for evaluation of diabetes control. [11] The HbA1c reveals the overall blood glucose levels over a period of 2-3 months, and the common use of the HbA1c assay is to assess changes in metabolic control that follow an alteration in treatment. [12] Magnesium (Mg) is one of the important components of many foods such as grains, nuts and

green leafy vegetables, and it plays a key role in many fundamental biological processes, including energy metabolism. Mg has received considerable attention for its potential role in improving insulin sensitivity and preventing diabetes and its cardiovascular complications. [13,14] It is claimed that Mg deficiency is common in diabetic patients and there is an inverse relationship between Mg intake and incidence of T2DM. [15]

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. It also plays an important role in the phosphorylation reactions of glucose and its metabolism. Its deficiency has been implicated in insulin resistance, carbohydrate intolerance, dyslipidemia, and complications of diabetes. [16] Mg has received considerable attention for its potential role in improving insulin sensitivity and preventing diabetes and its complications. However, results are inconsistent among the studies. [17,18] Observations in Caucasian diabetics have linked hypomagnesemia as being an additional risk factor for the development of diabetic retinopathy, but this correlation was not observed in black African diabetics. [17] Most of these studies could not be compared because of different methodology and inclusion and exclusion criteria.

The aim of the present study was to assess the level of serum magnesium in diagnosed Type II diabetics without microvascular and macrovascular complications and correlate with glycemic status.

Materials and Methods

A cross-sectional study was conducted in the Department of Biochemistry, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, India for eight months. The data was collected for finding out correlation between the glycemic index and serum magnesium was analysed and the results were obtained. The estimated sample size was 50. The sampling type was purposive sample.

In sampling technique consecutive patients who were satisfying inclusion and exclusion criteria were included. Patients with type 2 DM of age 18 years and above, who gave written informed consent, were included in the study. The Exclusion criteria were the patients with chronic renal failure, Patients on diuretics. Patients receiving Magnesium supplements or Magnesium containing antacids, Malabsorption or chronic diarrhea, Patients with history of Epilepsy. The samples were processed for Serum Magnesium and HbA1C test by Immunoturbidimetric method on XL 640- Fully Automated Biochemistry Analyzer (Transasia Biomedical Ltd, India).

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, hemoglobin 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 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 data

Gender	**N%**
Male	32 (64)
Female	18 (36)
Age in years	
19-40 years	10 (20)
41-60 years	32 (64)
61-80 years	8 (16)
Duration of diabetes	
0-10 years	15 (30)
11-20 years	24 (48)
21-30 years	8 (16)
>30 years	3 (6)

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. 32 (64%) were male and 18 (36%) were female. Thus, there was male preponderance. 24 (48%) were diabetic since 11–20 years, 15 (30%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 3 (6%) were diabetic since >30 years.

Table 2: Laboratory reports of the study population

Laboratory report	Mean±SD		P
	Normo-magnesemia	Hypo-magnesemia	
Hemoglobin	11.32±2.28	10.25±1.95	0.958
Total count	7544.86±2394.16	8428.16±2578.92	0.048
Platelets	2.03±0.88	2.11±0.89	0.576
Urea	35.85±17.52	43.07±25.75	0.55
Creatinine	1.24±0.92	1.52±1.38	0.155
SGPT	34.46±28.92	44.06±33.67	0.036
SGOT	32.28±20.46	46.44±28.62	0.001
Total bilirubin	1.12±0.86	1.21±0.66	0.412
Na+	135.35±3.77	135.75±2.86	0.432
K+	3.98±0.52	4.18±0.32	0.007
Cl-	99.25±3.05	98.42±1.68	0.088
RBG	228.92±62.06	258.82±70.65	0.007
HemoglobinA1C	7.23±1.20	8.72±1.56	<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

	Normo magnesemic, n (%)	Hypomagnesemic, n (%)	p-value
Optimal (<7%)	36 (60)	8 (20)	<0.001
Uncontrolled (>7%)	24 (40)	32 (80)	
Total	60 (100)	40 (100)	

The prevalence of hypomagnesemia in patient with HbA1c <7% was 20% as compared to that of normomagnesemia (60%), while the prevalence of hypomagnesemia in patient with HbA1c >7% was 80% as compared to that of normomagnesemia (40%). This difference of S. Mg level in relation to HbA1c was statistically highly significant.

Table 4: Association of diabetic complications with serum magnesium levels

Magnesium (mg%)	PDR		NPDR		Nephropathy	
	Absent %	Present %	Absent %	Present %	Absent %	Present %
<1.8	18 (90)	1 (10)	8 (42.10)	11 (57.90)	15 (78.94)	4 (21.06)
>1.8	27 (87.09)	4 (12.90)	24 (77.41)	7 (22.59)	29 (93.54)	2 (6.46)
Total	45 (90)	5 (10)	32 (64)	18 (36)	43 (86)	7 (14)
OR	3.189		4.871		5.4	
P Value	0.068		0.001		0.001	

The incidence of PDR in hypomagnesemia patients was 10% as compared to 12.90% among patient having normal magnesium level. There was a statistically significant association between hypomagnesemia and Proliferative diabetic retinopathy (PDR). ($P = 0.068$; odds ratio [OR] = 3.189). Incidence of Non proliferative diabetic retinopathy (NPDR) in hypomagnesemia patients was 57.90% as compared to 22.59% among patient having normal magnesium level. There was strong significant association between hypomagnesemia and NPDR ($P = 0.001$; OR = 4.871). Incidence of nephropathy in hypomagnesemia patients was 21.06% as compared to 6.46% among patient having normal magnesium level. There was strong significant association between hypomagnesemia and nephropathy ($P = 0.001$; OR = 5.4).

Discussion

Magnesium is an important and vital element in maintaining the body functions. It needs to be supplemented adequately. [19] Magnesium is the ninth most abundant element in the universe. [20,21] Magnesium is an essential element in biological systems. Magnesium typically known as the Mg^{2+} ion. It is an essential nutrient (i.e., element) for life and is present in every cell type in every organism. [22-25] 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. [26] Low levels of magnesium have shown to damage tyrosine kinase activity and receptors involved in signaling. [27] Both intracellular and extracellular magnesium deficits

are associated with type 2 diabetes mellitus. [28] Hypomagnesemia has been implicated in carbohydrate intolerance, hyperglycaemia, insulin resistance, complications of diabetes and hyperlipidemia. [29] Hypomagnesemia is common among diabetic patients which is frequently underdiagnosed.

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. 32 (64%) were male and 18 (36%) were female. Thus, there was male preponderance. 24 (48%) were diabetic since 11–20 years, 15 (30%) were diabetic since 0–10 years, 8 (16%) were diabetic since 21–30 years, while 3 (6%) 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+, Random 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 prevalence of hypomagnesemia in patient with HbA1c <7% was 20% as compared to that of normomagnesemia (60%), while the prevalence of hypomagnesemia in patient with HbA1c >7% was 80% as compared to that of normomagnesemia (40%). This difference of S. Mg level in relation to HbA1c was statistically highly significant. One study by Yossef HM et al [30] reported hypomagnesemia in almost 80% of their study population of type 2 DM patients. 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 [31] 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.

The incidence of PDR in hypomagnesemia patients was 10% as compared to 12.90% among patient having normal magnesium level. There was a statistically significant association between hypomagnesemia and Proliferative diabetic retinopathy (PDR). ($P = 0.068$; odds ratio [OR] = 3.189). Incidence of Non proliferative diabetic retinopathy (NPDR) in hypomagnesemia patients was 57.90% as compared to 22.59% among patient having normal magnesium level. There was strong significant association between hypomagnesemia and NPDR ($P = 0.001$; OR = 4.871). Incidence of nephropathy in hypomagnesemia patients was 21.06% as compared to 6.46% among patient having normal magnesium level. There was strong significant association between hypomagnesemia and nephropathy ($P = 0.001$; OR = 5.4) which is similar to study by Aksit et al [32] ($r = 0.332$, $P < 0.001$ respectively) and Yossef et al [31] ($r = 0.569$, $P < 0.0001$ respectively). In other studies, Wahid et al [33] and Kumar et al [34] reported significant difference in HbA1c values of diabetics with low and normal magnesium levels. [35] ($P < 0.0001$). Hence, there is a significant negative correlation of magnesium levels with HbA1c, however, the effect of Mg supplementation on glycemic control and bringing down HbA1c toward optimal remains to be seen which may be a topic for future research.

Conclusion

The study concluded that that low S. Mg level in type 2 diabetes patients may be associated with higher HbA1c level, higher incidence of retinopathy and nephropathy. Routine monitoring and correcting S. Mg levels in type 2 diabetes patients may help in better control of HbA1c and delaying progression to retinopathy and nephropathy. Furthermore, detailed analysis of the various parameters including dietary intake of magnesium, loss of magnesium owing to diuresis and malabsorption need to be considered while assessing serum magnesium levels in diabetic individuals and hence, call for detailed research in the area. Proper counseling should be given to diabetic patients about the need of taking magnesium through diet and the health care professionals should be made aware of the risks associated with hypomagnesemia left undiagnosed in diabetic patients and its ill effects.

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