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A COMPARATIVE STUDY OF SERUM MAGNESIUM IN TYPE 2 DIABETES MELLITUS PATIENTS AND NON DIABETICS AND ITS CORRELATION WITH GLYCEMIC STATUS

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Abstract: Diabetes mellitus (DM) is a heterogeneous group of metabolic disorders characterized by chronic hyperglycemia. Diabetes mellitus is the major healthcare problem worldwide. The metabolism of several minerals has been reported to alter in diabetes mellitus and these elements might have specific roles in the pathogenesis and progress of this disease. Of these minerals magnesium is the important one. Magnesium is a cofactor in phosphorylation of glucose, and it helps in carbohydrate metabolism. Hypomagnesaemia is a common feature in patients with type 2 DM and has been proposed as a risk factor for type 2 DM. Studies on this parameter have been done in many other countries but very few in India. Hence a study was conducted to estimate and compare the levels of serum magnesium in newly diagnosed uncomplicated type 2 DM patients and healthy controls. A case control study was conducted on 79 patients with clinically diagnosed type 2 DM and age and sex matched 79 apparently healthy subjects as controls from the general population. Blood samples were analyzed to estimate fasting blood sugar (FBS), postprandial blood sugar (PPBS), serum magnesium and glycated hemoglobin (HbA1c) levels in both cases and controls. The data was analyzed and expressed in terms of mean ± SD. Pearson correlation was performed to establish the relationship between the study variables. There was a statistically significant decreased level of serum magnesium ($p < 0.0001$) in cases. There was a highly significant negative correlation between serum magnesium and HbA_1c.

Key Words: Fasting blood sugar; HbA_1c; Post prandial blood sugar; Serum Magnesium; Type 2 DM

INTRODUCTION

Type 2 diabetes mellitus (Type 2 DM) represents a significant global health problem. The prevalence of known diabetes in adults is found to be 2-3% in rural and 4-11.6% in urban dwellers.[1] Type 2 DM may remain in subclinical form for years before diagnosis, which is of great concern for health care providers. Type 2 diabetes mellitus is on track to become one of the major global public health challenges of the 21st century. It accounts for approximately 90 to 95% of all diagnosed cases of diabetes[2]. Globally, the number of people with diabetes is expected to rise from an estimate of 285 million in 2010 to 438 million in 2030.[3]

Direct association of elements in diabetes mellitus has been observed in many research studies. The metabolism of several minerals has been reported to alter in diabetes mellitus and these elements might have specific roles in the pathogenesis and progress of this disease. Of these minerals magnesium is the important one. Magnesium is the fourth most abundant cation in the body and second in the intracellular environment. It takes part in more than 300 enzymatic reactions. Magnesium is a cofactor in phosphorylation of glucose, and it helps in carbohydrate metabolism.[4] Deficiency of magnesium has been associated with wide variety of clinical conditions, including diabetes mellitus. Hypomagnesaemia is a common feature in patients with type 2 DM and has been proposed as a risk factor for type 2 DM. Hypomagnesaemia may have negative impact on glucose homeostasis and insulin sensitivity in diabetes mellitus patients. Further, magnesium deficiency has been proposed as a novel factor implicated in the pathogenesis of late diabetic complications.[5,6]

Studies on this parameter have been done in many other countries but a very few in India. Hence, a study on this parameter is essential in clinically diagnosed type 2 DM patients to show its role in pathogenesis, to ascertain its role as biochemical marker of type 2 DM and to show the correlation of levels of magnesium with glycemic status.

MATERIALS AND METHODS

It is a case control study. 79 clinically diagnosed and confirmed cases of Type 2 DM without any complications attending the medicine outpatient department, SNMC and HSK hospital, Navanagar, Bagalkot were taken as cases. 79 age and sex matched healthy subjects as controls. Study duration was from January 2012 to July 2013. Ethical clearance was obtained from the institute's ethical clearance committee. Informed consent was taken from the subjects. Patients were diagnosed as Type 2 DM on the basis of Clinical history and WHO criteria. Age group between 30 years to 70 years was included in the study. Patients of diabetes having complications, Pregnant and lactating women, subjects currently

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taking nutritional supplements, magnesium containing laxatives, diuretics/alcohol were excluded in both groups. A sample of 3 ml venous blood was collected in both fasting and post prandial state. FBS and PPBS were estimated by using Glucose oxidase peroxidase method[7]. Serum magnesium was estimated by Xylidyl Blue method[8,9]. Estimations were done using semi auto analyser Stat Fax 3300. Glycated hemoglobin was estimated using Nycocard Reader II.[9] Data was analyzed by statistical tests by using SPSS package version number 19 Inc, Chicago, IL. Data was expressed in terms of mean ± SD. Chi- square test was applied to estimate the difference between the two groups of population. Unpaired 't'-test was used to study the changes in serum magnesium levels. Pearson correlation between the study variables is performed to establish the relationship. P value <0.05 was considered significant.

RESULTS

This was a comparative case control study conducted on 79 patients with clinically diagnosed type 2 diabetes mellitus and 79 healthy controls. Serum magnesium was estimated, analyzed and correlated with HbA_1c. The results are expressed as mean ± standard deviation.

Table 1: Age distribution of cases and controls

Age		Group		Total
		Cases	Control	
Age (Binned)	<= 30	0	1	1
	31 - 40	14	13	27
	41 - 50	17	19	36
	51 - 60	26	26	52
	61+	22	20	42
Total		79	79	158

The age distribution of cases and controls is depicted in **Table 1.** The mean age (in years) of 79 cases was 52.8 ± 10.3 and that of 79 controls was 51.65 ± 10.8 (p = 0.48) and was statistically non-significant.

Table 2: gender distribution of cases and controls

Age		Group		Total
		Cases	Control	
sex	male	51	52	103
	female	28	27	55
Total		79	79	158

Out of 79 cases, 51 (64%) were males and 28 (35%) were females. Out of 79 controls 52 (65%) were males and 27 (34%) were females and it was not significant. (p = 0.95) (Table 2)

Table 3: Comparison of serum magnesium levels between cases and controls

Groups	Serum magnesium(mg/dl)	
	Range	Mean±SD
Cases	1.5	2.0±0.41
Controls	2.1	2.6±0.47
t*	8.8	
P	<0.0001 HS	

*unpaired t test, HS- highly significant

The mean serum magnesium (mg/dL) in cases and controls were 2.0 ± 0.41 and 2.6 ± 0.47 and was highly significant. (p < 0.0001) (Table 3 and Figure 1)

Table 4: A comparison of FBS, PPBS and HbA_1c between two groups.

Study variables	Cases	Controls	p value
FBG(mg/dl)	164.5±40	84.1±13.7	<0.0001
PPBG(mg/dl)	215.5±46.2	138.4±48.2	<0.0001
HbA_1C(%)	6.7±0.64	5.2±0.52	<0.0001

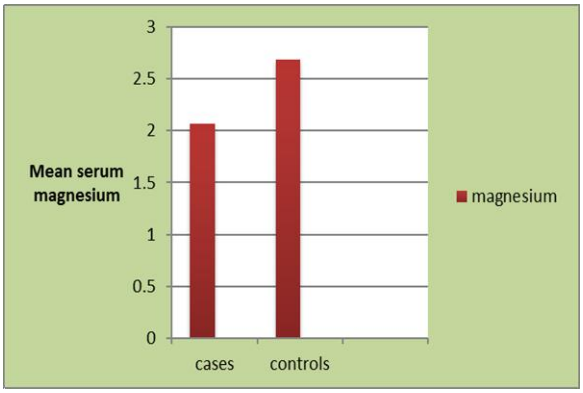

Figure 1: Serum magnesium levels in cases and controls

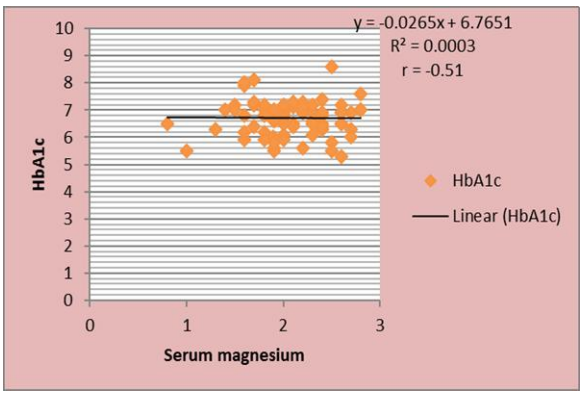

Figure 2: Correlation of serum magnesium with HbA_1c in cases.

Serum magnesium and HbA_1c: There was negative correlation between serum magnesium and HbA_1c. r = -0.51, p < 0.0001 and was highly significant. (Figure 2)

DISCUSSION

Diabetes mellitus is a complex and multifactorial disease indulging severe insulin dysfunction in conjunction with gross abnormalities

in glucose homeostasis, lipid and protein metabolism. Many trace elements are important for human metabolic function. Numerous studies have demonstrated the essential roles of elements such as magnesium carbohydrate metabolism[10]. In view of this, the present study had been taken up to assess clinical utility of promising biochemical marker like serum magnesium which is inexpensive and can be of some diagnostic and prognostic significance.

In this case control study, we have compared the above biochemical parameter in 79 cases with type 2 diabetes mellitus and 79 apparently healthy age and sex matched normal controls. The significance of the parameter between the two groups and its correlation with HbA_1c is analyzed and discussed.

In our study the mean FBS (mg/dL) values were 164.5±40 and 84.1±13.7 in cases and in controls respectively which is statistically highly significant ($p < 0.0001$). FBS values were higher than the cut off value of 110mg/dL in cases which correlated well with the clinical diagnosis. Similarly the mean PPBS (mg/dL) values were 215.5±46.2 in cases and 138.4±48.2 in controls. This increase in mean value of PPBS in cases as compared to controls is statistically highly significant ($p < 0.0001$). PPBS values were higher than the cut off value of 200mg/dL in cases which correlated well with the clinical diagnosis.

In our study the mean HbA_1c values were 6.7± 0.64 in cases and 5.2±0.52 in controls which is statistically highly significant ($p < 0.0001$). In cases HbA1c values were higher which correlated well with the clinical diagnosis

Serum Magnesium: In our study there were statistically decreased levels of serum magnesium in cases ($p < 0.0001$). Similar results were obtained by many other studies[11,12,13,14,15,16]. They all found a significant fall of serum magnesium in patients of diabetes. According to the study by Syed M. Farid[4], Saudi Arabia, osmotic diuresis is the cause for magnesium loss. It is believed that glycosuria that accompanies the diabetic state impairs renal tubular reabsorption of magnesium from glomerular filtrate. In contrast to these results, Naila masood *et al.,* [10] study showed, no significant difference between serum magnesium levels between both cases and control groups.

In the current study, we found highly significant negative correlation between serum magnesium and HbA_1c levels ($r = -0.51$, $p<0.0001$). This result is supported by previous studies[6,17] who found significantly elevated HbA_1c levels and serum magnesium. However, in contrast to our study, Monika K. Wälti (2003)[18] stated that plasma magnesium was not correlated with glycaemic control as measured by HbA_1c.

CONCLUSION

Following conclusions can be drawn from the present study. The study was undertaken to estimate serum magnesium and glycated haemoglobin levels and to assess the correlation of serum magnesium levels with glycemic Control in cases. There was a statistically significant increase in Levels of FBS, PPBS, and HbA1c in cases compared to controls. Correlation study revealed a large negative correlation between serum magnesium levels and HbA1c in diabetic patients.

Serum magnesium levels were significantly reduced in type 2 DM patients. Thus Hypomagnesaemia is a factor in type 2DM leading to various complications. Magnesium depletion reduces insulin sensitivity and secretion and may increase risk of secondary complications. It may be advisable in clinical practice to periodically monitor serum magnesium concentrations in diabetic patients. If serum magnesium is low, an intervention to increase dietary intakes of magnesium may be advisable so as to prevent the future complications.

Further studies on a larger sample are needed to substantiate our findings before firm conclusion can be drawn on the utility of this parameter for the diagnostic assessment of type 2DM.

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REFERENCES

1. Park K, Epidemiology of chronic non communicable diseases, 21st Edition, Bhanot Publishers, 2011, 362.

2. Colin Dayan, Gareth Williams. Disorders of glucose homeostasis. In: David A. Warrell, Timothy M. Cox, Jhon D. Firth editors. Oxford Textbook of Medicine, 5th edition, New York, Oxford, 2010, pg. 2003.

3. John B Buse, Kenneth S Polonsky, Charles F Brunnet. Type 2 diabetes mellitus. In: Kronenberg, Melmed, Polonsky, Larsen editors. Williams Textbook of Endocrinology, 12th edition, Philadelphia, Saunders Elsevier, 2011, pg. 1371-73.

4. Farid SM, Abulfaraj TG. Trace mineral status related to levels of glycated haemoglobin of type 2 diabetic subjects in Jeddah, Saudi Arabia. Medical Journal of Islamic World Academy of Sciences, 2013, 21(2), 47-56.

5. Xu J, Xu W, Yao H, Sun W, Zhou Q, *et al.,* Associations of Serum and Urinary Magnesium with the Pre-Diabetes, Diabetes and Diabetic Complications in the Chinese Northeast Population, PLoS ONE, 2013, 8(2), e56750.

6. Seyoum B, Siraj ES, Saenz C, Abdulkadir J. Hypomagnesemia in Ethiopians with diabetes mellitus. Ethnicity & Disease, 2008, 18, Spring.

7. Lott JA and Turner K. Evaluation of Trinder's Glucose Oxidase Method for Measuring Glucose in Serum and Urine. Clin. Chem, 1975, 21(12), 1754-60.

8. Baginski ES, Marie SS, Karcher RE, Zak B. Selected methods of Clinical Chemistry, 1982, 9:277.

9. Burtis A, Ashwood R, Bruns E, editors. Estimation method for magnesium. Teitz textbook of clinical chemistry and molecular diagnostics, 5th edition, New Delhi, 2012, p 1751-1755.

10. Masood Naila, Baloch Ghulam Hussain, Ghori Rafi Ahmed, Memon Iqbal Ahmed, Anwar Muhammad and Memon Muhmmad Sadik. Serum Zinc and Magnesium in Type 2 Diabetic patients. J Coll Physicians Surg Pak., 2009; 19(8), 483-486.

11. Lecube A, Baena-Fustegueras JA, Fort JM, Pelegrı´D, Herna´ndez C, *et al.,* Diabetes Is the Main Factor Accounting for Hypomagnesemia in Obese Subjects. PLoS ONE, 2012, 7(1), e30599.

12. Badyal A, Sodhi KS, Pandey R, Singh J. Serum Magnesium Levels: A Key Issue for Diabetes Mellitus, JK SCIENCE, 2011, Vol. 13(3).

13. Seyoum B, Siraj ES, Saenz C, Abdulkadir J. Hypomagnesemia in ethiopians with diabetes mellitus. Ethnicity & Disease 2008; Volume 18, Spring.

14. Chambers EC, Heshka S, Gallagher D, Wang J, Pi-Sunyer FX, Pierson RN. Serum Magnesium and Type-2 Diabetes in African Americans and Hispanics: A New York Cohort. Journal of the American College of Nutrition, 2006; Vol. 25(6), 509–13.

15. Ankush RD, Suryakar AN and Ankush NR. Hypomagnesaemia in type-2 diabetes mellitus patients. A study on the status of oxidative and nitrosative stress. Indian Journal of Clinical Biochemistry, 2009, 24 (2), 184-9.

16. Anjum A, Yousaf M, Zuber M, Ahmad HB, Zahoor AF. Comparative study on calcium, magnesium and cobalt in diabetic and non-diabetic patients (males) in Punjab, Pakistan. AJB, 2012, 11 (28), 7258-62.

17. Shaikh MK, Devrajani BR, Soomro AA, Ali Shah SZ, Devrajani T and Das T. Hypomagnesemia in Patients with Diabetes mellitus. World Applied Sciences Journal, 2011, 12 (10), 1803-6.

18. Monika K. Wälti, Michael B. Zimmermann, Giatgen A. Spinas, Richard F. Hurrell. Low plasma magnesium in type 2 diabetes. Swiss Med Wkly, 2003, 133, 289–92.

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