ORIGINAL ARTICLE

Serum Zinc and Magnesium in Type-2 Diabetic Patients

Naila Masood, Ghulam Hussain Baloch, Rafi Ahmed Ghori, Iqbal Ahmed Memon,
Muhammad Anwar Memon and *Muhammad Sadik Memon

ABSTRACT

Objective: To assess serum zinc and magnesium level in type-2 diabetic patients and the effect of age, gender, glycemic control and duration of diabetes on these trace elements in comparison with those of control subjects.
Study Design: Non-interventional case control study.
Place and Duration of Study: Department of Medicine, Liaquat University of Medical and Health Sciences, Jamshoro, Hyderabad, from October 2007 to March 2008.
Methodology: There were 42 diabetic patients and 42 age matched non-diabetic (control) subjects included in this study. Serum zinc, serum magnesium and fasting blood sugar measured among the diabetic and control groups and association of both trace elements were assessed with glycemic status, age, gender and duration of diabetes using SPSS version 16.0 for analysis.
Results: Serum zinc level was significantly lower (mean 2.03±0.39 mg/dL) in diabetic patients as compared to control subjects (4.84±4.217 mg/dL, p = < 0.001). No significant difference was found in serum magnesium level with mean of 22.67±24.5 mg/dL in diabetic patients as compared to controls (18.3±3.4 mg/dL, p = 0.26).
Conclusion: Serum zinc level was significantly lower in type-2 diabetics, whereas no significant difference was found in serum magnesium level when compared with control subjects. There was no association of age, gender, glycemic status and duration of diabetes on the serum concentration of these trace elements in type-2 diabetic patients.

Key words: *Serum zinc. Serum magnesium. Type-2 diabetes.*

INTRODUCTION

Genetic and environmental factors contribute to the pathogenesis of diabetes and acts as trigger for the disease among subjects at high-risk because of inherited susceptibility.[1] Diabetes is estimated to afflict about 170 million people worldwide[2] and this represents about 2% of the world's population.[2,3]

Speculations on the role of trace elements in human disease were aroused in 1929, when Glaser and Halpern noticed that yeast extracts potentiate the action of insulin.[4] Earlier works of Mertz, *et al.* in 1959 demonstrating the existence of glucose tolerance factor in yeast with the identification of the active component as trivalent chromium sparked off interest on the status of other trace and macro elements in health and diseases including diabetes.[5]

Direct associations of trace macro elements with Diabetes mellitus have been observed in many research studies.[6] Insulin action on reducing blood glucose was reported to be potentiated by some trace elements as chromium, magnesium, vanadium zinc, manganese, molybdenum and selenium.[7] The proposed mechanism of trace elements enhancing insulin action includes activation of insulin receptor sites, serving as cofactors or components for enzyme systems involved in glucose metabolism,[8,9] increasing insulin sensitivity and acting as antioxidants preventing tissue per oxidation.[10] Zinc is required for insulin synthesis and storage and insulin is secreted as zinc crystals, it maintains the structural integrity of insulin.[11] Magnesium is a cofactor in the glucose transporting mechanisms of the cell membrane and various enzymes in carbohydrate oxidation. It is also involved at multiple levels in insulin secretion, binding and enhancing the ability of insulin to activate tyrosine kinase.[12] Magnesium deficiencies have been implicated in insulin resistance, carbohydrate intolerance, dislipidemia and complications of diabetes.[13] Lower serum levels of these elements have been reported in the diabetic state. It is unknown whether difference in trace elements status is a consequence of diabetes and hyperglycemia or alternatively whether their deficiencies contribute to the expression of the disease.

The objective of this study was to determine the serum levels of zinc and magnesium in diabetic patients and control subjects and their association with age, gender, glycemic status and duration of diabetes.

METHODOLOGY

This case control study was carried out at Liaquat University of Medical and Health Sciences, Jamshoro,

Department of Medicine, Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, Sindh.
** Department of Medicine/Gastroenterology, Isra University Hospital, Hyderabad.*

***Correspondence:** Dr. Naila Masood, 312, Block-D, Unit No. 6, Latifabad, Hyderabad.*
E-mail: nailamasood3@yahoo.com

Received June 19, 2008; accepted March 9, 2009.

Hyderabad, from October 2007 to March 2008. Approval from Ethical Committee was obtained prior to the study. Sample size was calculated using statistical formula on 95% confidence interval ±2 error of margin and standard deviation on estimated population of 5000 for 6-month duration.

The subjects were selected by non-probability convenient sampling method. After obtaining well-informed written consent the subjects were recruited for both groups. Patients were known type-2 diabetic for at least past two years. These subjects were of either gender and between the ages of 40-70 years. Age was grouped as less than 45 years and more than 45 years. Duration of diabetes was grouped as less than 5 years, 6-10 years and more than 10 years. Age matched non-diabetic control subjects were selected from healthy workers of University with normal oral glucose tolerance test and no associated disease. Obese or pregnant subjects, subjects with renal complication, hypertension and currently taking nutritional supplements, magnesium containing laxatives, diuretics/alcohol were excluded in both groups. All data were recorded on pre-designed proforma, the data included demographic details, medical and personal history.

After overnight fasting, blood samples were collected via venepuncture. Fasting blood sugar was estimated by Micro lab 300 by kit method. Serum zinc and magnesium were assessed by STHS 12 method A-20 Varing Company. Height in centimeters and weight in kilograms were noted to calculate BMI of all the subjects. The expenses of this study were borne by the University. The study was subdivided into two groups normoglycemic and hyperglycemic diabetics. Fasting blood sugar was used as a marker of glycemic status due to funding constraints.

The reference value of serum zinc was 5 mg/dL, of serum magnesium 16-24 meq/dL and of fasting blood sugar 70-110 mg/dL.

To rule out hypertension, the blood pressure of all subjects was noted at three intervals in one month prior to their inclusion in this study. Urine DR, serum protein, urea and creatinine were also carried out along with other routine investigations to rule out nephropathy.

The data were evaluated in statistical program SPSS version 16.0. Student's t-test and one-way ANOVA (2 tailed) test were applied with mean±standard deviation for the continuous parameters. Descriptive statistics was calculated among the categorical variables on 95% confidence interval and Fisher's exact test of Chi-square was applied. The variable of duration of diabetic was categorized by recode option in SPSS. P-value ≤ 0.05 was considered as statistically significant.

RESULTS

Forty two diabetic patients were selected for the study, of these, 14 (33.3%) were male with mean age of 45.5 ± 12.24 years and 28 (66.6%) were female with mean age of 47.0 ± 8.31 years (p = 0.6). Forty two ages matched healthy subjects were selected as a control group. Out of them, 29 (69%) with mean age of 47.7 ± 9.79 were male and 13 (30.9%) with mean age of 41.5 ± 11.55 years were female (p = 0.08). The duration of diabetes ranged from at least 2 years to > 10 years. Mean fasting blood sugar was 88.21 ± 4.876 mg/dL in healthy subjects and 246.85 ± 109.83 mg/dL in diabetic patients (p < 0.001). Mean serum zinc was significantly lower in diabetic patients 2.03 ± 0.397 than in healthy subjects (4.48 ± 4.217 mg/dL, p < 0.001). No significant difference was found in serum magnesium level in both groups with mean of 22.67 ± 24.5 mg/dL in diabetic patients and 18.3 ± 3.4 mg/dL in healthy subjects (p = 0.26, Table I).

The difference of serum zinc in either gender was not statistically significant in the study group (p = 0.10) as well as in the control group (p = 0.99). Serum magnesium level was also not found to be significantly different in the study group (p = 0.40) or in the control group (p = 0.11). Age was categorized into two groups < 45 years and > 45 years and had no statistically significant association with serum zinc level, levels being higher both in the younger study group (p = 0.44) and the younger controls (p = 0.75). However, serum magnesium level were observed to be significantly higher in younger age in the control (p = 0.03), which was not different in the study group age divisions (p = 0.23, Table II).

Neither serum zinc not serum magnesium showed any association with fasting blood sugar or with duration of diabetes. There was not statistically significant association of normoglycemic or hyperglycemic diabetics with serum zinc (p = 0.81) or with serum magnesium (p = 0.67). Duration of diabetes showed no statistically significant association with either serum zinc (p = 0.76) or serum magnesium (p = 0.87) as shown in Table III.

Table I: Characteristics of the study subjects (n=84).

Parameter	Patient (n=42)	Control (n=42)	p-value
Age (in years)	46.55±9.67	45.81±10.62	0.74
Gender			
Male	14 (33.3%)	29 (69.0%)	
Female	28 (66.7%)	13 (31.0%)	0.002
Duration of diabetes			
< 5 years	21 (50.0%)	Nil	
6-10 years	15 (35.71%)	Nil	
> 10 years	06 (14.28%)	Nil	
Magnesium	22.67±24.5	18.3±3.4	0.26
Zinc	2.03±0.397	4.84±4.217	< 0.001*
FBS	88.21±4.876	246.85±109.832	< 0.001*

Results are expressed as mean ± standard deviation
FBS = Fasting blood sugar
** P-value is statistically highly significant*

Table II: Association of serum zinc and magnesium level with gender and age (n=84).

	Diabetic (n=42)		p-value	Control (n=42)		p-value
	Male (n=14)	Female (n=28)		Male (n=29)	Female (n=13)	
Age (in years)	45.5 ± 12.24	47.0 ± 8.31	0.6	47.7 ± 9.79	41.5 ± 11.55	0.08
Magnesium	18.13 ± 7.047	24.94 ± 29.591	0.4	18.90 ± 3.829	17.08 ± 2.031	0.11
Zinc	2.17 ± 0.424	1.96 ± 0.370	0.10	4.84 ± 3.621	4.84 ± 5.494	0.99
	Age < 45 years (n=19)	Age > 45 years (n=23)		Age < 45 years (n=20)	Age > 45 years (n=22)	
Magnesium	27.62 ± 35.8	18. 58 ± 5.8	0.23	19.50 ± 3.649	17.27 ± 2.963	0.03
Zinc	2.08 ± 0.420	1.98 ± 0.380	0.44	4.63 ± 1.064	5.03 ± 5.798	0.75
FBS	233.73 ± 114.876	257.69 ± 106.830	0.48	87.25 ± 4.517	89.09 ± 5.126	0.22

Results are presented as mean ± standard deviation
FBS = Fasting blood sugar

Table III: Association of zinc and magnesium with glycemic status and duration of diabetes.

Parameters	n (Percentage)	FBS mg/dL	Serum zinc mg/dL	Serum magnesium meq/dL
Normoglycemic diabetics	7 (16.67%)	133.85±5.45	2.06±0.42	19.04±6.57
Hyperglycemic diabetics	35 (83.33%)	269.45±106.7	2.02±0.4	23.4±6.95
P-value	-	0.002*	0.81	0.67
Duratioin				
< 5 years	21 (50.0%)	-	1.9±0.4	24.7±3.46
5-10 years	15 (35.7%)	-	2.0±0.32	21.9±5.0
> 10 years	06 (14.29%)	-	2.1±0.41	19.3±6.76
P-value	-	-	0.76	0.87

Results expressed as mean ± standard deviation.
** P-value is statistically significant.*

DISCUSSION

Many trace elements are important for human metabolic function. Numerous studies have demonstrated the essential roles of trace elements as chromium, zinc, magnesium, selenium, vanadium, molybdenum and margenase in insulin action and carbohydrate metabolism.[14] The actual role of these trace elements in the pathogenesis and progress of diabetes is still unclear.[15] The observed alterations in the status of these elements in diabetics have been attributed to hyperglycemia and increased protein glycosylation seen in this condition.[16] The serum levels of zinc and magnesium in diabetics and control group were determined in this study and related with the age, gender, glycemic status and duration of diabetes.

In the study, it was observed that mean serum zinc level was significantly low in diabetics as compared to control subjects. Similar observations are reported by Al-Maroof, who also observed significantly lower serum zinc level in diabetics than in control subjects.[17] The possible explanation of hypozincemia observed in diabetics can be hyperzincuria and/or decreased gastrointestinal absorption of zinc.[11] Some other studies have also reported lower serum and plasma zinc levels in diabetics.[18]

Magnesium is an essential ion involved in multiple levels in insulin's secretion, its binding and its activity; and it is also a critical cofactor of many enzymes in carbohydrate metabolism.[19] In this study, serum magnesium level was not significantly different between the groups, which are similar to the study done by Walter, which showed no difference in plasma magnesium level between control subjects and diabetic patients.[20]

In contrast to these results, Diwan, *et al.* reported that serum magnesium levels were significantly low in diabetic patients when compared with control group.[21]

Lower serum magnesium level in diabetics than in controls was also reported by Tripath, *et al.*[22] Sharma reported an inverse correlation between serum magnesium level and poor glycemic control; and a strong association with retinopathy.[23]

In this study, there were no significant associations of serum zinc and serum magnesium with age, gender, blood sugar or duration of diabetes. The gender related references in trace element levels in diabetics might be attributed to hormonal imbalance with the diabetic state.[24]

HbA1c was not included in the study, which is a reliable marker of Diabetes control and uncontrol because of the lack of sufficient funding. Further study needs to be carried out to determine trace elements in diabetic patients and their role in the development of diabetic complications.

CONCLUSION

Serum zinc level was significantly lower in type-2 diabetics, whereas no significant difference was found in serum magnesium level when compared with control subjects. There was no association of age, gender, glycemic status and duration of diabetes on the serum concentration of these trace elements in type-2 diabetic patients.

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