

Serum Level of Chromium in Newly Diagnosed Type-2 Diabetic Patients

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Diabetes mellitus is a chronic metabolic disorder which affects carbohydrate, lipid and protein metabolism. There is a tight relation between some specific oligoelements and diabetes mellitus. The study was undertaken to determine serum level of Chromium in 60 type 2 diabetic patients (group I) and 60 healthy non-diabetic people (group II). Diabetic patients studied were without any complications. Serum Chromium was estimated by Atomic Absorption Spectrophotometer. The Plasma Chromium level (0.045 ± 0.010) significantly decreased in type 2 diabetic patients when compared with control groups (0.168 ± 0.021). It is concluded that type 2 diabetes mellitus can result in changes in Chromium levels. Given the small sampling, it is, however, difficult to draw any definite conclusion from the study but may be suggested that estimation and supplementation of both Chromium is better to be considered in those cases.

[Dinajpur Med Col J 2015 Jan; 8 (1):216-221]

Key words: Chromium, Diabetes

Introduction

Diabetes mellitus is a clinical syndrome characterized by hyperglycaemia due to absolute or relative deficiency of insulin.¹ It is a multi-system disease that is widespread throughout the world, affecting carbohydrate, protein and lipid metabolism. Along with hyperglycaemia and abnormalities in serum lipids, diabetes is associated with microvascular and macrovascular complications, which are the major causes of morbidity and mortality in diabetic subjects.²

Diabetes mellitus is one of the greatest medical problems threatening the world. With

the worldwide explosion in its prevalence, type 2 DM has turned into a global epidemic.³ According to recent estimates the prevalence of diabetes mellitus is 4% worldwide and that indicates 143 million persons are affected which will increase to 300 million by the year 2025⁴. According to Sarah *et al*⁵ the existing prevalence of diabetes mellitus is expected to rise up to 4.4% by 2030. The World Health Organization (WHO) estimated that there were 135 million diabetic individuals in the year 1995 and it had projected that this number would increase to 300 million by the year 2025. So, the prevalence shows uptrend, which King *et al*⁶ in 1999 declared it to be epidemic proportions.

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Some trace elements like chromium, copper, zinc and magnesium are important for human growth and body's biological functions. They most commonly function as cofactors for metabolic reactions and thus support basic cellular reactions (i.e., glycolysis, the citric acid cycle, lipid and amino acid metabolism) required to maintain energy production and life.⁷ The importance of the trace elements in the living organism was shown over a century ago. Lamb *et al* in 1958 demonstrated the existence of a number of a trace-metal-containing enzyme (metalloenzymes) of importance to the structural and functional integrity of the living cells. Growing concern with environmental factors in human health over the last few years has aroused renewed interest in trace elements.⁸

Diabetes mellitus being a degenerative disease may be initiated as a result of peroxidation caused by free radicals. Some trace elements like Chromium, magnesium, Copper possesses antioxidant properties.⁹ Deficiency of this metal may thus increase susceptibility to this disease. The development of diabetic late complications (cataract, retinopathy, nephropathy and neuropathy) is associated with an increased presence of free radicals and therefore elevated oxidative stress.¹⁰ More than 15% of adult aged 40 to 74 are thought to have impaired glucose tolerance and it has been suggested that poor chromium nutritional status may be a factor.¹¹

Chromium as a component of the glucose tolerance factor (GFT) is essential for normal carbohydrate and lipid metabolism¹². It acts by activating insulin receptor kinase activity upto seven fold¹³ thus increasing autoamplification¹⁴ and efficiency.¹⁵ A severe

deficiency of chromium, resulting in impaired glucose tolerance and subsequent hyperglycaemia and glycosuria. Other signs of chromium deficiency include hyperinsulinaemia (common in type-2DM), decreased insulin receptor number, decreased insulin receptor binding and DM-associated neuropathies and vascular pathologies.¹⁶ More than 15% of adult aged 40 to 74 are thought to have impaired glucose tolerance and it has been suggested that poor chromium nutritional status may be a factor.¹¹

Diabetes can alter the nutrient status (both macro and micro nutrients) of the individual. Though there are many studies on macro nutrient status of diabetic subjects, relatively few studies have been done on the etiopathogenic role of trace elements in diabetes and also on effects of diabetes on trace element status of the individual. Therefore, the present study was done to estimate serum levels of zinc and magnesium in Bangladeshi people with type-2 diabetes and the results compared with those of apparently healthy non-diabetic subjects of comparable socio-economic status.

Methods

This, a cross sectional study, was carried out in the Department of Biochemistry, Mymensingh Medical College in cooperation with the outpatient department of endocrinology of Mymensingh Medical College, Bangabandhu Sheikh Mujib Medical University and BIRDEM, Dhaka during the period from July 2008 to June 2009. A total of 120 subjects aged 50 - 60 years were enrolled for this study. Of them 60 were newly diagnosed type 2 diabetic (group I) and 60 were apparently healthy non-diabetic (group II) subjects. For both case and

control, persons having no current medication, intercurrent illness, macro or microvascular complications and history of renal failure were selected.

A morning sample was taken after an overnight fasting of at least 12 hrs. From each subject 5 ml fasting blood samples was collected. Serum was separated and kept in eppendorfs after proper labeling. Diabetes mellitus was diagnosed as per ADA (2008)¹² criteria. According to this criteria, fasting plasma glucose (FPG) ≥ 7.0 mmol/l and 2 hrs plasma glucose 11.1 mmol/l in case of type 2 diabetic mellitus. Therefore, both FPG and OGTT were done in all study subjects to diagnose type 2 diabetes mellitus. Experiments were carried out as soon as possible. The fasting samples were used to measure serum Chromium level.

Serum Chromium level was estimated at the central laboratory of Bangladesh Agricultural University, Mymensingh by Atomic Absorption Spectrometer (UNICAM-AA Spectrometer, model no. 969, Spain). Serum glucose was measured by Glucose Oxidase (GOD-PAP) method.

All values were expressed as mean \pm SD. Statistical significance of difference between two groups were evaluated by using student's unpaired "t" test. All statistical analysis were done by using Statistical package for social science (SPSS) windows package

Results

In this study, a total of 120 subjects were enrolled out of which 60 were case and the rest 60 control. As per ADA criteria, OGTT was done in all study subjects. Then serum chromium levels was measured in fasting samples of both groups. Serum chromium was expressed in $\mu\text{g/l}$ while serum serum glucose level in mmol/l.

In group I (case) the mean (\pm SD) FBS levels was 7.19 ± 0.38 and 2hrs was 12.23 ± 0.64 , while in group II (control) the mean (\pm SD) FBS levels was 4.32 ± 0.23 and 2 hrs was 5.80 ± 0.23 respectively (Table I). In diabetic subjects fasting and 2 hrs serum glucose levels were significantly higher than control ($p < 0.001$). The mean \pm SD of serum chromium level in group I and group II were 0.045 ± 0.010 and 0.168 ± 0.021 , respectively (Table II). There was significant decrease ($p < 0.001$) of chromium in group I compared to that in group II.

Table I: Fasting and 2 hrs blood glucose levels of study subjects

Study groups	Fasting blood glucose (mmol/l) mean \pm SD	2 hrs blood glucose (mmol/l) mean \pm SD
Group I (case) n=60	7.19 ± 0.38 (6.72-7.98)	12.23 ± 0.64 (11.43-13.57)
Group II (control) n=60	4.32 ± 0.23 (4.00—5.20)	5.80 ± 0.23 (5.00—6.23)

Table II: Distribution of the study according to serum chromium (n=120)

Serum Chromium	Case (n=60)	Control (n=60)	p
	N(%)	N(%)	
<0.1 $\mu\text{g/l}$	60(100%)	0(0%)	$p < 0.001^s$
0.1-0.2 $\mu\text{g/l}$	0(0%)	60(100%)	
Mean \pm SD	0.045 ± 0.010	0.168 ± 0.021	
Range(min-max)	(0.03-0.06)	(0.14-0.20)	

S=significant

P value reached from unpaired t-test

Discussion

Alterations in the status of trace elements have been reported in a number of disease status, trauma and infections. The actual

status of these elements in diabetes and other ailments is still uncertain.

The present study was undertaken to establish an association between the chromium and diabetes mellitus. Chromium is the most vital trace element for the metabolic processes. The present study was an attempt to measure the serum level of chromium these in type-2 diabetic patients and compare those with that of healthy non-diabetic subjects belonging to Bangladeshi people with careful technical precautions.

Chromium acts as a cofactor for insulin, although its exact mechanism in carbohydrate metabolism yet not clear. In this study, serum chromium level in type 2 diabetic subjects were found highly significant ($p < 0.001$) than that of control group. The findings are consistent with those of Nouramohammadi *et al*,¹⁸ Adewumi *et al*,⁹ Timothy *et al*,¹⁶ Davis *et al*,¹² Ding *et al*,¹⁹ Nsonwu *et al*.²⁰ The possible reason for decreasing serum chromium concentration in diabetic patients is excessive urinary excretion. Hyperglycaemia and high levels of insulin increase chromium excretion.¹⁵ So low serum levels of chromium seen in diabetics has been attributed to insulin resistance, hyperglycaemia and osmotic diuresis resulting from glycosuria, which increase urine chromium excretion.²¹ According to Adewumi *et al*⁹ chromium has been reported to increase insulin binding to cells, number of insulin receptors and activates insulin receptor kinase leading to increase in insulin sensitivity.²² Trivalent chromium acts as a cofactor for insulin and is an integral part of the cellular response to this hormone.²³ Accordingly severe chromium deficiency was implicated to cause impaired glucose tolerance and subsequent hyperglycaemia and glycosuria.²² Baker and Campbell²⁴ also reported an association between chromium deficiency on hand and hyperinsulinemia,

diabetic. According to Timothy *et al*¹⁶ Chromium increase the number of insulin receptors present in a target tissue. Chromium also demonstrated to increase the binding of insulin to its receptor.²⁷ The latter action may involve chromium's ability to regulate key reactions involving phosphorylation /dephosphorylation, which turn on and of insulin action. Insulin activates its receptors by binding to the extracellular alpha subunit. This leads to phosphorylation of membrane bound beta subunit. Chromium via the enzyme insulin receptor tyrosine kinase, catalase the phosphorylation in the presence of insulin. Additionally, chromium inhibits tyrosine phosphatase, which is responsible for terminating the insulin receptor response. Thus, by both increasing activation and inhibiting termination of insulin receptor mediated responses, Chromium can significantly influence glucose utilization by peripheral tissues.

According to lower serum level of chromium was observed in the diabetics compared to healthy subjects though the differences were not significant. This agrees with the works of Ekmecioglu *et al*²⁸ who also demonstrated lower level of chromium only in the lymphocytes of diabetics and no differences in its level other blood components of both groups. This works is not consistent with our study.

Conclusion

Analyzing the findings of the present study, it can be concluded that significant decreases of serum chromium occur in type 2 diabetic patients. Although the small number of samples resists any definitive comment on the normal ranges, it, however, gives an elementary idea on the serum levels of zinc and magnesium in type 2 diabetic patients.

However, the decreased plasma chromium in type 2 diabetes mellitus probably reduce

sensitivity and may increase risk of secondary complications. Therefore, an intervention to increase of dietary intake of chromium may be beneficial for these patients.

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