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RESEARCH ARTICLE

STATUS OF SERUM MAGNESIUM, ZINC & COPPER IN PATIENTS SUFFERING FROM TYPE -2 DIABETES MELLITUS

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ABSTRACT

Alterations in serum concentrations of several trace elements including copper, zinc, manganese, and the macroelement magnesium have been reported to occur in type-2 diabetes mellitus. This study is done to evaluate copper, zinc and magnesium status in diabetic and nondiabetic human subjects. In this comparative analysis, the serum concentration of copper, zinc and magnesium was estimated in 60 patients with type 2 diabetes mellitus without complication and 40 healthy non-diabetic subjects. The data was analyzed by students't' test and Pearson's correlation coefficient test.Mean serum concentration of copper was significantly elevated in diabetic patients compared to control subjects. Serum zinc levels were significantly low ($p < 0.001$) in diabetic subjects compared to controls . There were no significant differences in serum magnesium between groups. Fasting plasma glucose level has significant positive correlation with serum level of copper ($r = 0.567$; $p < 0.001$), while zinc has negative correlation ($r = -0.311$; $p < 0.047$), but there is no significant correlation of plasma glucose level with serum magnesium level. Diabetic patients have significantly lower mean serum zinc levels and significantly higher serum copper concentration compared with healthy controls respectively. Along with antidiabetic therapy, supplementation of zinc and magnesium and chelation of copper can reduce complications due to diabetes mellitus.

Keywords: Type-2 diabetes mellitus, copper, zinc, magnesium

INTRODUCTION

Minerals are structural component of body tissues as well as involved in various physiological processes like cofactors of several enzymes. They also play an important role in energy production[1]. Diabetes mellitus is a metabolic syndrome of heterogeneous etiology with the common denominator hyperglycaemia due to absolute or relative deficiency of insulin [2]. Disturbances in trace element status and increased oxidative stress in diabetes may contribute to insulin resistance and the development of diabetes and diabetic complications [3,4] . On the other hand, progression of diabetes may also lead to perturbation in trace element metabolism and homeostasis [5].

Trace elements like chromium, selenium, magnesium and molybdenum have essential role in insulin action [6]. Zinc, an essential trace element is involved in synthesis, storage and secretion of insulin, as well as maintains conformational integrity of insulin. Magnesium is an essential ion which helps in insulin secretion and also acts as critical cofactor of several enzymes in carbohydrate metabolism [7]. Magnesium has been reported to be mainly intracellular, and its intracellular uptake is stimulated by insulin, although the cellular physiology of magnesium metabolism is not fully understood [8]. Optimum level of chromium aids in binding of insulin to cells by increasing insulin receptors and there is increased insulin sensitivity, glucose utilization and beta cell activity. Reactive oxygen species (ROS) are generated when a person is suffering from hyperglycemia and copper facilitates production of ROS through Fenton reaction [9]. In this backdrop our present study is designed to observe the serum levels of magnesium, zinc and copper in patients suffering from type 2 diabetes mellitus.

MATERIALS & METHODS

The present study was carried out during 2012 at BIN and R.G. Kar Medical College, Kolkata in the department of Biochemistry. Sixty patients of type 2 diabetes mellitus without any complication, attending Medicine OPD were selected for the study. The patients were considered for study at their first visit before starting of drug therapy. Forty healthy individuals without any disorder were chosen as controls. Informed consent was obtained from all the participants of the study and the protocol was approved by Institutional Ethics Committee.

Exclusion criteria:

Diabetic patients with complication were excluded. Patients suffering from coronary heart disease, thyroid disorder and renal disorder were also excluded from this study.

Fasting blood samples were collected in sterile, dry and acid washed vials. Biochemical parameters, such as fasting plasma glucose, serum Copper, Zinc and Magnesium were measured using NOVA-SPEC spectrophotometer.

Estimation of Plasma Glucose:

Plasma glucose estimation was done by Glucose Oxidase-Peroxidase method [10].

Estimation of Serum Copper:

Colorimetric method was used for the quantitative determination of serum copper level [11]

Estimation of Serum Zinc:

Serum zinc was detected by colorimetric method [12].

Estimation of Serum Magnesium:

Serum magnesium was estimated by Calmagite method [13].

STATISTICAL ANALYSIS

Statistical analysis was done by students't' test and correlation between variables were studied by Pearson's correlation coefficient test. p values less than 0.05 were considered significant. The statistical analysis was done by using SPSS software (version – 16)

RESULTS

Table 1: Serum concentrations of Glucose, Copper, Zinc & Magnesium in cases & controls

Parameters		N	Mean	SE	P value
Glucose (mg/dl)	**Case**	60	153.41	10.25	**< 0.001**
	Control	40	86.67	1.809	
Copper (µg/dl)	**Case**	60	131.79	6.544	**< 0.001**
	Control	40	101.43	3.27	
Zinc(µg/dl)	**Case**	60	65.75	2.760	**< 0.001**
	Control	40	77.95	2.332	
Magnesium(mg/dl)	**Case**	60	1.94	0.104	< 0.054
	Control	40	2.21	0.087	

Table 1 shows that serum copper level was significantly elevated in diabetic subject compared to healthy individuals, but serum zinc and magnesium level was low.

Table 2: Correlation of Serum Glucose with Copper, Zinc & Magnesium

	r =	p
FBS & Cu	0.567	< 0.001
FBS & Zn	-0.311	< 0.047
FBS & Mg	0.036	0.425

Fasting plasma glucose level has significant positive correlation with serum level of copper ($r = 0.567$; $p < 0.001$), while zinc has negative correlation ($r = -0.311$; $p < 0.047$), but there is no significant correlation of plasma glucose level with serum magnesium level.

Table 3: Correlation of Serum Copper with Zinc & Magnesium

	r =	p
Cu & Mg	0.359	< 0.026
Cu & Zn	-0.815	< 0.001

It is further observed that in these patients serum copper level has positive correlation with serum magnesium level ($r = 0.359$; $p < 0.026$), but significant negative correlation with serum zinc level ($r = -0.815$; $p < 0.001$).

DISCUSSION

Direct association of trace element with health and disease is already established. Diabetes mellitus, one of the commonest diseases of the mankind is linked with alteration in mineral metabolism. It is a dilemma whether DM and high plasma glucose level affect mineral metabolism or alteration in mineral homeostasis influence carbohydrate metabolism [14]. In our study it was observed that serum copper level was elevated in

 ISSN: 2250-1177 CODEN (USA): JDDTAO

diabetic subject compared to healthy individuals, but serum zinc and magnesium level was significantly low. Hypercupremia has positive correlation with plasma glucose level, while zinc has negative correlation, but there is no such correlation with magnesium level. These findings corroborate with the study Kaji et al [15]. Tanaka et al [16] reported that oxidative stress in type 2 DM is facilitated by hypercupremia as excess copper stimulates Fenton reaction. Zinc is essential for assembling insulin into structurally stable and functional hexamic structure [17]. Zinc is also related to the synthesis, storage and secretion of insulin [6]. Moreover zinc is a cofactor of superoxide dismutase which has a protective effect on pancreas from ROS [18]. In hypozincaemia the storage, synthesis and function of insulin can be affected. Escobar et al in 1995 reported that low level of zinc in diabetes mellitus is due to loss of zinc via urine or may be due to loss of zinc from cells as glucose is translocated into muscle [19]. Hence it can be stated low level of zinc can affect the function of pancreas and plays an important role in pathogenesis of DM. Deficiency of magnesium have been implicated in insulin resistance, carbohydrate intolerance, dyslipidaemia and complication of DM. Thus therapeutic replacement of zinc and magnesium and chelating excess copper can delay the development of complications from DM.

CONCLUSION

It is being observed that there are abnormalities in the metabolism of several trace elements in diabetes mellitus which play a significant role in pathogenesis and progression of the disease. Hypomagnesimia can lead to insulin-resistance, abnormalities in carbohydrate and lipid metabolism. Along with antidiabetic therapy, supplementation of zinc and magnesium and chelation of copper can reduce complications due to diabetes mellitus.

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 ISSN: 2250-1177 CODEN (USA): JDDTAO