

Level of Serum Magnesium in Sudanese Type 1 and Type 2 Diabetes Mellitus PatientsHajir Taj Elsir Hamd¹, Abdelmula Mohamed Abdalla²¹Department of clinical Chemistry, Faculty of Medical Lab Sciences, Alneelain University, Khartoum, Sudan.²Department of Clinical Chemistry, Faculty of Medical Lab Sciences, Alneelain University, Khartoum, Sudan.**Correspondence Author: Abdelmula Mohamed Abdalla**, Department of Clinical Chemistry, Faculty of Medical Lab Sciences, Alneelain University, Khartoum, Sudan.**Conflicts of Interest:** Nil**Abstract**

Background: Magnesium (Mg) is the fourth most abundant cation in the human body and is a critical cofactor in many enzymatic reactions. It plays an important role in many fundamental biological processes. It appears to play an important role in glucose metabolism and insulin homeostasis. The role of Mg in causing diabetes mellitus was investigated by several previous studies, However, to our knowledge, little research has addressed the relationship between serum magnesium levels and diabetes mellitus.

Objectives : to evaluate the status of serum Mg in Sudanese patients with type 1 & 2 diabetes mellitus , and assessing its relationship to age and duration of diabetes mellitus.

Materials and Method: This case control hospital based study was performed at diabetic center in Khartoum state, hundred blood samples were collected from males and females Sudanese patients with diabetes mellitus(50 type1 and 50 type 2 diabetic patients).In addition to 50 healthy individuals as control group for type1 and other 50 healthy individuals as control group for type 2 , the two control groups were age and sex matched with their corresponding test groups, for the comparison of serum magnesium level . The level of magnesium in the study and control groups were estimated by enzymatic method with the aid of the spectrophotometer Janwey 300.

Results: the study result showed significant decrease in serum magnesium in both type 1 and type 2 diabetes mellitus case group when compared with corresponding control groups (1.23 ± 0.25 versus 1.27 ± 0.23 mg/dl. $P \pm 0.001$, 1.17 ± 0.19 versus, 1.20 ± 0.21 .mg/dl . $p \pm 0.01$ respectively)..Based on gender the study shows insignificant difference in mean serum magnesium level between male when compared with female in both type 1 and type 2 diabetic patients (1.24 ± 0.21 versus 1.22 ± 0.22 mg/dl. $P = 0.71$, 1.23 ± 0.21 versus 1.17 ± 0.17 mg/dl. $P = 0.72$ respectively). Also the study recorded significant negative association between serum magnesium level with both the age and duration in both type 1 & 2 Diabetes Mellitus, ($p \leq 0.05$).

Conclusions: serum magnesium is deficient in type 1 and type 2 diabetic patients. This deficiency may be related to disease control and/or complications. Supplementation of diabetic patients with magnesium may help in control of the disease and its complications

.Keywords: Type 1 diabetes mellitus, Magnesium, Sudanese patients ,Type 2 diabetes mellitus.

1. Introduction

Diabetes mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycemia(1). Several distinct types of DM exist and are caused by a complex interaction of genetics and environmental factors. Depending on the etiology of the

DM, factors contributing to hyperglycemia include reduced insulin secretion, decreased glucose utilization, and increased glucose production.(1) The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multiple organ systems that impose a tremendous burden on the individual with diabetes and on the health care system.

The incidence of diabetes is increasing globally day by day that lead to increase risk of mortality or morbidity on mankind worldwide. 1, 2 ,3).

Magnesium is the fourth most abundant cation in the body. Approximately 55% of the total body magnesium is in skeleton and 45% is intracellular where it is the most prevalent cation(4,1) .Magnesium in addition to being a structural body component. It play important role as a co-factor for enzymatic reactions ,energy metabolism and production, insulin secretion, binding and activity also cellular proliferation and apoptosis.(5,2,4).

Hypomagnesaemia, is low serum magnesium concentrations which effect glucose homeostasis and insulin sensitivity in patients with diabetes mellitus especially who had complication also Magnesium depletion may lead to development of thrombosis and diabetic retinopathy [6,7,3,5).

Most of the research were focused to study the complications of diabetes mellitus on the kidney ,heart, vascular .Despite the large literature on the role of dietary composition in causing and management of diabetes mellitus, there are relatively few studies on the effect of diabetes mellitus on magnesium status of the individual, as most of the published studies focused on the management of diabetes mellitus complications, and very few studies with conflicting results discussed the effect of the disease on the magnesium status (7.8).

The aim of this study is to evaluate the serum status in magnesium Sudanese diabetes mellitus patients. All participants in this study were carefully selected following a very restrict inclusion and exclusion criteria

2. Materials and Methods

A descriptive case control hospital base study included 200 participants, , hundred Sudanese patients with diabetes mellitus(50 type1 and 50 type 2 diabetic patients).In addition to 50 healthy individuals as control group for type1 and other 50 healthy individuals as control group for type 2 , the control groups were apparently healthy individuals age and sex matched with their corresponding test groups. The study was approved by the ethical committee of faculty of medical laboratory sciences – Alneelain University. An informed verbal consent was obtained from each participant prior to specimen collection. All participants were randomly recruited from diabetic centers after a primary random glucose test and HbA1C estimation. Individuals were assign test or control groups based on the following criteria for diabetes; HbA1C above 6.5%, random blood glucose ≥ 200 mg/dl, fasting blood glucose ≥ 140 mg/dl, while assigning patients to type 1 and type 2 based on the age of disease onset. Individuals were excluded from the study if they suffered from any acute or chronic illness, under medications that affect magnesium homeostasis. Two specimens were drawn from all participants, 3 ml each, were collected in two different containers, fluoride oxalate for glucose estimation, and plain containers for serum preparation for magnesium estimation. Plasma glucose was measured using the glucose oxidase method , described by Barham and Trinder, using commercially available kits from Biosystems (Spain), HbA1c measured by [HPLC-high performance liquid chromatography-Biorad Variant II Turbo (Biorad Medical Diagnostics, California, USA)], while the magnesium level was

measured using by spectrophotometer end point methods with ksilidil blue (Roche Diagnostics GmbH, Mannheim, Germany) .

Quality control

Sample representing the normal and pathological level of serum magnesium, was used for assessment of the quality control .Result $\pm 2SD$ of the target values of the control sera were accepted.

Statistical analysis

The collected data were coded, tabulated, and statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 20.Descriptive statistics were done for numerical data by mean, standard deviation, and minimum& maximum of the range. Analytical analysis was done for quantitative variables using t-test in cases of two groups with parametric data and the mean difference is significant at $p \leq 0.05$, while correlations were done using Spearman Correlation and is considered to be statistically significant at $P \leq 0.05$.

3. Results

The study population comprised of 200 individual in Khartoum state 100 test subject ,50 with non Insulin dependent diabetes mellitus (25 females and 25 males) with age range from 35-75years and duration from 1-43 years, and 50 with Insulin dependent diabetes mellitus (25 females ,and 25 males),with age range from 6-26 years and duration from 1-10 years ,In addition to 50 healthy volunteers as control group for type 1 and other 50 healthy volunteers as control group for type 2 , the two controls groups were age and sex matched with their corresponding test croups.

As illustrated in figure 1,2, and table 1, 2 & 3 ,there is significant decrease in serum magnesium in both type 1 and type 2 diabetes mellitus case group when compared with corresponding control groups (1.23 \pm 0.25 versus

1.27 \pm 0.23mg/dl. $P \leq 0.001$, 1.17 \pm 0.19 versus, 1.20 \pm 0.21 .mg/dl . $p \leq 0.01$ respectively).

Table 3 shows mean of serum magnesium level of the study groups according to gender, there is insignificant difference in serum magnesium level between male when compared with female in both type 1 and type 2 diabetic patients (1.24 \pm 0.21 versus 1.22 \pm 0.22 mg/dl. $P = 0.71$, 1.23 \pm 0.21 versus 1.17 \pm 0.17 mg/dl. $P = 0.72$ respectively) .

As presented in table (4) there is significance negative correlation between serum magnesium with both the age and duration in both type 1 & 2 Diabetes Mellitus,($p \leq 0.05$).

Figure .1 Show the mean of serum magnesium level in patients with type1 diabetes mellitus with their control.

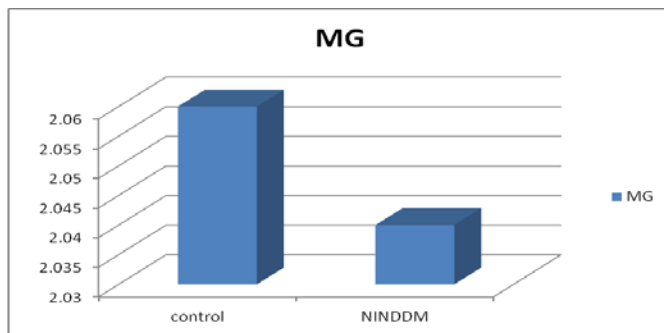


Figure: Show the mean of serum magnesium level in patients with type 1 diabetes mellitus with their control.

Table (1) Descriptive statistic of magnesium level in type1 & type 2 diabetic patients with their control

Groups	N	Mean \pm SD mg/dl	Minimum	Maximum
DM type1	50	1.23 \pm 0.25	0.44	2.036
Control group	50	1.27 \pm 0.23	0.46	2.058
DM type 2	50	1.17 \pm 0.19	0.30	2.043
Control group	50	1.20 \pm 0.21	0.35	2.055

Table (2). Comparisons of magnesium level in type 1 and type 2 diabetic patients with their

controls

Groups	Mean difference	P value
Type1 + control	0.04***	0.001
Type 2 + control	0.03**	0.01

*The mean difference is significant at the $p \leq 0.05$

**The mean difference is significant at the $p \leq 0.01$

*** The mean difference is significant at the $p \leq 0.001$

Table (3) Mean of serum magnesium level of the study groups according to gender.

Study groups	Gender	N	Mean \pm SD mg/dl	P value
DM type 1	Male	25	1.24 \pm 0.21	0.71
	Female	25	1.22 \pm 0.22	
DM type 2	Male	25	1.23 \pm 0.21	0.72
	Female	25	1.17 \pm 0.17	

*The mean difference is significant at the $p \leq 0.05$

**The mean difference is significant at the $p \leq 0.01$

***The mean difference is significant at the $p \leq 0.001$

Table (4) Correlation of magnesium level in type 1 and type 2 diabetes mellitus with age and duration of diabetes mellitus.

Parameters	Correlation	Duration	Age
Magnesium level in type 1	Person correlation	-0.04*	-0.03*
	Significant	0.04	0.05
Magnesium level in type 2	Person correlation	0.03*	0.02*
	Significant	0.05	0.05

*The correlation is significant at the $p \leq 0.05$ level

**The correlation is significant at the $p \leq 0.01$ level

***The correlation is significant at the $p \leq 0.001$

4. Discussion

Magnesium is the second predominant component in the intracellular compartment, an important regulator of the cellular processes, co-factor of more than 300 essential metabolic reactions, including the ones that produce or use the MgATP complex [9].The interrelationship between diabetes and various minerals is characterized by a high

degree of reciprocity. Chronic uncontrolled hyperglycemia can cause significant alterations in the status of serum magnesium, and conversely magnesium can directly modulate glucose homeostasis.(10) Hence, any imbalance of essential nutrients like serum magnesium can significantly play a role in the pathobiology of the diabetes mellitus. In the present study, as regards serum magnesium in patients with type 1 & 2 diabetes showed significantly lower levels than controls ($P \leq 0.001$, $p \leq 0.01$ respectively). These findings are consistent with Maher M et al (2002)(11) in Egypt ,whom studied serum magnesium level in children with type 1 diabetes mellitus they found serum and plasma magnesium to be lower in diabetic patients than in controls. Magnesium levels may decrease due to urinary loss by osmotic action, glucosuria and hyperglycemia. Asmaa MN, et al (2016) (12),Jain and his colleagues,(13) in 1976, showed that hypomagnesemia is common among adolescent with type 1 diabetes and is due to glucosuria causing excessive urinary loss of magnesium. Also, Isbir et al.,(14) in 1994, reported that insulin dependent diabetic patients showed significantly lower magnesium levels than controls ($P < 0.01$). Pham PC et al (2005) (15) and Farid SM (2013)(16) ,(15.16) evaluate the trace mineral status in relation to levels of glycosylated hemoglobin subjects with type 1 diabetes, and explained the hypomagnesaemia that associated with diabetes mellitus by osmotic diuresis which 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. Conversely, insulin deficiency may explain the increased urinary magnesium excretion, because insulin has been recognized to stimulate magnesium conservation in the loop of Henle and distal tubule (16) . Moreover, uncontrolled hyperglycemia and hyperglycemia may

increase magnesium excretion through osmotic diuresis (17,18).

Our study observed significant decrease in serum magnesium level in patients with type 2 diabetes when compared with corresponding reference group ($p \leq 0.01$), which is consistent with the result of the study performed by Rajendra Prasad et al (2016)(19) and Yeluri Seshagiri Rao (2016) (20), whom found significant reduction in serum magnesium levels in diabetics patients with type 2 compared to the controls. Several studies have reported increased urinary magnesium excretion in type 1 and type 2 diabetes. (21,22). 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 is unclear. Insulin treatment has been shown to correct renal magnesium loss in diabetics. Low dietary intake is an unlikely cause of impaired magnesium status in diabetes. A dietary assessment conducted in Europe showed that only 5.4% of the diabetic group and 9.1% of the control group had intakes of magnesium below their individual requirements. In addition, recently it has been shown that type 2 diabetics in reasonable metabolic control absorb dietary magnesium to a similar extent as healthy controls. Increased urinary magnesium excretion due to hyperglycemia and osmotic diuresis may contribute to hypomagnesemia in diabetes.

Based on gender our study observed insignificant difference in serum magnesium level in both type 1 & 2 diabetes mellitus ($p > 0.05$). The level of serum magnesium of males and females showed no difference in all study groups, these findings are in good agreement with the results of study (23) carried out to determine the level of the magnesium in different biological specimens, where the difference on serum Mg based on the gender was

reported to be between the study groups rather than within the same group.

In our study, we detected inverse correlation between serum Mg level and both age and duration of diabetes in both type 1 & 2 diabetes, which agree with the results obtained by Ewald et al., (24) in 1983, found an inverse correlation between serum magnesium levels and duration of diabetes mellitus. This agrees with the study done by Shaikh et al (2011)(25) on type 1 and 2 diabetic patients who detected hypomagnesemia in 36% of patients with 3 to 5 years duration of diabetes versus 71% of patients with 6 to 10 years duration of diabetes and 72% of patients with 11 to 15 years duration of diabetes. This is also consistent with a study on adults with T2DM by Mishra et al (26) that showed a negative correlation between serum Mg level and duration of diabetes ($r = -0.789$).

In contrast the level of magnesium is slightly reduced in patients with type 2 when compared with type 1 diabetes (1.17 ± 0.19 versus 1.23 ± 0.25 respectively). Unlike type 2, DM type 1 is generally insulin dependent and insulin sensitivity not altered, therefore the level of serum magnesium is slightly high in type 1 as compared to type 2. Patients with DM type 2 frequently show diminished insulin sensitivity and relative deficiency of endogenous insulin secretion (27,28) [30, 31] low concentration of insulin in addition to increased glucagon secretion will lead to high rate of hepatic glucose anabolism, thus, elevated fasting blood glucose levels [26] due to increased glucose production in the liver and increased free fatty acids production, this results in hyperglycemia and osmotic diuresis, therefore, increase urine magnesium excretion, as reported previously (29) that patients with DM type 2 show abnormally high urine magnesium levels.

5. Conclusion: Our study demonstrates that serum Mg level is frequently low in Sudanese patients with type

1&2 diabetes, and it is inversely correlated with age and duration of the diabetes mellitus.

6. Reference

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