Serum Copper Concentration in type-1 diabetes mellitus by Atomic Absorption Spectroscopy

Saira Baloch[1]*, Shahida Hassan Memon[2], Muhammad Yousuf Memon[2], Zoheb Rafique[2] and Amber Mahmood[1]

*[1]Medical Research Centre (MRC)
Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro, Pakistan.
[2]Department of Biochemistry, Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro, Pakistan.
*E-mail: saira_dr01@yahoo.com

Abstract: Type 1 diabetes mellitus (DM) is an endocrinological disease associated with hyperglycemia characterized by both insulin resistance and defective insulin secretion. It is associated with the alteration of trace elements like copper which may be a contributing factor in the progression of Diabetes Mellitus and its complications. The aim of the present study was to estimate serum copper, in patients with type 1 DM and compare it with controls .This study was conducted in 100 subjects, out of which 50 were type 1 diabetes mellitus patients and 50 were healthy subjects (controls). Serum copper was determined by Atomic Absorption Spectroscopy using air-acetylene flame (AAS, Model Varian A-20). Serum Copper concentrations was significantly higher in patients as compared with the controls and It could be concluded that there is an association between oxidative stress and metabolic control in diabetic patients.

Keywords: Type-1 diabetes mellitus, copper, serum, Atomic absorption spectrometer

1. Introduction

Diabetes Mellitus is characterized by metabolic disorders related to high blood glucose levels. This hyperglycemia leads to various vascular complications like coronary artery disease, (1) neuropathy, retinopathy and nephropathy. In type 1 DM prevalence gradually increase from onset of disease while in type 2 DM it can be observed in both newly diagnosed and established (2) diabetes .Diabetic nephropathy is the most important cause of (3) death in type 1 diabetes patients compares to type 2 DM. In general (non-diabetic) population, hypertension is found to be the major responsible factor of microalbuminuria. Individuals with essential hypertension who develop microalbuminuria have (4) higher incidence of biochemical disturbances. Trace metals are important for optimum human metabolic function, and serve a variety of functions including catalytic, structural and regulatory activities in which, they interact with enzymes, prohormones, presecretory granules and biological membranes.(5) There is accumulating evidence that the metabolism of several trace elements are altered in type-1 diabetes mellitus (DM) and that these nutrients might have specific roles in the pathogenesis and progression of this disease.(6) It is reported that plasma copper levels has been found to be elevated in type-1 DM patients, while the urinary excretion of copper has been found to be affected by DM.(6,7) has been reported in diabetic patients This study evaluated the serum concentration of copper in diabetic patients and controls.

2. Material and Methods

The metal copper in the serum was determined by using Atomic Absorption Spectrometry (AAS) (Model, A-20 Varian). The concentration of the Copper was determined by air-acetylene flame. The standards from 1 to 5 ppm were run on the spectrometer and the calibration curves were obtained prior to running the samples for the determination of copper in the blood serum of controls and the patients. Blood samples were collected from fifty healthy controls in fasting conditions and a similar condition was maintained while taking blood samples of patients. Each blood sample was centrifuged at 5000 rpm for 20 min. The supernatant of blood serum was used for the analysis of metals copper using Atomic Absorption Spectrometer inserting appropriate hollow cathode lamp in it. All standards used were of analytical grade.

Chemicals and reagents

Sulphosalicylic acid was obtained from Merck, Darmstadt, Germany and Copper chloride to prepare standards were purchased from Sigma Chemical Company. All chemicals were of analytical grade.

Stock Solutions and working Metal standards

Commercial trace metal (**Cu**) atomic absorption standard solution (1000 μg/mL, Sigma Co.) was used. Working standards were prepared from the stock standard solution by diluting with deionized water with addition of few drops of corresponding concentrated acid solution.

Statistical analysis was carried out with Statistical Package for Social Sciences (SPSS) version 16 All data are expressed as mean ± standard error of mean (SEM).

3. RESULTS

Serum copper concentration in controls and in patients determined to be 70.01±1.30 ppm and 75.04 ±0.62 respectively. Serum copper was found statistically highly significant in patients as compared with the controls.

All values are expressed as mean SEM.

Table 1. Serum Copper concentration in patients and controls.

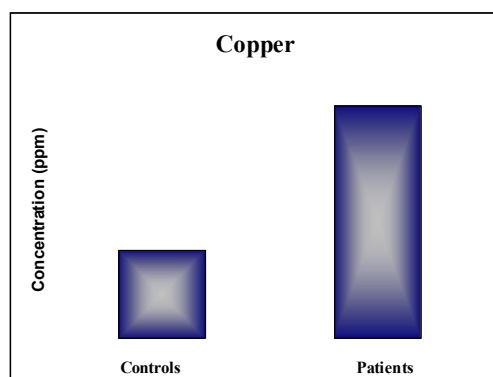| Variables	Controls	Patients
Copper	70.01±1.30	75.04 ±0.62

Copper

Fig: 1 shows Copper mean concentration in patients as compared to the controls.

4. Discussion

Trace elements have important physiological effects when present at concentrations other than those associated with classical toxicity or with extreme deficiency. (5) Many studies have reported significant though variable alteration in trace element concentration in type-1 and type-2 DM patients. (6, 7, 8, 9) In a recent study, we documented that serum copper concentration was comparable between patients with normal control subjects. Copper, an essential trace element, plays an important role in cytochrome oxidase function in the mitochondria. Copper deficiency results in swelling and subsequent disruption of the mitochondria of metabolically active tissues like hepatocytes and pancreatic acinar cells. (5) In our study, copper levels were comparable between type-1 DM patients and non-diabetic controls. Glycemic control and presence of microalbuminuria did not affect the serum copper levels. Earlier, we have documented elevated plasma

copper levels in type-2 DM patients (10). Conflicting results have been reported regarding the copper levels in type-1 DM, both elevated as well as decreased plasma copper concentrations had been reported. (11, 12).

The redox chemistry of Cu makes this both a powerful enzyme catalyst and a dangerous reactant that generates hydroxyl radical. Although virtually all cells from microbes to mammals must acquire Cu to drive important biochemical reactions, the potential toxicity of Cu demands an exquisite level of vectorial transport and homeostatic control (13). Abnormal copper metabolism can lead to several chronic pathogenesis, such as diabetes or diabetic complications (14). Serum Cu level in the diabetic group did not show statistical significant difference compared to the nondiabetic which is not consistent with findings of Kazi *et al*. (15). Our study indicates possible increase in copper mediated generation of ROS leading to increased consumption of available antioxidants in the body. These findings further confirm that alteration of serum copper levels is due to antioxidant imbalance in diabetic patients. From this study, it could be concluded that there is an association between oxidative stress and metabolic control in diabetic patients.

Corresponding Author:
Dr. Saira Baloch
Assistant Professor
Medical Research Centre (MRC) Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro, Pakistan. E-mail: **saira_dr01@yahoo.ocm**

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