Low serum chromium in Nigerian Type 2 diabetes

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ABSTRACT: A highly refined diet that contains too few micronutrients has been recognized as the dominant factor in the rising incidence of diabetes and other insulin related conditions. Among the missing micronutrients, chromium (Cr) has the greatest impact on insulin response. The objective of this study was to determine serum chromium concentrations in Nigerian type 2 diabetes and to determine whether such concentration has any effects on glucose intolerance in diabetes. The study took place at the medical department of a secondary referral hospital in Nigeria. Subjects included those attending the diabetes clinic and those hospitalized due to the disease. Mean (± SD) serum Cr concentration of the diabetics and controls were significantly different 0.3 (0.32)nmol/L and 1.08 (0.63)nmol/L respectively (p<0.05). Serum chromium concentrations were below normal reference range in 81.3% of the diabetes patients and 20% of the control subjects (p<0.05). Serum chromium was not correlated with glycemic control as measured by FPG. In conclusion, lower serum chromium concentrations and poor chromium status are common in type 2 diabetics in Nigeria.

Key words: micronutrients, chromium, diabetes, glucose tolerance, insulin.

INTRODUCTION

Type 2 (Non insulin dependent) diabetes mellitus is a common disease of adulthood with acute, sometimes life-threatening symptomatic hyperglycaemia. This type of disease is basically due to predominant insulin resistance or predominant insulin secretory defects (Khan and Safder, 2003). Its incidence is ever increasing worldwide and repugnanty affecting young adults. It’s estimated to afflict about 2% of the world population (Unwin et al., 2001). In Nigeria alone the burden of the disease is on about 7% of its population and over 90% of these being non-insulin dependent (Fabiyi et al., 2002). A recent prevalence rate of diabetes among fresh intake of a Nigerian university was 3.47% of the study group (Ogunkolo and Amballi, 2005). A highly refined diet that contains too few micronutrients has been recognized as the dominant factor in the rising incidence of diabetes and other insulin related conditions. Among the missing micronutrients, chromium has the greatest impact on insulin response (Zimmerman, 2000).

Chromium III has been identified as the essential component of glucose tolerance factor (GTF). The body needs GTF to metabolize sugar. Scientists have found that eating foods high in simple sugars stimulate chromium loss through the urine. In addition, refined carbohydrates are devoid of chromium and other important trace minerals. Besides the prevalence of these foods today, a stressful lifestyle, traumatic experiences and heavy

Chromium III is believed to be an insulin-sensitizing agent and may facilitate insulin attachment to the insulin receptor. Chromium may improve insulin sensitivity by activating insulin receptor tyrosine kinase, an effect that has been shown in rats and by inhibiting phosphotyrosine phosphatase (PTP-1), which is a rat homologue of human tyrosine phosphatase (PTP-1B), which inactivates the activated (phosphorylated) insulin receptor. Thus, chromium may promote phosphorylation of, and hence activation of, the insulin receptor, leading to improvement in insulin sensitivity (Davis, et al., 1997). There are difficulties in the measurement of chromium concentrations. Chromium is a common substance in the general environment and is present in concentrations equal to or greater than those seen in the circulation. This renders contamination a significant problem because the amount of chromium in a sample may increase by much more than the original amount presents (Offenbacher et al., 1986, Offenbacher and Pi-Sunyer 1988).

Therefore, the objective of this study was to determine serum chromium concentrations of type 2 diabetes in our locality and to determine whether such concentration has any effects on glucose intolerance in diabetes.

MATERIALS AND METHODS

Subjects

One hundred and three (103) persons were recruited into this cross-sectional study of 3 month period (Table I). The test group was fifty-three (53) type 2 diabetics, diagnosed according to WHO standard (WHO, 1999). Their medical history and personal data(s) were obtained via a questionnaire (Table II).

Patients taking loop diuretics or receiving mineral supplements of any form in the last one-month were excluded from this study, as loop diuretics were associated with higher urinary excretion of trace elements (Walti et al., 2003). The fifty apparently healthy (age and sex matched) control individuals were sourced from among the hospital staff and blood donors. Key exclusion criteria for control subjects include pregnant and lactating women, persons receiving trace elements supplements in the last one-month or persons with any history of a recent surgery and acute infection in previous one month.

METHODS

After counseling and informed written consent in each subject, fasting venous blood samples were aseptically collected via venipuncture for fasting plasma glucose (FPG) in fluoride oxalate tubes and plain tubes (Vacutainer, Becton Dickson, Meylan, France) for serum chromium determination. The samples in plain bottles were allowed to clot undisturbed. The serum (plasma from the fluoride-oxalate bottles), were separated from the blood cells by centrifugation at 3000rpm for 15minutes (Uniscope SM 106, Surgifriend Medicals, England) and stored at -25°C until analysis. FPG was estimated using glucose-oxidase method, while serum chromium was analyzed by graphite furnace atomic absorption spectrometry.

Data processing and statistical analysis of the result were performed using Excel 2008 (Microsoft, Seattle WA, USA) and SPSS statistical package for windows 15.0 (SPSS Inc., Chicago IL, USA). The results obtained were summarized as Mean (±SD) and variables not normally distributed were expressed as medians and ranges. Differences between the groups were compared using unpaired Student’s t-test and Bonferroni’s method. The level of significance was set at p<0.05. ANOVA was also done to test for associations with serum Cr concentration as the dependent variable.

RESULTS

Mean (± SD) serum Cr concentration of the diabetics and controls were 0.3 (0.32)nmol/L and 1.08 (.63)nmol/L respectively (p<.05) (figure 1). In 81.3% of the diabetes patients and 20% of the control subjects sera Cr
concentrations were below the normal reference range of 0.6 to 6nmol/L (Tona et al., 1999). By ANOVA, sex and age were not significant predictors of serum Cr in this sample. Median FPG concentration (range) in the diabetic group was 6.9mmol/L (3.3-14.4mmol/L). By ANOVA, FPG (figure 2), duration of diabetes and diabetes treatment (medication) did not significantly predict serum Cr concentration.

DISCUSSION

This study used only serum chromium concentrations, and the problems with measurement mentioned in the introduction of this article may apply to these data. Our prospective data collected for a period of 3 months strongly suggests that sera chromium levels do exhibit significant variation between type 2 diabetes patients and non-diabetes control subjects. This result is similar to those found by researchers from other countries of the world (Ekimekicioglu, et al., 2001, Ekin, et al., 2003). The striking findings in this population were the high prevalence of low serum Cr concentrations among the diabetic subjects as Serum Cr concentration of 81.3% diabetics were below the reference range (Tona et al., 1999), a prevalence of low chromium status that is similar to that reported by Nourmohammadi, et al., (2001) and Gunton, et al., (2001) in the chromium pool of their respective type 2 diabetics. This low chromium content from our study is more pronounced among diabetes subjects with complications a result also reported by Anderson, (2000) who showed that chromium deficiency contribute to the development of vascular complications associated with diabetes. Significant reductions in chromium levels are indicators of metabolic response to oxidative stress in patients with diabetes. Thus preventing low Cr status in diabetics may therefore be beneficial in the management of the disease.

The reason for the high prevalence of Cr deficiency in diabetes are not clear, but may include increased urinary loss due to hyperglycaemia and osmotic diuresis experienced during diabetes (Nourmuhammadi, et al., 2001), lower dietary intake or impaired absorption of Cr as reported by Ding et al., (1998) is also a factor contributing to the low levels of chromium in diabetes. Body stores of chromium can also be depleted by deficiencies which are believed to fairly widespread among the general population as age plays a major role in the status of Cr. Cr levels stabilize at certain ages and the decline (Nourmuhammadi, et al., 2001).

Several authors have described a correlation between body pool of chromium in diabetes and glucose control (HBA1C / FPG) (Anderson, 2000, Anderson, et al., 1997, Ding, et al., 1998, Akhuemokhan et al., 2010). However, no such correlation was found between FPG and chromium concentration of type 2 diabetes in our study.

In summary this study has shown that sera chromium level of Nigerians type 2 diabetics does exhibit a significant low variation when compared to their non-diabetic counterparts. Thus, we advocate for chromium estimation in the body of diabetics, as dietary supplementation of this elements could therefore be beneficial in the management of the disease. Further studies in the area of Chromium and diabetes mellitus are thus advocated to include:

- Investigation of different tissue concentrations of chromium to ascertain the best tissue sample for providing accurate assessments of chromium storage in the body
- Further studies of chromium supplementation, which should incorporate measurements of serum chromium to ascertain whether baseline chromium or changes in serum chromium are predictive of a therapeutic effect.

REFERENCES


Table I Characteristics of the Subjects

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Diabetics (Test)</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of subjects</td>
<td>53</td>
<td>50</td>
</tr>
<tr>
<td>Sex</td>
<td>19 men / 34 women</td>
<td>22 men / 28 women</td>
</tr>
<tr>
<td>Age (y) ± SD</td>
<td>57.4 ± 10.4</td>
<td>57.1 ± 11.2</td>
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</tbody>
</table>

Table II Characteristics of the Diabetic patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>5-8yrs (0-8)</th>
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</thead>
<tbody>
<tr>
<td>Duration of diabetes (years)</td>
<td>11.3%</td>
</tr>
<tr>
<td>Medication</td>
<td>Oral-hypoglycemic 47.2%</td>
</tr>
<tr>
<td></td>
<td>Insulin+ Oral-hypoglycemic 15.1%</td>
</tr>
<tr>
<td></td>
<td>Diet 18.9%</td>
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<tr>
<td></td>
<td>*Traditional medicine 7.5%</td>
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<tr>
<td>Complications</td>
<td>Hypertension 35.7%</td>
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<tr>
<td></td>
<td>Retinopathy 10.7%</td>
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<tr>
<td></td>
<td>Nephropathy 21.4%</td>
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<tr>
<td></td>
<td>Arteriosclerosis 14.3%</td>
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<tr>
<td></td>
<td>Foot Diabetic 17.9%</td>
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</tbody>
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1 Median and range
* These patients were taking herbal concoctions along with their prescribed medications
Fig. 1 Sera chromium concentrations of type 2 diabetics and controls. Box-whiskers plot showing medians, first and third quartiles, and minima and maxima.

Fig. 2 Relationship between serum Cr concentration and glycaemic control measured as FPG in 53 diabetic patients.