Original Article

Relationship of Chromium Toxicity with Diabetes Mellitus and Chronic Renal Failure

Chromium Toxicity with DM & CRF

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ABSTRACT

Objective: To assess the association between diabetes mellitus and chronic renal failure with toxic effects of chromium on the onset of the Chronic Kidney disease.

Study Design: A prospective cross sectional study**.**

Place and Duration of Study: This study was carried out at the Jinnah Post graduate Medical Centre and Kidney Centre Karachi during December 2012 to December 2013.

Materials and Methods: The present study was conducted on a total of 150 patients (age > 40 years) divided into three groups. Patients in Group I included 50 patients with diabetes mellitus type 2 whereas Group II included 50 patients with diabetes mellitus associated with chronic renal failure (CRF) and Group III consisted of 50 healthy controls.

Results: Results showed that levels of fasting blood sugar and HbA1c in both group I and group II were significantly high where as it was lower in controls. Serum urea (125.2 ± 32.49) and creatinine (7.3 ± 1.41) levels in patients with DM with CRF were significantly high as compared to patients with DM only and control group. The Creatinine clearance (55.1 ± 9.61) in patients with DM with CRF was decreased in comparison with DM patients and control group. Serum chromium levels were significantly high in patients with DM with CRF and in patients with DM.

Conclusion: Serum chromium level showed significant correlation with glycemic index when the two groups including DM patients and patients with DM accompanied with CRF were compared with the controls, while correlation with renal failure was significant only in group II patients.

Key Words: Diabetes, Serum chromium, Chronic renal failure, Creatinine

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INTRODUCTION

Worldwide the disease burden created by chronic kidney disease (CKD) is a main concern to the health professionals. According to National Kidney Foundation guidelines of the US population, CKD is affecting about 20 million adults. Out of these individuals 40% are having moderate to severe involvement of kidney (Weiner DE et al 2004)[1]. The most serious consequences of untreated CKD include hypertension, cardiovascular vascular disease and end stage renal disease which leads to dialysis and kidney transplantation, thus resulting in decreased quality of life, increased health-care cost, and premature death. There is evidence that these outcomes of CKD can be prevented or delayed, with timely diagnosis and treatment (Flessner et al 2009)[2].

Chronic kidney disease (CKD) is the major health problem which causes circulatory imbalance like hyperkalemia, metabolic acidosis, neurological complications and thus increases the risk of mortality. The frequency of CKD is rising with the corresponding increase in the world population and it is widely accepted that even with the use of newer technology and detection methods for the early diagnosis of CKD; the mortality rate is still very high. (Xue et al 2006)[3].

Association of chronic kidney disease (CKD) with other disease conditions including diabetes mellitus, hypertension and infections is well documented. Also the industrial exposure with heavy metals and extremes of temperature are related with CKD (Soderland et al 2010)[4]. The well-known factors for CKD are comprised of diabetes mellitus, hypertension, and metabolic syndrome (Ryu et al. 2009)[5]. Diabetes mellitus (DM) and chronic kidney disease (CKD) are common co-morbidities in heart failure with poor outcomes (Ekundayo et al 2009)[6]. Diabetes and hypertension are among the chronic diseases that affect the largest number of individuals and lead to severe complications (Poljičanin et al 2010)[7]. American Diabetes Association (ADA) in 2002 has entitled essential hypertension as one of the major contributing factor in the

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etiopathogenesis of type 2 diabetes mellitus (Tugrul et al 2009)[8].

The international agency for Research on Cancer categorizes chromium as carcinogenic to human. The adverse effects of chromium have also been reported that include growth depression, damage to kidney and liver and cancer (Frisbie et al 2002)[9]. Chromium is known to cause adverse effects on the health and causes cellular damages to the tissues of lungs, kidneys, liver, and other vital organs (Permenter et al 2011)[10].

This study aims at identifying the main risk factors that lead to the onset of CKD in Karachi, Pakistan and to assess the association between chronic diseases such as diabetes mellitus and toxic effects of heavy metals on the onset of the CKD.

MATERIALS AND METHODS

This is a prospective cross sectional study which included patients divided three in groups. Patients in Group I included 50 patients (age > 40 years) with diabetes mellitus type 2 whereas Group II included 50 patients (age > 40 years) with diabetes mellitus associated with chronic renal failure (CRF) and Group III consisted of 50 healthy controls (age > 40 years). Population with exposure to heavy water pollution by the toxic metals was selected for the study.

Informed written consent was taken from all patients and detailed history and examination was carried out. Exclusion criteria included Patients suffering from any other endocrine disease, liver disease, alcoholic liver disease pregnant female and females using oral contraceptive pills. Patient's blood was collected for Plasma glucose level, Direct Enzymatic Hemoglobin A1c (HbA1c) to assess the glycemic index of all the three groups. Renal function was tested by checking the serum urea level, Creatinine concentration and Creatinine clearance (Owiredu et al, 2013)[11]. Serum chromium level was also monitored in all the groups. The data was analyzed statistically on SPSS (Statistical Packages of Social Sciences) version 16. Mean ± SD was used for the different study parameters. The p-value <0.05 was considered significant.

RESULTS

A total of 150 blood samples from three groups of patients of different ages and genders were examined in this study.

Results showed that levels of fasting blood sugar (197.4 ± 51.93) and HbA1c (8.3 ± 1.69) in group II consisting of diabetic patients with chronic renal failure (CRF) were almost similar to group I patients with Type II diabetes. Thus no significant difference was observed in patients of group I in comparison with group II. However Fasting blood sugar and HbA1c in both diabetic patients (Group I) and Type II diabetic with CRF patients (Group II) were significantly high (p<0.01) as compared to controls (Group III) as shown in Table 1.

The results showed that levels of serum urea (125.2 ± 32.49) and creatinine (7.3 ± 1.41) in group II patients (Diabetes with CRF) were significantly high (p<0.01) as compared to group I (Diabetes) and group III (Controls) patients. However Creatinine clearance (55.1 ± 9.61) in group II patients (Diabetes with CRF) were significantly less (p<0.01) as compared to group I (Diabetes) and group III (Controls) patients. Serum chromium levels were significantly high (p<0.01) (11.5 ± 4.06) group II patients (Diabetes with CRF) and (11.4 ± 3.82) in group I patients (Diabetes) as compared to controls (group III) as shown in Table 2.

Table No. 1: Comparison of glycemic index in patients with Diabetes, Diabetes with CRF and controls

Glycemic index	(Group I) Diabetes (n=50)	(Group II) Diabetes with CRF (n=50)	(Group III) Controls (n=50)	p-Value
Fasting Blood Sugar (mg/dl)	201.4 ± 58.50 *	197.4 ± 51.93 *	100.8 ± 15.47	0.001
HbA1c (%)	8.4 ± 1.84 *	8.3 ± 1.69 *	5.5 ± 0.94	0.001

* As compared to controls p<0.01

Table No.2: Comparison of renal function in patients with Diabetes, Diabetes with CRF and controls

Renal function and serum chromium levels	(Group I) Diabetes (n=50)	(Group II) Diabetes with CRF (n=50)	(Group III) Controls (n=50)	p-Value
Urea (mg%)	**23.4 ± 9.32**	**125.2 ± 32.49****	**22.3 ± 8.49**	**0.001**
Creatinine (mg%)	**1.05 ± 0.24**	**7.3 ± 1.41****	**1.12 ± 0.23**	**0.001**
Creatinine Clearance (ml/min)	**111.9 ± 14.59**	**55.1 ± 9.61****	**108.8 ± 14.36**	**0.001**
Chromium (ug/dl)	**2.13 ± 0.82 ***	**2.22 ± 0.83 ***	**1.5 ± 1.07**	**0.001**

* As compared to controls p<0.01.
**As compared to Type II diabetic p<0.01

Table No.3: Correlation between Chromium, glycemic index and renal parameters in groups.

		FBS	HbA1c	Urea	Creat-inine	Creatinine clearance
Chromium (Pearson Correlation)	Control & DM	.385**	.363**	-.017	.030	.025
	Control & DM with CRF	.306**	.271**	.428**	.434**	-.432**

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 3 shows the correlation of serum chromium level with glycemic index (FBS, HBA1c) and renal

parameters (Urea, Creatinine and Creatinine clearance) in group I (Diabetes) and group II (Diabetes with CRF) patients. Analysis have shown that chromium has significant correlation with glycemic index ($p<0.01$) in both in group I (Diabetes) and group II (Diabetes with CRF) patients with controls, while correlation with renal failure was significant ($p<0.01$) only in group II (Diabetes with CRF) patients.

DISCUSSION

The results of this study showed that patients with diabetes and chronic renal failure in certain zones of the city particularly industrial areas had very high serum levels of chromium. Also the most of the patients were asymptomatic. These findings are also supported by Hwang et al (2001)[12] indicating that chromium is a tremendously toxic metal usually found in industrial place of work. As it is extensively used for stainless steel production, chrome plating, and pigments Chronic toxic levels of the chromium could be the possible cause of chronic renal failure but the scope of the present study does not indicate the possible role of chromium in the etiopathogenesis of CRF.

The serum chromium levels in our study were significantly higher when compared between patients with diabetics and diabetes with CRF patients to that of control group. Zadrazil (2011)[13] has also reported that kidney ailment is often caused by chromium exposure. The adverse effects of chromium toxic metal include growth depression, kidney damage and liver cancer which have been reported throughout world**.** In contrast to our findings Balk et al (2007)[14] have reported favourable outcome in patients with diabetes when treated with chromium supplementation. Most (about 97%) of the patients with diabetes associated with chronic renal failure had chromium levels above the levels recommended by W.H.O.

The findings of the present study do not support the correlation between CRF and chromium accumulation. If CRF patients are exposed to chronic exposure to chromium then one of the etiologic agent of CRF could be chromium, however the source of exposure to chromium remains uncertain. In contrast to our findings many researchers have reported mixed etiopathogenesis of CRF, with and without prior exposure to chromium. The main aim of this study was to determine the number of patients with CRF of unknown etiology is exposed to high levels of chromium leading to chronic kidney disease. Thus the results are concluded as chromium poisoning may be one of the pronounced risk factor for CRF.

CONCLUSION

Serum chromium level has significant correlation with glycemic index when the two groups including DM patients and patients with DM accompanied with CRF were compared with the controls, while correlation with renal failure was significant only in group II patients.

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