Effect of Chromium Supplementation on Blood Glucose, Hemoglobin A1c, Lipid Profile and Lipid Peroxidation in Type 2 Diabetic Patients

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Abstract

Objective: Type 2 diabetes mellitus is a complex metabolic disorder with adverse cardiovascular risk. Chromium (Cr) is an essential nutrient and its role in carbohydrate and lipid metabolism has not been clarified especially in Iran. The aim of this study was to evaluate the effect of chromium picolinate administration on blood glucose, HbA1c, lipid profile and lipid peroxidation in type 2 diabetic patients.

Materials and Methods: One-hundred subjects were studied in double-blinded and placebo-controlled. They divided into study and placebo groups by simple randomization. The study group received 200µg chromium picolinate capsule twice daily and the placebo group received capsule devoid of chromium (from Century Company) for 12 weeks. Subjects were instructed not to change their normal eating and living habits and medication. Fasting blood glucose, HbA1c, lipid profile and malondialdehyde were measured and analyzed at beginning and completion of the study.

Results: Results revealed that chromium picolinate consumption in type 2 diabetic patients reduced fasting blood glucose (48.83%, $p \leq 0.01$), HbA1c (22%, $p<0.001$), total cholesterol (6.17%, $p \leq 0.02$), triglyceride (11.36%, $p < 0.5$), LDL (17.22%, $p< 0.05$), HDL (5.78%, $p< 0.05$) and malondialdehyde (11.37).

Conclusion: These data demonstrate beneficial effect of chromium picolinate supplementation on blood glucose, HbA1c, lipid profile and lipids peroxidation in type 2 diabetic patients.

Keywords: Chromium picolinate, diabetic patients, blood glucose, HbA1c, lipid profile, lipid Peroxidation

Introduction

Diabetes mellitus is a very common metabolic disorder with chronic complications. The metabolism of micronutrients is affected by diabetes mellitus. Chromium is an essential mineral thought to be necessary for normal glucose and lipid homeostasis (1-3).

Trivalent chromium in a complex known as glucose tolerance factor is considered the biologically active form. It was originally discovered in brewer's yeast. Chromium chloride, chromium nicotinate, and chromium picolinate are commonly used formulations trivalent chromium. Chromium picolinate is a

formulation designed to improve absorption (4).

Severe chromium deficiency is known to cause reversible insulin resistance and diabetes. However, the effect of chromium supplementation in individuals who are not severely chromium deficient is unclear. Manufacturers aggressively promote the benefits of chromium in the prevention and treatment of insulin resistance and its associated conditions (type 2 diabetes, dyslipidemia, and cardiovascular disease) (5).

Trivalent chromium (Cr) is considered as an essential element for insulin function and glucose disposal in mammalian nutrition (6). Chromium works by helping to lower insulin levels, which in turn aids in lowering cholesterol and triglyceride levels (7).

Between 20 to 35µg of chromium is daily required for adults depending on age and gender. In general, oral intake of chromium has a low level of toxicity partially due to its very poor absorption (8).

There is no clinically defined state of chromium deficiency, but diabetes has been shown to develop because of low chromium levels in experimental animals and in humans. These results suggest that there may be a more general relationship between chromium levels and glucose and/or lipid metabolism. In a cross-sectional analysis, lower toenail chromium levels have also been associated with increased risk of type 2 diabetes (9). Diabetic subjects may have altered chromium metabolism compared with nondiabetic subjects, as both absorption and excretion may be higher (10-11). Another study reported that chromium levels were reduced >50% in both diabetic men and women compared with control subjects (12), which was supported by Ekmekcioglu et al. (13), who reported significantly lower chromium levels in the plasma of type 2 diabetic individuals compared with nondiabetic healthy control subjects. Yet, another study suggested no alteration of chromium levels in type 2 diabetes (14).

However, chromium is considered as a nutrient in spite of being a therapeutic agent and therefore seems beneficial for problems due to suboptimal intake of chromium (15). Chromium supplementation in type 2 diabetic patients can improve glucose metabolism (16). On the other hand, some studies denied importance of chromium in treatment of type 2 diabetes (17-18).

Chromium picolinate capsule has become a popular nutrient as well as therapeutic agent for diabetes mellitus. In several studies, inorganic chromium usage caused limited intestinal absorption and intracellular uptake of inorganic chromium (19). There are not definitive studies on beneficial effects of chromium in diabetic patients in Iran.

This study was carried out to investigate the effect of chromium supplementation on blood glucose, HbA1c, lipid profile and lipid peroxidation in type 2 diabetic patients.

Materials and Methods

Subjects of this study were selected from patients attending Yazd Central Laboratory. One-hundred type 2 diabetic patients ranging from 40-70 years were selected on the basis of calculated sample size. Diabetic patients with a history of liver, kidney and intestinal disorders, gout and those taking nutrient supplement contains chromium were excluded. The patients were instructed not to change their normal eating and living habits and medications. The subjects were randomly assigned into one of supplementation groups. The study group received 200µg chromium picolinate capsule and the placebo group received placebo capsules twice daily after lunch and dinner for 12 weeks. Fasting blood samples were collected and blood glucose, lipid profile, blood cholesterol, triglyceride and HDL-c were measured by enzymatic methods (Pars Azmoon kits). HbA1c was analyzed by Ion exchange chromatography. Low density lipoprotein cholesterol (LDLc) was then calculated using Friedwald formula. Malondialdehyde levels were measured by the method of thiobarbituric acid reactive substances (TBARS, Sigma Company).

Data were analyzed by SPSS package Version 13. All data are expressed as mean±Standard Deviation (SD). Statistical analysis was performed using the Student's t-test.

Results

This study included 100 type 2 diabetic patients at the outset. Out of the initial 50 patients in case group, 43 completed the study. Four patients had to be put on insulin regime due to uncontrolled hyperglycaemia and other complications, while the other three did not wish to continue on personal causes.

Baseline characteristics of both groups were well matched (Table 1). The effect of chromium picolinate supplementation on fasting blood glucose, HbA1c, lipid profile and lipid peroxidation has been compared in placebo and study group in Table 2. After supplementation with chromium, the mean fasting blood glucose level and HbA1c of subject showed a significant reduction ($p \leq 0.001$).

The effect of chromium intervention on lipid profile is shown in Table 2. Mean cholesterol, triglyceride and LDL levels reduced significantly. But the mean malondialdehyde level decreased insignificantly. The mean HDL values increased insignificantly. In placebo group, none of these parameters changed significantly.

Discussion

In the present study, chromium picolinate supplementation showed beneficial effect on fasting glucose, HbA1c, lipid profile and lipid peroxidation. Chromium deficiency is associated with many metabolic disorders including insulin resistance and type 2 diabetes. The majority of studies reported a statistically significant reduction in fasting glucose and HbA1c (20-26) and two additional studies stated there were large reduction but not statistically significant in fasting glucose and HbA1c (27-28). Some studies found no effect of chromium supplementation on fasting glucose and HbA1c (29-34). A research by Rabinovitz et al showed beneficial effects of chromium supplementation in type 2 diabetes. Consumption of 200µg of chromium twice a day for three-week caused differences in the fasting blood level of glucose compared to the baseline (190mg/dL vs. 150mg/dL, $p<0.001$). HbA1c also improved from 8.2% to 7.6% ($p<0.01$). Total cholesterol was also reduced from 235mg/dL to 213mg/dL ($p<0.02$). A

Table 1. Comparison of clinical parameters of the study and placebo groups in type 2 diabetic patients.

Variables	Placebo group (Mean ± SD)	Study group (Mean ± SD)	p
Age (years)	52.7 ± 12.5	53.15 ± 11.9	NS
Sex ratio (M:F)	3:2	2.8:2	NS
BMI (Kg/m2)	23.8 ± 3.2	24.0 ± 4.1	<0.05
W/H ratio	0.89 ± 0.1	0.98 ± 0.1	<0.05
Systolic blood pressure (mmHg)	133.4 ± 17.5	132.7 ± 18.1	<0. 5
Diastolic blood pressure (mmHg)	91.5 ± 4.8	89.5 ± 5.33	< 0.8

NS: Not significant

Table 2. Comparison of some relevant parameters (Mean±SD) in chromium and placebo phases, before and after treatment

Parameter	Chromium phases		Placebo phases		p
	Before	After	Before	After	
Fasting blood glucose (mg/dl)	199.76±7.5	108.9±7.2	198.99 ± 8.36	197.66±8.24	≤0.01
HbA1c (%)	9.5± 0.26	7.5± 0.28	9.45±0.22	9.37 ± 0.24	<0.001
Total cholesterol (mg/dl)	192.25±4.2	180.12±3.6	191.76±5.11	191.34± 5	<0.02
Triglyceride (mg/dl)	176.34±8.7	152.44±8.4	177.11±7.6	176.26±7.1	<0.05
LDL-cholesterol (mg/dl)	139.42±1.89	98.84±1.23	137.87±1.92	136.94±1.87	<0.05
HDL-cholesterol (mg/dl)	42.82±1.87	49.90±1.22	43.12 ±1.77	43.88±1.23	<0.05
Malondialdehyde (nmol)	0.075±0.055	0.074±0.043	0.076±0.41	0.075±0.039	NS

p: Differences in the percentage change on mean value and initial reading after treatment between chromium and placebo phases.
NS: Not significant

trend towards lowered triglyceride levels was also observed (152mg/dL vs. 136mg/dL). They concluded that, in this population of elderly diabetic patients, dietary supplementation with chromium is beneficial in moderating glucose intolerance.

In addition, chromium intake appears to lower plasma lipid levels (17). Anderson et al reported that supplement of 100µg chromium as chromium picolinate two times per day had significant beneficial effects on HbA1c, glucose, insulin, and cholesterol in subjects with type 2 diabetes (10).These results are in accordance with our results.

Uusitupa et al study was carried out to assess the effect of chromium supplementation (200µg trivalent chromium daily for 6 weeks) on glucose tolerance, insulin response, long-term diabetic control, and serum lipids in 10 noninsulin-dependent diabetics aged 37 to 68 years. Serum total cholesterol, triglycerides and their high-density, low-density, and very low-density lipoprotein subfractions showed no change after chromium supplementation as compared to the placebo (25). Sherman et al evaluated the effect of trivalent chromium supplements on blood sugar concentrations of normal and diabetic human subjects. They took 50µg of trivalent chromium and a chromium-placebo thrice daily by mouth for a 16-week period. Chromium did not improve hyperglycemia in diabetic patients (27). Lee et al investigated the effect of chromium picolinate supplementation on lipid profile of subjects with non-insulin dependent diabetes mellitus. They received either chromium picolinate or placebo for 2 months. No differences were noted between the control and chromium-treated subjects in glucose control, high-density lipoprotein cholesterol levels, or low-density lipoprotein cholesterol levels while triglyceride levels were reduced significantly (17.4%, $p<0.05$) during the 2 months of chromium supplementation (28). Dietary chromium intake has been decreased due to the increasing consumption of processed foods, sugar rich food and refined grain products.

The variation observed in various studies may be attributed to the duration of study, form of chromium used, individual chromium status and degree of glucose intolerance (30). The present study documents significant improvement in cholesterol, triglyceride, LDL and HDL. While there are some clinical evidences that chromium supplementation may decrease serum cholesterol, triglyceride and LDL levels (25,26), significant changes in lipid profile were seen in some other studies (11,27,28). One double-blind trial found that high amounts of chromium (500µg per day) in combination with daily exercise were highly effective, producing nearly a 20% decrease in total cholesterol levels in just 13 weeks (25). In a double-blind trial, 30 people with type 2 diabetes received 200µg of chromium per day (as chromium picolinate) for two months and a placebo for an additional two months. The average TG level was significantly lower (by an average of 17.4%) during chromium supplementation compared to the placebo (26). Some, but not all, studies support these findings. It is not clear whether chromium supplementation affects TG levels in nondiabetics, but some evidences suggests that it does not (11,27,28). In our study, changes in lipid parameters (total cholesterol, triglyceride, HDL-c and LDL-c) showed significant differences between the study group and placebo after chromium supplementation. More favorable effect may be seen with higher dosages and for longer period of follow-up (30).

Malondialdehyde (MDA) is a highly toxic by-product formed in part by oxidation of free lipid radicals and studies have shown its considerably raised concentrations in diabetes mellitus. Malondialdehyde reacts both irreversibly and reversibly with proteins and phospholipids with profound effects (35). Salem et al investigated the relationship between the serum levels of chromium and the serum MDA in patients with type 2 diabetes. Findings of their study did not show any association between the serum levels of chromium and malondialdehyde, in spite of a

decreased serum concentration of chromium and an increased level in serum MDA in diabetic patients (36). In our study, chromium supplementation did not change malondialdehyde concentration significantly.

Conclusion

In conclusion, the addition of chromium supplements results in the reduction of glucose, HbA1c, cholesterol, triglyceride and LDL. So, chromium supplementation is an effective regimen and may provide beneficial effects on other risk factors in type 2 diabetic patients.

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