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Investigating the effect of hyperglycemia on iron, copper, and zinc micronutrients in diabetic patients

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Abstract

Diabetes is a common disease caused by defections in insulin hormone. Symptoms of this disease include the increase in blood glucose or hyperglycemia. Due to the fact that pancreatic hormones play an important role in the metabolism of micronutrients, the effect of hyperglycemia on the metabolism of these elements was evaluated. 100 diabetic patients were selected as the experimental group, and 100 healthy individuals were selected as controls, and ceruloplasmin, serum iron, copper and zinc were measured in them. The results of this study showed that ceruloplasmin increased by 21%, zinc increased by 16.5%, copper increased by 8.9%, and iron increased by 14.5%, which should be considered in the treatment of these patients.

Keywords: Hyperglycemia; Ceruloplasmin; Copper; Zinc and Iron

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1. Introduction

Diabetes is defined as a deficiency in the regulation of carbohydrate and fat homeostasis by insulin, which leads to an increase in blood glucose. The disease is divided into two types including insulin-dependent (type I) and non-insulin dependent (type II). Type I diabetes is due to insulin deficiency or insufficiency and includes circa 5-10 percent of the cases [1-3]. Type II diabetes include a lack of secretion and insufficiency in insulin function, and it is more complicated for treatment because of reasons such as insulin resistance, high insulin levels in the blood, insulin secretion deficiency, and decrease of glucose uptake due to insulin [4-6].

Table 1 shows a number of the characteristics of insulin-dependent diabetes (type I) and non-insulin dependent (type II).

According to the estimation of World Health Organization (WHO) [3,4], four million people in the world have been died during the year 2010 due to this disease, and statistics show that 347 million people in the world are suffering from this disease [7].

Clinical manifestations of diabetes include hyperglycemia, glucosuria, polydipsia and polyuria [7]. Because the insulin levels are decreased in diabetes, and this hormone seems to have an effect on the metabolism of micronutrients, the effect of hyperglycemia on these elements was investigated in this study.

2. Materials and methods

During this study, 200 individuals including 100 diabetic males and 100 healthy controls were selected and blood samples were obtained from them. Blood samples were collected from all participants before the injection of insulin and the serum was isolated. Ceruloplasmin was determined using para-phenylenediamine dihydrochloride by amino oxidase method.

Copper and zinc were measured using an atomic absorption device.

The amount of iron serum was determined using the Iron rapid test method by biochemical kit.

In this research, the T-test was used to analyze the data.

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Table 1. Characteristics of insulin-dependent (type I) and non-insulin dependent (type II) diabetes.

Characteristics	Insulin Dependent(Type I)	Non-insulin Dependent(Type II)
Genetic locus	Chromosome 6	
Age of onset	Usually < 40	Unknown >40
Habitus	Normal to wasted	Obese
Plasma insulin	Low to absent	Normal to high
Acute complication	Ketoacidosis	Hyper osmolar coma
Plasma glucagon	High,supportable	high, resistant
Insulin therapy	Responsive	Responsive / resistant
Sulfonyl urea	Unresponsive	Responsive

3. Results

Table 2 shows serum ceruloplasmin concentration in patients and controls. Based on the results, the ceruloplasmin was increased by 21% compared with control (P <0.05).

Groups	Abundance	Ceruloplasmin level (ug/dl)
Control	100 persons	23.5 ± 5.2
Patients	100 persons	28.6 ± 6.2

Table 3 shows the concentration of copper in patients and controls. The concentration of copper shows an increase in the patient's group.

Groups	Abundance	Copper level (ug/dl)
Control	100 persons	87.5 ± 7.2
Patients	100 persons	109 ± 12.5

Table 4 shows the concentration of zinc cation in diabetic patients and controls. This cation is increased in patients by 8.9%.

Groups	Abundance	Zinc level (ug/dl)
Control	100 persons	93 ± 7.4
Patients	100 persons	105.2 ± 9.7

The table shows the serum iron level in diabetic patients, which indicate a 14.5 increase with P <0.05.

Groups	Abundance	Iron level (ug/dl)
Control	100	100 ± 8.5
Patients	100	119 ± 16.5

4. Discussion

In diabetic patients, proteins are glycolized by the non-enzymatic pathway. Glycolized proteins produce harmful radicals that attack side chain fatty acids and increase the peroxidation of lipids [8].

Inouye et al (1998) showed that there is an increase in ceruloplasmin and HbA1c levels in diabetic patients, and the peroxidation of lipids by iron and ceruloplasmin is done through converting iron II into iron III [9]. In our study, the increased ceruloplasmin led to hyperglycemia.

Table 3 and 4 show the increased copper and zinc in diabetic patients, respectively. In diabetic patients, the \ glucagon-insulin ratio increases, and glucagon induces intracellular synthesis of these two cations.

The increase in harmful radicals leads to acute phase reactions in patients. In response to this, metallothionein increases in the liver which leads to an increase in plasma copper and zinc levels [10]. Studies done by Vushobove and Culebras show elevated iron levels in diabetic patients [11]. In our study, the same results were obtained and serum iron levels were increased. Considering to the fact that Fe, Cu and Zn ions are increased in diabetic patients, in addition to monitoring the metabolism of sugars, the metabolism of these cations should be carefully monitored in order to control the disease.

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