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Research Article

A Cross Sectional Study of Fasting Serum Magnesium Levels in the Patients with Type 2 Diabetes Mellitus and Its Relation to Diabetic Complications

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Abstract: The objective of the study was to estimate fasting serum magnesium concentration in patients with type 2 DM and correlating serum magnesium concentration with micro and macro vascular complication of type 2 DM.100 type 2 diabetes mellitus patients admitted in Navodaya Medical Collage Hospital, Raichur over the period of one year between 1stJanuary 2011 to 31st December 2011, were selected for this study. Detailed history, general physical examination, systemic examination, and various investigations like FBS, PPBS,HbA1C,Blood urea, serum creatinine and urine examination were carried out. Serum magnesium was estimated by Calmagite dye method. ECG findings were recorded. Retinopathy was assessed by direct opthalmoscopy. Hypomagnesemia was found in 35 patients. Observations revealed a significant co-relations between hypomagnesium and diabetic retinopathy (chisquare=9.672,P=0.0019,DF=1)prevalence of hypomagnesemia in diabetic with complications was significantly higher compared to diabetic with no complications (47.36%vs18.60%)(chi-square=7.69, P=0.005 DF=1).Higher prevalence of HbA1C >7% (40.30%vs 24.25%)but the result were not statistically significant for P value <0.05.Prevalence of hypomagnesemia in type 2 diabetic was 35%. Prevalence of hypomagnesemia was significantly higher in diabetic with microvascular complications compared to diabetic s with no microvascular complications. Prevalence of hypomagnesium was significantly higher in patients with retinopathy .Prevalence of hypomagnesemia was higher in patients with FBS>130 and HbA1C >7 .No significant associations existed between serum magnesium concentrations and other factors like age, sex, durations of diabetes, mode of treatment,diabetic neuropathy, ischemic heart disease and hypertension.
Keywords: Fasting serum magnesium, Type 2 diabetis, Calmagite dye method, Hypomagnesemia, Retinopathy

INTRODUCTION

Diabetes mellitus is a heterogeneous group of metabolic disorders characterized by chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolism resulting from defects in Insulin secretion, insulin action or both the effect of diabetes mellitus include long term damage, dysfunction and failure of various organs, eyes, kidneys, nerves and heart and blood vessels [1]. Several distinct types of DM are caused by complex interaction of genetics and environmental factors. Depending on etiology of the DM factors contributing to hyperglycemia include reduced insulin secretion, decreased glucose utilization, and increased glucose production [2]. Several vitamins a minerals act as a cofactors an enzyme reaction regulated by insulin deficiencies of certain vitamin and minerals such as vitamin E, potassium, magnesium zinc and chromium may aggravate carbohydrate intolerance out of all these, it is relatively easy to detect potassium or magnesium concentrations in serum and to replace them based on their low serum levels [3].

Magnesium is an essential element and has a fundamental role in carbohydrate metabolism in general and in Insulin action in particular. Magnesium is a cofactor in both glucose transport mechanism of the cell membranes and for various intracellular enzymes involved in the carbohydrate oxidation. The concentration of magnesium in serum of healthy people is constant were as 25 to 39% people of diabetic has low concentrations of serum magnesium. Magnesium depletion has a negative impact on glucose homeostasis and insulin sensitivity in patients with type 2diabetes as well as on the evolution of complications such as retinopathy, arterial atherosclerosis and nephropathy [4]. Moreover a low serum magnesium level is strong, independent predictor of development with type 2 diabetic.

The present study is undertaken with an aim to estimate prevalence of hypomagnesemia in patients with type 2 diabetic and to correlate the serum magnesium concentrations with micro and macro vascular complication of diabetes i.e retinopathy, nephropathy, neuropathy and ischemic heart disease as the prevalence of DM is more in India and even Raichur district is no exception to this fact, this study is done for the assessment of serum magnesium levels in patients suffering from type 2 DM with and without complications, as magnesium has got fundamental role in carbohydrate metabolism and insulin action

MATERIALS AND METHODS

100 randomly selected patients with type 2 DM either on oral hypoglycemic agents or insulin treatment admitted in Navodhya Medical College and Hospital and Research Center, Raichur constituted the study population. Patients with renal failure, acute MI, patients of diuretics, aminoglycosides and other drugs causing magnesium supplements and magnesium containing antacids, pregnant and lactating women were excluded. Detailed history was obtained followed by general physical and systemic examination. ECG findings were recorded. Retinopathy was assessed by direct ophthalmoscopy. Blood samples were collected for measurement of fasting blood glucose and serum magnesium. Post prandial blood sugar was measured 2 hours after standard meal. Blood urea, serum creatinine and 24 hrs urinary albumin were estimated. Serum magnesium was estimated by calmagite dye method. HBA1C estimated was carried out by modified calorimetric method.

Statistical method

Statistical method analysis was done using Chi-square test and Fischer's exact test to compare proportions. Statistical results were considered significant at P value< 0.05.

RESULTS

100 patients with type 2 diabetes(69 men,31 women) comprised the study group . this patients were further grouped with regards to their age, duration of diabetes, mode of diabetic treatment, glycemic control, presence/absence of comorbidities (ischemic heart disease and hypertension) and presence/absence of diabetic complications (diabetic retinopathy, diabetic neuropathy, diabetic neuropathy) hypoglycemia (defined as fasting serum magnesium concentration >1.7 mg/dl) was found in 35 patients. No significant difference was found in rate of hypomagnesemia in men and women (31.88% and 41.99%respectively). The duration of diabetes did not significantly predict serum magnesium concentration. A higher prevalence of hypomagnesemia was observed in patients treated with insulin. However, the difference was statistically insignificant. (CHI-SQUARE value of 0.0004 and P value of 0.9822 at degree of freedom 1)

Table 1: Characteristics of study population

Characteristics	
No. of Subjects	100
Age (Years)	58.67 (40 - 76)
Men	69
Women	31
Duration Of Diabetes (Years)	6.89 (0 - 26)
Medication	
Insulin	07
Oral Hypoglycemics	67
Insulin And Oral Hypoglycemics	26
Co morbidities	
Hypertension	34
Ischemic Heart Disease	15
Diabetic Retinopathy	38
NPDR	32
PDR	06
Diabetic Neuropathy	15
Diabetic Nephropathy	19
Microalbuminuria	16
Macroalbuminuria	03
Poor Glycemic Control (HbAlC> 7%)	67

Poor glycemic control according to the treatment goals for adults with diabetes patients HBA1C < 7% and FBS should be between 70/130 mg/dl, to say that the patient is having good glycemic control.

Serum magnesium concentration showed no significant correlation with poor glycemic control i.e HbA1C should be < 7% and FBS >130mg/dl, through a higher prevalence of hypomagnesemia was found in patients having poor glycemic control. Results for HbA1C were (40.30% vs 24.25%)(Chi-square valve =1.849, P=0.174, DF = 1). Result foe FDS were (50% vs 29.3%)(chi-square=3.297, p=0.069, TF=1). Patients with diabetic retinopathy had aa significantly higher prevalence of hypomagnesemia compared to without retinopathy (55.26% vs 22.58%).The difference was statistically significant (Chi- square value = 9.672 and P value 0.0019 (< 0.05) at degree of freedom 1) (Table 2). The difference in prevalence rates of hypomagnesemia in patients with nephropathy and without nephropathy had no statistical significance (Chi-square value = 0.0064, P = 0.936, DF=1). A marginally higher prevalence of hypomagnesemia was noted in patients with neuropathy(40.0% vs 34.12%). However the difference was not statistically significant (Chi- square value = 0.0215, P = 0.88, DF=1). There was no significant correlation seen between hypomagnesemia and IHD. (Chi-square value = 0.194 and P = 0.6597 at DF of 1.) There was no significant correlation seen between hypomagnesemia and hypertension. (Chi-square value = 0.384 and P = 0.535 at DF of 1.) Prevalence of hypomagnesemia in diabetics with complications was significantly higher compared to diabetics with no complications (47.36% versus 18.60%). The difference was statistically significant (Chi-square value is 7.69 and P value 0.005 at DF of 1) (Table 3).

Table 2: Prevalence of hypomagnesemia and diabetic retinopathy

Retinopathy		**No. of Patients**	**Hypomagnesemia**(%)	**Normomagnesemia**(%)
Retinopathy	NPDR	32	18 (56.25)	14 (43.75)
	PDR	06	03 (50.00)	03 (50.00)
	TOTAL	38	21 (55.26)	17 (44.73)
No Retinopathy		62	14 (22.58)	48 (77.41)

NPDR - Non proliferative diabetic retinopathy, PDR- Proliferative diabetic retinopathy

Table 3: Prevalence of hypomagnesemia and diabetic complications

Complications	**No. of Patients**	**Hypomagnesemia**(%)	**Normomagnesemia**(%)
Only Retinopathy	24	16 (66.66)	08 (33.34)
Retinopathy& Neuropathy	07	04 (57.14)	03 (42.86)
Retinopathy & Nephropathy	07	01 (14.28)	06 (85.72)
All Three Complications	00	00 (00.00)	00 (00.00)
Diabetics &Complications	57	27 (47.36)	30 (52.64)
No Complications	43	08 (18.60)	35 (81.40)

DISCUSSION

Magnesium is mainly an intracellular cation, with less than 2% of total body content present in the extracellular fluids [5]. Nevertheless, serum magnesium concentration though less sensitive, is a highly specific indicator of low magnesium status. In addition, serum magnesium measurement is the most readily available and widely used test for determination of magnesium status [6, 7].

Magnesium is a cofactor in both glucose transporting mechanisms of cell membrane andvarious enzymes important in carbohydrate oxidation. Nadler *et al*. have reported that insulin sensitivity decreases even in nondiabetic individuals after induction of magnesium deficiency. Likewise elderly subjects were shown to have improved glucose tolerance when received magnesium supplements[7].

Magnesium deficiency has been reported in the previous studies in patients with type 2diabetes. However, some workers have also reported normal and even high levels [8]. In the present study, serum magnesium concentrations of 35 patients with type 2 diabetes were below the reference range. This confirms to the reported prevalence of low plasma magnesium status in type 2 diabetics in several studies, which ranged from 25 to 39%.

The reasons for the high prevalence of magnesium deficiency in diabetes are not clear, but may include increased urinary loss, lower dietary intake, or impaired absorption of magnesium compared to healthy individuals [9]. Several studies have reported increased urinarymagnesium excretion in type 2 diabetes [10]. A specific tubular defect in magnesium reabsorption in thick ascending loop of Henle is postulated [11].

Insulin treated diabetics have significantly lower serummagnesium levels compared to non-insulin treated ones [14]. In the present study prevalence ofhypomagnesemia in insulin treated diabetics was higher than in noninsulin treated (36.36%v/s 34.33%). Redistribution of magnesium from plasma in to red blood cells is caused byinsulin.

In a study Alzaida*et al*. [12] have found that cellular uptake of magnesium is normally stimulated by insulin. So insulin treatment may enhance cellular magnesium uptake and result in increased prevalence of hypomagnesemia. Serum levels of magnesium have been found by several investigators to correlate inversely with fasting blood glucoseconcentration and the percentage of HbAlC. The present study revealed that a higher prevalence of hypomagnesemia was found in patients having HbAlC> 7% and FBS > 130mg/dl.

Hypomagnesemia has been reported in patients with diabetic retinopathy, with lowermagnesium levels predicting a greater risk of severe diabetic retinopathy [13]. Present study also revealed a significant difference in prevalence of hypomagnesemia in diabetics with retinopathy and without retinopathy [55.26% vs 22.58% ; with P value 0.0019 (<0.05).

Grafton *et al*. [4] have proposed the inositol transport theory to explain this association. But the exact reason remains obscure.

Magnesium depletion is also found to play a role in the pathogenesis of diabetic polyneuropathy. But in the present study no significant association was found between prevalence of hypomagnesemia and diabetic neuropathy.

In summary, the present study has demonstrated that hypomagnesemia is common in type 2 diabetics. Prevalence of hypomagnesemia is significantly higher in diabetics with microvascular complications compared to diabetics with no microvascular complications. Magnesium deficiency is conclusively associated with diabetic retinopathy.

So it may be prudent in clinical practice to periodically monitor plasma magnesium concentrations in diabetic patients. If plasma magnesium is low, an intervention to increase dietary intakes of magnesium may be beneficial. Various food sources of magnesium are: Almonds - 315, Cashews - 260, Peanuts - 175, Shredded Wheat -110 (Magnesium content in mg/l00gm). Also several preparations are available that can be given as oral replacement like: Slow Mag (magnesium chloride), Magonate (magnesium gluconate), MagOx400 (magnesium oxide). However, the role of magnesium supplements remains to be evaluated.

CONCLUSION

Prevalence of hypomagnesemia in type 2 diabetics is 35%. Prevalence of hypomagnesemia is significantly higher in diabetics with microvascular complications compared to diabetics with no microvascular complications. Prevalence of hypomagnesemia is significantly higher in patients with diabetic retinopathy. Prevalence of hypomagnesemia is higher in patients with poor glycemic control i.e FBS > 130 mg/dl and HbAlC> 7% but the results are statistically not significant. No significant association exists between serum magnesium concentrations and other factors like age, sex, duration of diabetes, mode of diabetic treatment, nephropathy, neuropathy, ischemic heart disease and hypertension.

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