Original Research Article

Assessment of serum trace element (copper) level, as an associated risk factor in patients with chronic kidney disease

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Abstract

Background: Chronic Kidney Disease (CKD) is a progressive loss of kidney function and is a worldwide public health problem both for the number of patients and for the cost of treatment. Trace elements such as copper (Cu) is altered in CKD. We assessed 100 subjects of both sex with different age groups, among them 50 are normal healthy controls (group 1) and 50 are CKD patients (group 2) from dialysis ward (medicine) S.R.G. Hospital, Jhalawar Medical College, Jhalawar (Raj.) Serum copper was estimated using Flame Atomic Absorption Spectrophotometer (AAS). **Results**: Serum copper level was significantly low in CKD patients, mean ± SD (1.2041 ±0.46360) ($p<0.05$) when compared with the healthy control group (1.3823 ± 0.25259) ($p<0.05$). Gender had no significant effect on serum copper level, in males, (1.1992± 0.41431) and females (1.2146± 0.56946) ($p>0.05$). **Conclusion**: This study shows that in CKD patients, trace elements derangement is important in the primary diagnosis of trace element dysfunction and medical management of CKD.

Keywords: Chronic Kidney Disease, Trace Elements.

Introduction

Chronic kidney disease (CKD) is highly prevalent with morbidity, mortality, and health burden on the human population, about 3% of landmass and India represents 17% of the worldwide outcome of disease[1]. In CKD patients there is a progressive loss of kidney functions and damage of renal tissues with an irreversible reduction in kidney function[2]. It has been demonstrated that the presence of proteinuria, albuminuria, hematuria, and anatomical abnormality in chronic kidney disease subjects and chronic renal failure is important characteristics with reduced glomerular filtration perturbation of extracellular fluid volume, acid-base balance, and protein catabolism with nitrogenous waste retention by kidneys[3,4]. National Kidney Foundation (NKF) established a definition and classification of CKD which describe "kidney damage or a decreased glomerular filtration rate (GFR) of less than 60 ml/min/1.73 m2 for at least 3 months[5]. However in CKD subjects decreased kidney function due to loss of nephron which leads to declined GFR progressively[6].

Trace elements constitute a small amount of total body tissue and are defined as one that makes up less than 0.01% of the body's mass (µg/dl in body fluids and at mg/kg in tissues). Trace elements have significant properties in biochemical reaction participation, the structure of proteins, enzymes and carbohydrates, metallic ions such as copper and iron[7].

Level of trace elements not only play important role in chronic kidney disease but also other associated diseases such as cancer, cardiovascular diseases, osteodystrophy, anemia, insulin resistance, decline renal function[8] and thyroid disorders[9]. Copper is an important trace element that constitutes in total body 100mg and seen in several tissues such as brain, hair, heart, bone marrow, liver, muscles, kidney, and copper role in biological electron transport and oxygen transportation[10].

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Chronic kidney disease patients are at high risk for both deficiency and accumulation of trace elements and depend on dietary intake and dialysis.

In the present study, we determined serum copper levels in chronic kidney disease hemodialyzed patients and in non-chronic kidney subjects for prognostic and medical management of CKD patients in the Jhalawar region of Haroti, Rajasthan (India).

Materials and methods

The present study was aimed to know serum copper levels in 100 subjects among them 50 were chronic kidney disease (CKD) and 50 non-chronic kidney disease healthy subjects. This study was conducted in the Department of Biochemistry and Dialysis Unit of Medicine, S.R.G hospital (tertiary care hospital), and Jhalawar Medical College, Jhalawar (Raj.). The present study was conducted between September 2018 to April 2019. Ethical permission and written consent were taken from all participants. Present study data collection procedure was based on name, age, sex and for diagnosis of chronic kidney disease, clinical history with associated biochemical parameters (evidence) were taken as criteria of the study. Non-chronic kidney disease subjects were healthy for comparison of study.

Inclusion criteria

Case

1) Patients with history and physical findings of kidney disease.
2) Both males and females above 20 years of age.
3) Biochemical analysis suggestive of chronic kidney disease.

Control

1) Healthy male and female above 20 years of age.

Exclusion criteria

1) Patients with diabetes mellitus.
2) History of anti-thyroid drugs.
3) Chronic use of medicine (e.g. steroids, anti-cancer drugs).
4) Pregnancy.
5) Any systemic disease: connective disorders, liver disease, and psychiatric disorders.

In the course of the present study, the conditions of ethics and regulation were followed and there were not carried out no experiments to impair the health of patients.

5ml of blood (venous) samples were taken under aseptic conditions in sterile tubes from the normal healthy controls and the patients of chronic kidney disease. Samples were allowed to clot and centrifuged at 3000 rpm for 10 min and serum separated.

Serum copper was estimated in serum of subjects of control group I and case (patients) group II by flame atomic absorption spectrophotometer.

The amount of copper in the sample standard solution was determined. The working standard solution of copper was prepared. Next, the instrument was operated, by optimizing the Burner System and then the performance was checked and lastly, a calibration curve was created and samples were analyzed. The graph of absorbance against concentration was plotted to show the Beer-Lambert law.

Principle of atomic absorption spectrophotometer

The sample is subjected to a high-energy thermal environment to produce excited-state atoms. This environment can be provided by a flame. The "ground state" atom absorbs light energy of a specific wavelength as it enters the "excited state." As the number of atoms in the light path increases, the amount of light absorbed also increases. By measuring the amount of light absorbed, a quantitative determination of the amount of analyte can be made. The use of special light sources and careful selection of wavelengths allows the specific determination of individual elements[11].

Normal Range (Laboratory)

COPPER - 12-25 µmol/L or
0.76-1.58 ppm

Results

In the present study among 100 subjects, 50 were healthy control (group I) and 50 cases of known chronic kidney disease. The mean age was found to be 39.96 and in group II 42.18 (Table 1). The statistical data in our study were expressed as mean ± SD. P<0.05 was considered statistically significant.

Table 1: Distribution of Age according to Group I (Control) and Group II (Cases) Patients

Group	N	Mean Age	Std. Deviation	T value	P value
GROUP I (Control)	50	39.96	15.331	0.715	0.476
GROUP II (Cases)	50	42.18	15.709		

We have determined serum copper levels in CKD cases and non-CKD subjects. Table 2 and Graph 1 show the distribution of gender according to the group I and group II and no statistically significant difference of gender between these two groups.

Table 2: Distribution of Gender according to Group I (Control) and Group II (Cases) Patients

Gender	Group		Total	P value
	Group I (control)	Group II (cases)		
Male	25 (42.4%)	34 (52.6%)	59 (100.0%)	0.067
Female	25 (61.0%)	16 (39.0%)	41 (100.0%)	
Total	50 (50.0%)	50 (50.0%)	100 (100.0%)	

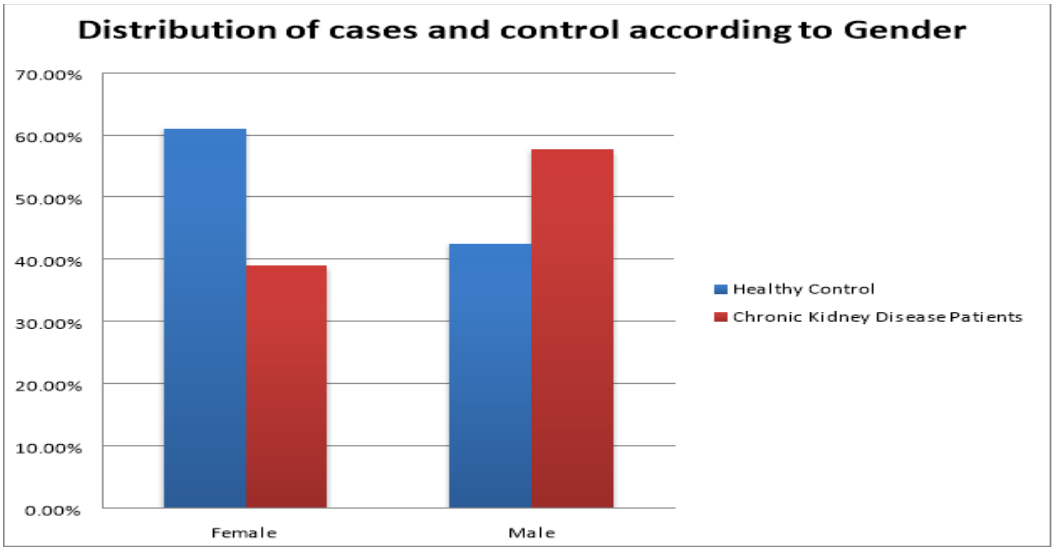

Fig. 1: Distribution of cases and control according to gender

The mean level of copper in both groups (I & II) demonstrates in table3 and there was a statistically significant difference found (P<0.05) which suggest that patient with chronic kidney disease have low serum copper as compared to the control group.

Table 3: Distribution of Copper (ppm) according to Group I (Control) and Group II (Cases) Patients

Biological reference value	Group	N	Mean	Std. Deviation	T value	P value
Copper	GROUP I (Control)	50	1.3823	0.25259	2.386	0.019*
0.76-1.58 ppm	GROUP II (Cases)	50	1.2041	0.46360		

The overall distribution of copper according to gender (male & female) is presented in table 4 and there was no significant effect on serum copper level (P>0.05).

Table 4: Distribution of Copper (Cu) according to Gender in Group II (Cases) Patients

	Gender	N	Mean Cu	Std. Deviation	T value	P value
Copper (Cu)	Male	34	1.1992	0.41431	0.108	0.914
	Female	16	1.2146	0.56946		

Discussion

Trace elements are important markers in the development and progression of chronic kidney disease. Copper level in serum was found to be a variable marker in impairment of kidney functions, proteinuria exceeding free radicals, dietary restriction, and changed in intestinal uptake[12]. Copper participates in cytochrome oxidation of tissue cells for energy production, promotes the absorption of iron from the intestine and transfer from tissue to plasma, and is essential to hemoglobin formation[13].Chronic kidney disease is a burden to society and a threat to the affected population globally. There is persistent loss of both tubular and glomerular functions. Copper is a trace element of its deranged value during chronic renal failure for example – dialysis and restricted protein intake[14].

In our study, two groups were selected. In group I 50 subjects of normal healthy function and in group II 50 patients with chronic kidney disease attended the dialysis unit of Jhalawar Medical College and S.R.G. Hospital, Jhalawar (Raj.).

Mean ages of both groups are found. Statistically, there were no differences in gender and mean ages of both groups, a similar study reported by other workers[15].In the present study serum copper level was decreased and statistically significant when compared to healthy control group I with patient group II (chronic kidney disease). Similar study demonstrated in literature[16,17,18,19].Study shows that a lower level of copper was correlated with increased activities of the antioxidant metalloenzyme superoxide dismutase in chronic kidney disease subjects[20].

However, hypercupremia has been reported in subjects undergoing chronic dialysis[21,22]. Serum copper level affected by the time of sample collection, inadequate intake, and malabsorption[23].

In our study decreased level of copper in chronic kidney disease patients is important due to primary diagnosis and medical management of kidney disease.

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