

Hypomagnesemia in Patients with *Diabetes mellitus*

Muhammed Khalid Shaikh, Bikha Ram Devrajani, Aftab Ahmed Soomro,
Syed Zulfiqar Ali Shah, Tarachand Devrajani and Thanver Das

Department of Medicine,
Liaquat University of Medical and Health Sciences Jamshoro, Hyderabad (LUMHS), Pakistan

Abstract: This study evaluated the frequency of hypomagnesemia in patients with *diabetes mellitus* and was conducted at Liaquat University Hospital Hyderabad from October 2009 to March 2010. The diabetic patients (type 1 and 2) were evaluated for their serum magnesium level by taking 2cc venous blood sample and sent to laboratory for analysis. Total 100 diabetic patients were studied, of which 77(77%) patients were type 2 diabetic and 23(23%) patients were type 1 diabetic. The mean age and standard deviation of patients with type 1 and type 2 diabetes was 21.34 ± 3.43 (SD) and 42.43 ± 6.521 (SD), respectively. The mean \pm SD for serum magnesium in overall subjects was 1.34 ± 0.53 . The hypomagnesemia was identified in 08 (14.5%) patients of type 1 diabetes and 47 (85.5%) of type 2 diabetes ($P = 0.02$). The mean \pm SD of serum magnesium level in male and female population was 1.3000 ± 0.5087 and 1.3882 ± 0.5577 , respectively. The hypomagnesemia was identified in patients with *diabetes mellitus* (type 1 and type 2 with statistical significant values. Of 55 hypomagnesemic diabetic patients the Hemoglobin A1c (HbA1c) was raised in 40 (72.7%) patients.

Key words: Magnesium • Diabetes mellitus • Type 2 diabetes • Type 1 diabetes

INTRODUCTION

The number of people with diabetes is increasing due to population growth, aging, urbanization and increasing prevalence of obesity and physical inactivity. Quantifying the prevalence of diabetes and the number of people affected by diabetes, now and in the future, is important to allow rational planning and allocation of resources [1]. There are an estimated 23.6 million people in the U.S. (7.8% of the population) with diabetes and 17.9 million being diagnosed, [2] 90% of whom are type 2[3]. With prevalence rates doubling between 1990 and 2005, CDC has characterized the increase as an epidemic [4]. Pakistan is estimated to have 7 million people with diabetes. Currently it is 8th in the world according to WHO estimation of prevalence of diabetes and by the year 2025 is expected to be 4th with 15 million people with diabetes, representing a 2 fold increase in caseload [5]. It is also one of the most common chronic diseases affecting children with about 200 children world-wide develop type 1 diabetes every day [6].

The magnesium (Mg) is present in greatest concentration within the cell and is the second most abundant intracellular cation after potassium. It is the 11th

most abundant element by mass in the human body and its ions are essential to all living cells, whereas they play a major role in manipulating important biological polyphosphate compounds [7]. The disturbance in serum magnesium level i.e. hypomagnesemia has been reported to occur among patients of *diabetes mellitus* [8]. The prevalence of hypomagnesemia in *diabetes mellitus* is 65% [9]. The persistent hypomagnesemia leads to raised serum glucose level, insulin resistance and the degree of magnesium depletion correlates positively with serum glucose concentration and the degree of glucosuria [10]. Secondly, hypomagnesemia may increase the risk of cardiovascular abnormalities [11,12]. Intracellular Mg plays a key role in regulating insulin action, insulin-mediated-glucose uptake and vascular tone. Reduced intracellular Mg concentrations result in a defective tyrosine-kinase activity, post-receptorial impairment in insulin action and worsening of insulin resistance in diabetic patients.

Therefore, keeping all relevant discussion in mind, the present study was conducted in a tertiary care teaching hospital of Hyderabad. This study focused on the disturbance in serum magnesium level (hypomagnesemia) in patients with *diabetes mellitus*.

Corresponding Author: Syed Zulfiqar Ali Shah, Department of Medicine,
Liaquat University of Medical and Health Sciences Jamshoro / Hyderabad (LUMHS), Pakistan.
Cell: +92-300-3057155, E-mail: zulfikar229@hotmail.com.

The present study opened new forum of discussion and provide new ideas, knowledge and protocol regarding the medical workup and management plan for the patients with *diabetes mellitus*.

Patients and Methods: This descriptive case series study was conducted in medical ward at Liaquat University Hospital Hyderabad from October 2009 to March 2010 on the patients with history of *diabetes mellitus* for ≥ 3 years duration attending the medical OPD or admitted in medical ward. The inclusion criteria for the study were patients ≥ 18 years of age present at Liaquat university hospital, known cases of *diabetes mellitus* (type 1 and type2), of either gender and patients who were agree and ready to give consent for participation in the study, whereas the exclusion criteria of they study were: Patients with acute pancreatitis and had a history of alcoholism, patients with history of diarrhea, vomiting and nasogastric suction, gastrointestinal fistulas and ostomies, patients on Diuretics, antimicrobials (Amphotericin B, aminoglycosides, pentamidine, capreomycin, viomycin and foscarnet), chemotherapeutic agents (cisplatin), immunosuppressants (tacrolimus and cyclosporine) and proton-pump inhibitors. A written consent was taken from all patients for participation in the study. All such patients who meet the inclusion criteria were evaluated for their blood glucose level and serum magnesium level by taking 3 cc venous blood sample in a disposable syringe and sent to laboratory for analysis. The serum magnesium level was estimated by Calmagite dye method. The normal serum magnesium level considered was 1.8 - 2.5 mg/dl so the value < 1.8 mg/dl was labeled as hypomagnesemia. The HbA1C estimation was carried out by a modified calorimetric method. The data was collected on pre-designed proforma and all such maneuvers were under medical ethics.. The frequency and percentage was calculated for hypomagnesemia in *diabetes mellitus* 1 and 2 as well as for gender distribution. The chi-square test was applied between categorical variables at 95% confidence interval while independent t-test was also applied as far as mean \pm SD concerned. The p-value ≤ 0.05 was considered as statistically significant. The stratification was done between hypomagnesemia and duration of diabetes where as the mean \pm standard deviation (SD) calculated for age.

RESULTS

Out of 100 diabetic patients, 77 were type 2 diabetes and 23 patients were type 1 *diabetes mellitus*. The mean age and standard deviation of patients with type 1 and

Table 1: Gender Distribution of Diabetic Patients

	Diabetes Mellitus		Total	P - Value
	Type 1	Type 2		
Gender				
Male	15 (65.2%)	34 (44.2%)	49 (49%)	0.07*
Female	08 (34.8%)	43 (55.8%)	51 (51%)	
Total	23 (100%)	77 (100%)	100 (100%)	

*p-value is statistically not significant

Table 2: Frequency of hypomagnesemia in patients with diabetes mellitus (type 1 and 2)

	Magnesium		Total	P-value
	Hypomagnesemia	Normal		
Diabetes				
Type 1	08 (14.5%)	15 (33.3%)	23 (23%)	0.02*
Type 2	47 (85.5%)	30 (66.7%)	77 (77%)	
Total	55 (100%)	45 (100%)	100 (100%)	

*p-value is statistically significant

Table 3: Mean magnesium in relation to gender distribution

Gender	(n = 100)	Mean magnesium \pm SD	P - value
Male	49	1.3000 \pm 0.5087	0.411*
Female	51	1.3882 \pm 0.5577	

*p-value is statically not significant

Table 4: Frequency of hypomagnesemia in relation to glycated hemoglobin (hba1c)

	Magnesium		Total	P-value
	Hypomagnesemia	Normal		
HbA1c				
Raised	40 (72.7%)	13 (28.9%)	53 (53%)	< 0.01 *
Normal	15 (27.3%)	33 (71.1%)	47 (47%)	
Total	55 (100%)	45 (100%)	100 (100%)	

*p-value is statistically significant

Table 5: Prevalence of hypomagnesemia and duration of diabetes mellitus

Duration of diabetes	No: of patients	Hypomagnesemia	Prevalence (%)
3-5 years	22	08	36
6-10 years	28	20	71
11-15 years	25	18	72
15-20 years	15	05	33
> 20 years	10	04	40

type 2 diabetes was 21.34 \pm 3.431 (SD) and 42.43 \pm 6.521 (SD), respectively. The mean \pm SD for serum magnesium in overall subjects was 1.3450 \pm 0.5334. The distribution of diabetic patients participated in the study is shown in table1 where as the frequency of hypomagnesemia as far as *diabetes mellitus* and gender is concerned is shown in tables2 and 3. The mean random blood glucose level was 220.52 \pm 13.68 (SD) in hypomagnesimic diabetic whereas

it was 168.63 ± 10.83 (SD) in normomagnesimic diabetic patients. The hypomagnesemia in relation to haemoglobin A1c (HbA1c) is shown in table 2. Out of 55 hypomagnesemic diabetic patients, 34 (62%) were males and 21 (38%) were females. The hypomagnesemia in relation to duration of diabetes is shown in table 5. Regarding the demographical distribution majority of the patients were belonged to rural populations (76%).

DISCUSSION

In the presence of diabetes, it is observed that inadequate metabolic control can affect the concentrations of magnesium, developing hypomagnesemia, which may be still directly related with some micro and macrovascular complications observed in diabetes, as cardiovascular disease, retinopathy and neuropathy [13]. Some epidemiologic studies have indicated that the mortality from ischemic heart disease (IHD) is lower in populations living in areas with “hard” water (i.e. water with high calcium and magnesium concentrations) than in populations living in areas with water with low concentrations of these minerals. In present study, the hypomagnesemia was identified in 55% diabetic patients whereas Pham *et al.* [14] reported hypomagnesemia in 47.7% of non hospitalized patients with *diabetes mellitus*. There is considerable evidence to suggest that hypomagnesemia may adversely affect various aspects of cellular physiology. Available data suggest that low Mg levels may promote endothelial cell dysfunction and thrombogenesis by increasing platelet aggregation and vascular calcifications [14]. On the other hand Sales *et al.* [13] suggested magnesium supplementation in patients with *diabetes mellitus* who have proven hypomagnesemia. It could be demonstrated that there is a relationship between hypomagnesemia and late diabetic complications and this evidence shows the concept of evaluating magnesium levels in serum of diabetic patients particularly with poor glycemic control [15]. The hyperglycemia is inversely related to hypomagnesemia and serum magnesium can be used for prognostic assessment in diabetic individuals. Regarding gender distribution the findings of the present study also correlates with the study conducted in India by Kumar *et al.* [16] In our study the glycated hemoglobin (HbA1c) was raised in 40(72.7%) of diabetic hypoglycemic patients and it is consistent with the study by Viktorínová *et al* [17].

CONCLUSION

In conclusion, hypomagnesemia was identified in patients with *diabetes mellitus* whereas mean magnesium in relation to gender distribution was not statistically significant $p = 0.411$. glycated hemoglobin (HbA1c) was raised in hypomagnesemia diabetic patients.

REFERENCES

1. McPhee, S.J. and M.A. Papadakis, 2010. *Diabetes mellitus* and Hyperglycemia. In: Masharani U, editor. Current Medical Diagnosis and Treatment. 49th ed. USA: Churchill Livingstone The McGraw-Hill Companies, pp: 1079-1133.
2. Rother, K.I., 2007. Diabetes treatment-bridging the divide. N. Engl. J. Med., 356(15): 1499-501.
3. Holman, R.R., S.K. Paul, M.A. Bethel, D.R. Matthews and H.A. Neil, 2008. 10-year follow-up of intensive glucose control in type 2 *diabetes*. N. Engl. J. Med., 359(15): 1577-89.
4. Homer, J.B. and G.B. Hirsch, 2006. System Dynamics Modeling for Public Health: Background and Opportunities. Am. J. Public. Health, 96(3): 452-58.
5. Alberti, K.G., P. Zimmet and P. Shaw, 2007. International *Diabetes* Federation: a consensus on Type 2 *diabetes* prevention. Diabet. Med., 24(5): 451-63.
6. Narula, P., L. Porter, J. Langton, V. Rao, P. Davies and C. Cummins, 2009. Gastrointestinal Symptoms in Children With Type 1 *Diabetes* Screened for Celiac Disease. Pediatrics, 124(3): e489-e95.
7. Wang J.L., N.S. Shaw, H.Y. Yeh and M.D. Kao, 2005. Magnesium status and association with *diabetes* in the Taiwanese elderly. Asia. Pac. J. Clin. Nutr., 14(3): 263-9.
8. Phuong-Chi, T., T. Phuong-Mai, S.V. Pham, J.M. Miller and T. Phuong-Thu, 2007. Hypomagnesemia in patients with type 2 *diabetes*. Clin. J. Am. Soc. Nephrol., 2: 366-73.
9. Seyoum, B., E.S. Siraj, C. Saenz and J. Abdulkadir, 2008. Hypomagnesemia in Ethiopians with *diabetes mellitus*. Ethn. Dis., 18(2): 147-51
10. Barbagallo, M. and L.J. Dominguez, 2007. Magnesium metabolism in type 2 *diabetes mellitus*, metabolic syndrome and insulin resistance. Archives of Biochemistry and Biophysics, 458(1): 40-7

11. Corica, F., A. Corsonello; R. Lentile, D. Cucinotta, A.D. Benedetto and F. Perticone, 2006. Serum Ionized Magnesium Levels in Relation to Metabolic Syndrome in Type 2 Diabetic Patients. *J. the American College of Nutrition*, 25(3): 210-5.
12. Ahmad, A., M. Akram, Z.H. Tanveer, I.Ahmad and S. Masud, 2006. Significance of serum magnesium and electrolyte levels in acute myocardial infarction in first six hours. *Pak. J. Cardiol.*, 17(1): 25-9.
13. Sales, C.H. and L.F. Pedrosa, 2006. Magnesium and *diabetes mellitus*: Their relation. *Clin. Nutr.*, 25(4): 554-62.
14. Pham, P.C., P.M. Pham, P.A. Pham, S.V. Pham, H.V. Pham and J.M. Miller, 2005. Lower serum magnesium levels are associated with more rapid decline of renal function in patients with *diabetes mellitus* type 2. *Clin. Nephrol.*, 63(6): 429-36.
15. Hans, C.P., R. Sialy and D.D. Bansal, 2002. Hypomagnesemia in Diabetic Patients: Correlation with Oxidative Stress. *Int. J. Diab. Dev. Ctries.*, 22: 122.
16. Kumar, N.L., J. Deepthi; Y.N. Rao and M.K. Deedi 2010. Study of lipid profile, serum magnesium and blood glucose in hypertension. *Biology and Med.*, 2(1): 6-16.
17. Viktorínová, A., E. Toserová; M. Krizko and Z. Duracková, 2009. Altered metabolism of copper, zinc and magnesium is associated with increased levels of glycated hemoglobin in patients with *diabetes mellitus*. *Metabolism*, 58(10): 1477-82.