www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 71.58
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i10.160

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Serum Magnesium Level as a Predictor of Micro and Macro Vascular Complications of Type 2 Diabetes Mellitus

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Abstract
Background: *Diabetes mellitus promote to impaired metabolism of carbohydrates, proteins, fats, water and electrolytes. Micronutrient have been explore as a potential, preventive and therapeutic agents for type 2 diabetes mellitus and their complications. Hence, this study was planned to evaluate the serum magnesium levels in patients with type 2 DM and to correlate them with the microvascular complications.*
Material & Methods: *A cross sectional study was done, in which subjects with DM type 2 attending medicine OPD and admitted in S.P. Medical College, Bikaner were taken as cases also of age group above 30 years. A total of 150 patients with type 2 diabetes mellitus were included in the study.*
Results: *This is a hospital based cross sectional study observed that majority of patients were male (71.33%) and female were (28.67%). The serum magnesium levels were between 1.8 to 2.5 mg/dL (normomagnesemia) among 58.67% of the patients while 41.33% of the patients had serum magnesium levels of < 1.8 mg/dL (hypomagnesemia) and hypomagnesemia (< 1.8 mg/dL) is seen in 58.54% of the patients with microvascular complications compared to 20.59% of the patients. This difference was statistically significant (p<0.001).*
Conclusion: *Hypomagnesemia is widely prevalent (41.33%) among patients with type 2 diabetes mellitus and lower serum magnesium was seen in patients with poor control and longer duration of diabetes.*
Keywords: *Diabetes mellitus, Serum magnesium, Microvascular complication.*

Introduction

The term diabetes mellitus (DM, derived from Greek words meaning - Siphon and sweet) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. It results from decreased insulin secretion and/or action, reduced glucose utilization, and increased glucose production. The effect of diabetes mellitus include long term damage, dysfunction and failure of various organs, eyes, kidneys, nerves and heart and blood vessels.

In worldwide the number diabetes subjects expected to increase 11.4% from 366 million in 2011 to 552 million by 2030, affecting one in 10 adults[1]. According to the International Diabetes Foundation,[2] although the diabetes currently

affects more than 62 million Indians, which is more than 7.1% of the adult population[3] The average age on onset is 42.5 years. Nearly 1 million Indians die due to diabetes every year.

Diabetes mellitus promote to impaired metabolism of carbohydrates, proteins, fats, water and electrolytes. The resolves of these metabolic disturbances may promote to permanent and irreversible changes of function and structure in the cells of the body which in turn lead to the development of "complications in diabetes", characteristically affecting, the cardiovascular system, eye, kidney and nervous system mainly.[4] Chronic complications of diabetes mellitus may be divided into vascular and avascular complications. The vascular complications of DM are further subdivided into microvascular (retinopathy, neuropathy, nephropathy) and macrovascular complications [coronary artery disease (CAD), peripheral arterial disease (PAD), cerebrovascular disease].[5]

Micronutrient have been explore as a potential, preventive and therapeutic agents for type 2 diabetes mellitus and their complications.[6] In particular, diabetes has shown to be associated with irregularity in the metabolism of zinc, chromium, copper, magnesium and manganese.[7] Out of these micronutrients, magnesium has been investigated as a clinically, for a long term global policy to lower the burden of diabetes mellitus, with new findings and researches.[8] Studies have shown that magnesium levels are lower in patients with diabetes compared with nondiabetic controls.[9] The reported incidence of hypomagnesemia in patients with type 2 DM varies between 13.5 to as high as 47.7%.[10]

Magnesium is the fourth most abundant electrolyte in the human body and the second most abundant intracellular cation.[11] It's plays a major role in the carbohydrate metabolism. It serves as a cofactor for all enzymatic reactions that require kinases.[12] It is also an essential enzyme activator for neuromuscular excitability and cell permeability, a regulator of ion channels and mitochondrial function, a critical element in cellular proliferation and apoptosis, and an important factor in both cellular and humoral functions.[13] Magnesium depletion has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2 diabetes as well as on the evolution of complications such as retinopathy, arterial atherosclerosis and nephropathy. Moreover a low serum magnesium level is strong, independent predictor of development of microvascular complications in type 2 DM.[14]

Although, serum magnesium levels are known to be low in type 2 DM, the entity of hypomagnesemia very often remains under-diagnosed and under-evaluated due to its usual asymptomatic presentation. Also, to date, there are very few studies which have evaluated the association of serum magnesium levels with the microvascular complications especially in India. Hence, this study was planned to evaluate the serum magnesium levels in patients with type 2 DM and to correlate them with the microvascular complications.

Material & Methods

A cross sectional study was done, in which subjects with DM type 2 attending medicine OPD and admitted in S.P. Medical College, Bikaner were taken as cases also of age group above 30 years. A total of 150 patients with type 2 diabetes mellitus were included in the study.

Inclusion criteria

- All the newly diagnosed patients with type 2 diabetes mellitus between the age group of 30-70 years.
- All diagnosed cases of diabetes mellitus type 2.

Exclusion criteria

- Alcoholics.
- Patients with drug induced hyperglycaemia.
- All type 1 diabetes patients, Gestational diabetics.
- Patients with pancreatitis.
- Drugs causing Hypomagnesaemia.

Patients were interviewed to obtain the demographic characteristics such as age and sex, presenting complaints, diabetic history and history of other comorbid conditions. These patients were subjected to clinical examination and the findings including vitals and systemic examination findings were noted. Patients were evaluated for the features of diabetic peripheral neuropathy.

Results

A hospital based cross sectional study observed that majority of patients were male (71.33%) and female were (28.67%). The male to female ration was 2.48:1 (table 1). The mean age was 60.38 ± 10.81 years and median age was 60.5 years (Range 36-89 years) (table 2).

In this study serum magnesium levels were between 1.8 to 2.5 mg/dL (normomagnesemia) among 58.67% of the patients while 41.33% of the patients had serum magnesium levels of < 1.8 mg/dL (hypomagnesemia) (table 3)

In the present study hypomagnesemia (< 1.8 mg/dL) is seen in 58.54% of the patients with microvascular complications compared to 20.59% of the patients. This difference was statistically significant (p<0.001) (table 4).

Table 1: Sex wise distribution of cases

Sex distribution	Number	Percentage
Male	107	71.33%
Female	43	28.67%
Total	150	100%

Table 2: Age wise distribution of cases

Age (yrs)	Number	Percentage
18-30	0	0%
31-45	18	12%
46-60	57	38%
>60	75	50%
Total	150	100%

Table 3: Serum magnesium of cases

Serum magnesium (mg/dl)	Number	Percentage
<1.8	62	41.33%
1.8-2.5	88	58.67%
Total	150	100%

Table 4: Microvascular complication relation to serum magnesium

Microvascular complication	<1.8 mg/dl	1.8-2.5 mg/dl
Present	48 (58.54%)	34 (41.46%)
Absent	14 (20.59%)	54 (79.41%)
Total	62 (41.33%)	88 (58.67%)

Discussion

Type 2 diabetes mellitus is one of the major global health challenges encountered in physicians practice in 21st century. The chronic complications of diabetes mellitus can be subdivided into microvascular (retinopathy, neuropathy, nephropathy) and macrovascular complications [coronary artery disease (CAD), peripheral arterial disease (PAD), cerebrovascular disease].[15]

Hypomagnesaemia in patients with type 2 diabetes mellitus is frequently under-diagnosed and under-evaluated due to its usual asymptomatic presentation. Hence, this study was aimed to evaluate the serum magnesium levels in patients with type 2 DM and further to correlate with the microvascular complications.

It is reported that, the prevalence of diabetes is higher in men than women.[16-19] The same was true in the present study as males (71.33%) outnumbered females (28.67%) with male to female ratio 2.48:1. These findings suggest higher prevalence of diabetes among males in this study which was consistent with the previous literature.[16-19]

Unlike in the West, where older persons are most affected, diabetes in Asian countries is disproportionately high in young to middle-aged adults.[16-19] However, in this study nearly half of the study population (50%) presented with age > 60 years. The next common age group was 46 to 60 (38%) followed by 31 to 45 years (12%). Further mean age of the study population was 60.38 ± 10.81 years and m edian age was 60.5 years with youngest patients being 36 years and oldest being 89 years. The findings show that diabetes mellitus was widely prevalent among elderly. The higher prevalence of diabetes among

aged can be explained by the rise in the segment of geriatric population.[20]

In this study hypomagnesemia (<1.8mg/dL) was present in 41.33% of the patients and normomagnesemia (1.8 to 2.5 mg/dL) among 58.67% of the patients. These findings suggest that there was high prevalence of hypomagnesemia and every second patient was diagnosed to have hypomagnesemia.

Studies have reported incidence rates of 13.5–47.7% in diabetic subjects.[21,22] Prevalence of hypomagnesemia in type – 2 diabetics in our study was comparable to that reported by Nadler et al.[62] in type 2 diabetics attending outpatient clinics in the US. Walti MK et al.[23] also reported a prevalence of hypomagnesemia in type 2 diabetics at 37.6% versus 10.9% in nondiabetic controls in a study conducted in Zurich, Switzerland.

In contrast, recently, Dasgupta A., et al.[24] from Assam reported hypomagnesemia in only 11% of diabetics. The lower incidence of hypomagnesemia in their study was attributed to stricter exclusion criteria followed in the study.

The prevalence of hypomagnesemia in our study was comparable to the western studies,[23] and in contrast to the Indian studies,[24] our study had a higher prevalence of hypomagnesemia among diabetic subjects.

The reasons for the high prevalence of magnesium deficiency in diabetes are not clear, but may include increased urinary loss, due to osmotic diuresis, lower dietary intake, rampant use of loop and thiazides diuretics promoting magnesium wasting, diabetic autonomic neuropathies**,** impaired absorption of magnesium compared to healthy individuals. Sometimes frequent use of antibiotics and antifungals such as aminoglycosides and amphotericin in patients with diabetes may also contribute to renal magnesium wasting. Recently a specific tubular defect in magnesium reabsorption in thick ascending loop of Henle is postulated. This defect results in reduction in tubular reabsorption of magnesium and consequently hypomagnesemia. The reason for this tubular defect in diabetics in unclear. Insulin treatment has been shown to correct renal magnesium loss in diabetics.[25]

In the present study, the overall microvascular complications were significantly high in patients with hypomagnesemia that is, 58.54% of the patients with hypomagnesemia (<1.8 mg/dL) had microvascular complications compared to 41.46% of the patients with normomagnesemia (p<0.001).

A study by Sajjan NB et al.[26] from Gulbarga Karnataka reported that serum levels of Magnesium showed statistically significant difference when compared in healthy subjects & subjects with Diabetic nephropathy. Recently, Dasgupta A., et al.[24] from Assam reported higher incidence of retinopathy in the hypomagnesemia group (64% vs 45.8%). The existence of a close relationship between impaired magnesium balance and retinopathy was established by Fujii et al.,[27] who found a marked depletion in plasma and erythrocyte magnesium levels in diabetic patients with advanced retinopathy.

This study reveals a strong association between hypomagnesemia and microvascular complications. Hence it could be suggested that routine surveillance for hypomagnesemia is done in patients of type 2 diabetes mellitus.

Conclusion

Hypomagnesemia is widely prevalent (41.33%) among patients with type 2 diabetes mellitus and lower serum magnesium was seen in patients with poor control and longer duration of diabetes. With special reference to neuropathy, there was a higher prevalence of hypomagnesemia in neuropathy than with other complications. Low serum magnesium is one of the additional risk factors for the development of microvascular complications in type 2 diabetes mellitus.

References

1. International Diabetes Federation. Diabetes atlas. 5th ed. Brussels: International Diabetes Federation; 2011.
2. Gale, Jason (November 7, 2010). "India's Diabetes Epidemic Cuts Down Millions

Who Escape Poverty". *Bloomberg*. Retrieved 8 June 2012.

3. "Diabetes can be controlled in 80 percent of Cases in India". *IANS*. news. Biharprabha. com. Retrieved 6 February 2014.
4. Koda-Kimble MA, Carlisle BA. Diabetes mellitus. In: Young LY, Koda- Kimble MA, Kradjan WA, Guglielmo BJ, eds. Applied therapeutics: the clinical use of drugs. 6th ed., Vancouver (WA): Applied therapeutics 1995; 48:481-5.
5. Fauci AS, Kasper DS, Longo DL, Braunwald E, Hauser SL, Jameson JL, et al. Harrison's principles of internal medicine. United States; McGraw Hill: 2008.
6. Mooradian AD, Failla M, Hoogwerf B, Maryniuk M, Wylie-Rosett J. Selected vitamins and minerals in diabetes. Diabetes Care 1994;17:464-79.
7. Walter RM, Bhandarkar SD. Trace elements in diabetes mellitus. J Postgrad Med 1981;27:129-32.
8. American Diabetes Associates. Clinical Practice Recommendations: Diabetes Care 2004;6:1-16.
9. Dasgupta A, Sarma D, Saikia UK. Hypomagnesemia in type 2 diabetes mellitus. Indian J Endocr Metab 2012;16:1000-3
10. Pham PC, Pham PM, Pham SV, Miller JM, Pham PT. Hypomagnesemia in patients with type 2 diabetes. Clin J Am Soc Nephrol 2007;2:366-73.
11. Saris NEL, Mervaala E, Karppanen H, Khawaja JA, Lewenstam A. Magnesium: An update on physiological, clinical and analytical aspects. Clin Chem Acta 2000;294:1-26.
12. Elamin A, Tuvemo T. Magnesium and insulindependent diabetes mellitus. Diabetes Res Clin Pract 1990;10:203-9.
13. Kao WHL, Folsom AR, Nieto FJ, Watson RL, Brancati, FL. Serum and dietary magnesium and the risk for type 2 diabetes: The Atherosclerosis Risk in Communities Study. Arch Intern Med 1999;159:2151-9.
14. Grafton G, Baxter MA, Sheppard MC. Effects of magnesium on sodium dependant inositol transport. Diabetes 1992;41:35-9.
15. Puri M, Gujaral M, Nayyar SB. Comparative study of serum zinc, magnesium and copper levels among patients of type 2 diabetes mellitus with and without microangiopathic complications. Innovative Journal of Medical and Health Science 2013;3(6)L274-8.
16. Swain RP, Subudhi BB, Mahapatra AK, Bolapreddi V. Bridging Between Disease, Prevalence and Treatment of Diabetes Mellitus: A Review. Int J Pharm Tech Res 2015;7(2):212-28.
17. Kopelman PG, Hitman GA. Naturally occurring antihyper glycemic and antidyslipedimic agents. The Lancet 1998;5:352.
18. Shi Y, Frank B. The global implications of diabetes and cancer. The Lancet 1947;9933:383.
19. Melmed S, Polonsky KS, Larsen PR. William's text book of endocrinology. 12th ed., Philadelphia: Elsevier; 1996.
20. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res 2007;125:217-30.
21. Pham PC, Pham PM, Pham SV, Miller JM, Pham PT. Hypomagnesemia in patients with type 2 diabetes. Clin J Am Soc Nephrol 2007;2:366-73.
22. Voets T, Nilius B, Hoefs S, van der Kemp AW, Droogmans G, Bindels RJ, Hoenderop JG: TRPM6 forms the $Mg2^+$ influx channel involved in intestinal and renal $Mg2^+$ absorption. J Biol Chem 2004;279:19–25.
23. Walti MK, Zimmermann MB, Hurrell RF. Low plasma magnesium in type-2 diabetes. Swiss Med Wkly 2003;133:289-92.

24. Dasgupta A, Sarma D, Saikia UK. Hypomagnesemia in type 2 diabetes mellitus. Indian J Endocr Metab 2012;16:1000-3
25. Choudhary R, Thanna RC, Vamne A, Pathak S. A Retrospective Study Of Serum Magnesium In Type 2 Diabetes Mellitus And Correlation With Strategy Of Treatment. GJBB 2015;4(2):172-4.
26. Sajjan NB, Choudhari AS, Desai GM, Dharapur MS, Wali VV. Evaluation of association of serum magnesium with dyslipidaemia in diabetic nephropathy – a case control study. National J Med Res 2014;4(4):318-21.
27. Fujii S, Takemura T, Wada M, Akai T, Okuda K. Magnesium levels in plasma erythrocytes and urine in patients with diabetes mellitus. Horm Metab Res 1982;14:61-2.