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Effects of Hemodialysis on Serum Copper and Zinc Levels in Sudanese Patients with Chronic Kidney Disease

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Abstract

Background: Trace elements are essential nutrients with a gamut of functions in human being. Hemodialysis patients are at risk for deficiency of essential trace elements and excess of toxic trace elements, both of which can affect health. Alterations in trace element levels in patients receiving long-term renal replacement therapy have been implicated in immune dysfunction and increased oxidative stress.

Patients and Methods: This was a case control study conducted at Gezira Hospital for Renal Disease and Surgery, Wad Medani, Gezira State, from July 2020 to May 2021 was aimed to evaluate the effect of hemodialysis on serum copper and zinc levels in patients suffering from chronic kidney disease. A total of 90 individuals were included in this study which divided into two groups; 60 healthy person as control group and 30 patients with chronic kidney disease as case group. Blood samples were collected, one time from control group and two times from case group at pre and post dialysis. Serum copper and zinc were estimated with atomic absorption spectroscopy. Data were collected by questionnaire and analyzed by statistical package for social sciences version (21) and medical calculator.

Results: it showed that 66.7% of patients were males and 33.3% were females, 43.3% of patients age from 23-40 year, 40% from 41-57 year and 16.7% from 58-75year, 3.3% patient were underweight, 33.3% were with normal weight, 30% overweight and 33.3% obese. The family history showed that 13.3% had family history and 86.7% had no family history. Duration of disease showed that 60% were less than 5 years and 40% more than 5 years. The history of chronic disease found that 76.7% of patients were hypertensive and 26.7% were diabetic. There is no significant deference in serum zinc levels between pre hemodialysis and control group (p. value 0.656), while, a significantly decrease levels observed after hemodialysis when compared to control group and pre hemodialysis (p. value 0.014 and 0.000). Serum copper levels were significantly decreased in pre hemodialysis and post hemodialysis when compared to control group with P. value (0.000), also serum copper levels were significantly decreased in post hemodialysis when compared with pre hemodialysis with P. value (0.000). Serum copper and zinc levels had weak correlations with age, gender, BMI and duration of hemodialysis, whereas, the level of serum zinc after hemodialysis had strong positive correlation with their levels before dialysis (Person correlation: 0.727 and P. value 0.000). Homolateral, there is strong positive correlation in copper levels between post and pre dialysis (Person correlation: 0.716 and P. value 0.000).

Conclusion: Hemodialysis has an effect on serum copper and zinc levels by decreasing their levels in serum, thus, regular monitoring of serum copper and zinc levels in hemodialysis patients and copper - zinc supplements are recommended after hemodialysis.

Key words: Hemodialysis, Copper, Zinc, Trace Element, Sudanese, Renal disease.

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Introduction:

Kidney function declines slowly and steadily in chronic renal failure. It is typically a side effect of another serious medical illness, and it is currently one of the most significant health issues in the world (1). Early screening is essential to stop the onset of end-stage renal failure because the mortality rates in individuals with chronic renal failure are high both before and after the start of renal replacement treatment (2). Chronic renal failure (CRF) is a slowly progressing kidney illness that affects the kidneys over months and years (3). Low rates of glomerular filtration are its defining feature for CRF (4). CRF is a sign of a severe illness that requires specialized replacement therapy for the renal system, such as dialysis, to address (5). CRF has a 1 in 5000 incidence rate and primarily affects middle-aged and elderly individuals. It is largely irreversible and may eventually result in renal failure (6). Removal of waste materials and fluids from the bloodstream and disposal through the urine pathway are key components of the kidney's physiological function (7). Dialysis, which involves removing excessive toxic fluids and metabolic waste products from the body, is one form of treatment for patients who have unexpectedly lost their renal function or who have reached end-stage renal stage (8). To better understand how dialysis affects CRF patients, it is crucial to compare the mean values of serum renal biochemical indicators before and after dialysis. A trace element is an element in a sample with an average concentration of fewer than 100 parts per million, or less than 100 micrograms per gram, as measured in atomic count (9). A trace element is a dietary mineral in biochemistry that is required in very small amounts for the appropriate physiology, growth, and development of the organism. In biology, a trace element, sometimes known as a micronutrient, is any chemical element needed by living things in very small amounts, typically as a component of an essential enzyme or a catalytic protein made by the cell (10). Despite being strong and relatively soft, copper (Cu) has outstanding electrical and heat transmitting qualities. Both in its elemental form and in compounds, copper are widely present in the natural world. Tin, nickel, and copper combine to make the alloy cupronickel, which is commonly used in coinage (11). Copper is a mineral that is necessary for several processes. Even though copper insufficiency is uncommon in the majority of people, people with end-stage renal disease (ESRD) are more likely to develop copper deficit than people without ESRD (12). First, those on HD have limited access to dietary copper. Second, antacid or alkali therapy may result in impaired copper absorption and/or copper insufficiency. The consumption of mineral supplements is a third factor that could have an impact on HD patients' copper status (13). The importance of zinc in human nutrition has been clearly shown by the identification of numerous clinical conditions that are related to zinc (14). It is the second-most prevalent trace element in the body after iron (15). Some

common uremic symptoms, such as immunological dysfunction, impairments of taste and smell, growth retardation in children, and male testicular shrinkage, have been linked to zinc deficiency (16). The objective of present study was to evaluate the effect of hemodialysis on serum copper and zinc levels in patients suffering from chronic kidney disease.

Patients and Methods:

The study was analytical case control hospital based study carried out in Gezira hospital for renal disease and surgery, Wad Madani city, Gezira State during the period from July 2020 to May 2021. Three ml of venous blood samples were collected in plain containers from healthy individuals as control and two times from patients with chronic kidney at pre and post dialysis. Ninety subjects; 30 patients with hemodialysis (sample pre-dialysis and second sample post-dialysis) and other 60 healthy subjects as control groups were enrolled in this study. Chronic kidney disease patients under indapamide and amlodipine treatment or with recently blood transfusion and patients receiving supplements containing zinc or copper were excluded from this study. The blood samples were collected randomly in the plain containers from study population after taking verbal consent, then the samples were mixed and centrifuged for 3 minutes. The plasma was transferred into new plain containers. Data were collected using structured interviewing questionnaire that include many variable such as age, gender, BMI, and duration of disease. Serum zinc and copper were estimated with buck model 210 VGP atomic absorption spectroscopy. Serum copper normal value from 0.7 to 1.4 mg/L, and serum zinc normal value from 0.5 to 1.2 mg/L. Ethical consideration was include permission to conduct this study was obtained from Ministry of health and health insurance, research approval was obtained from research board faculty of medical laboratory sciences, University of Gezira, and written consent from each patient had been taken. The precision and accuracy of the methods used in this study were checked each time by using control material. The data of this study were analyzed using the statistical package for social study (SPSS) software (version21). T-test presented as (Mean ± SD) and correlation test (R value). A P-value of less than 0.05 was considered statistically significant.

Results:

A total of 90 individuals were included in this study when 60 healthy people as control group and 30 patients with chronic kidney disease as case group which two samples were collected at pre and post dialysis. Results showed that 66.7% of patients were males, 43.3% of patient's age from 23-40year, and 63.3% overweight and obese. The family history of renal disease showed that 13.3% had family history and 86.7% had no family history. Duration of the disease showed that 60% were less than 5 years and 40% more than 5 years. The history of chronic disease found that 76.7% of patients were hypertensive and 26.7% were diabetic.

Table 1: Distribution of chronic renal disease according to demographic data:

Risk Factors		Number	Percent %
Age	23 – 40 Year	13	43
	41 – 57 Year	12	40
	58 – 75 Year	5	17
Sex	Male	20	67
	Female	10	33
Obesity	Underweight	1	3.3
	Normal Weight	10	33.3
	Obese	10	33.3
	Overweight	9	30
Hypertension	Hypertensive	23	77
	Normotensive	7	23
Diabetes Mellitus	Diabetic	8	27
	Non-Diabetic	22	73
Disease Duration	Less than or equal 5 year	18	60
	More than 5 years	12	40
Family History of renal disease	Yes	4	13
	No	26	87
Total		30	100

Table 2: Means of serum copper and zinc levels in pre and post dialysis:

Trace elements		N	Mean	STD	P. Value
Copper	**Pre**	30	0.29	0.08	**0.000**
	Post	30	0.23	0.07	
Zinc	**Pre**	30	0.50	0.21	**0.000**
	Post	30	0.35	0.15	

Table 3: Comparison of serum copper and zinc levels between control group and cases (pre and post dialysis):

Trace elements		N	Mean	STD	P. Value
Zinc	Pre	30	0.50	0.21	0.656
	Control	60	0.47	0.37	
	Post	30	0.35	0.15	0.014
	Control	60	0.47	0.37	
Copper	Pre	30	0.29	0.08	0.000
	Control	60	1.13	0.45	
	Post	30	0.23	0.07	0.000
	Control	60	1.13	0.45	

Table 4: Correlation between serum zinc with age, gender, BMI and duration of dialysis:

Zinc	Correlation coefficient r	P. Value	95% Confidence interval for r
Age	-0.32	0.083	-0.61 to 0.043
BMI	0.03	0.884	-0.34 to 0.38
Duration	-0.01	0.952	-0.37 to 0.35

Table 5: Correlation between serum copper with age, gender, BMI and duration of dialysis:

Copper	Correlation coefficient r	P. Value	95% Confidence interval for r
Age	-0.16	0.403	-0.49 to 0.21
BMI	0.11	0.555	-0.26 to 0.45
Duration	-0.16	0.402	-0.49 to 0.21

Table 6: Correlations between serum zinc and serum copper levels in pre and post dialysis:

		ZnPre	ZnPost	CoPre	CoPost
ZnPre	Pearson Correlation	1	0.727	0.284	0.113
	P. value)	-	0.000	0.128	0.551
ZnPost	Pearson Correlation	0.727	1	0.101	-0.065
	P. value)	0.000	-	0.595	0.733
CoPre	Pearson Correlation	0.284	0.101	1	0.716
	P. value)	0.128	0.595	-	0.000
CoPost	Pearson Correlation	0.113	-0.065	0.716	1
	P. value)	0.551	0.733	0.000	-
	N	30	30	30	30

Discussion:

Slowly progressive disease of the kidney function progressing over a period of months and years was called chronic renal failure which mange usually by compensation of renal function especially the waste elimination by artificial purification systems as hemodialysis (17). This case control study conducted to evaluate the effect of hemodialysis on serum copper and zinc levels in patients suffering from chronic kidney disease at Gezira Hospital for Renal Disease and Surgery, Wad Medani, Gezira State, Sudan. This research included 90 participants: 60 healthy individuals as control group and 30 patients with chronic renal failure. The trace elements (serum copper and zinc) levels were measured before and after hemodialysis. The CRF patients were age between 23 to 75 years and most of them male and above 40 years (67%, 57%). The most risk factors were found in study patients were 77% hypertensive, 63.3 obese and overweight, while decrease a probability of some risk factors

like diabetes and family history of CRF(73% non-diabetic and 87% without family history). Majority of patients were affected recently with disease duration less than 5 years about 60%.Serum zinc levels as same in pre hemodialysis and control group without significant deference but significantly decrease after hemodialysis when compeers with control group and pre hemodialysis, this finding agree with study done by Ashraf Naged Ismael *et al.* in Egypt (2022) (18) and other study done by Rana M. Hasanato in Sudia Arabia (2014) (19) but disagree with study done in Sudan by Shehab and Amar were concluded to increased serum zinc after dialysis (20). Serum copper level was significantly decreased in CRF patients when compeer with healthy individuals, Moreover, copper level was affected by hemodialysis which significantly decreased after dialysis less than before it, this result was near to study done in Rajasthan by Ritika Gupta *et al.* (2022) (21). Serum copper and zinc levels had weak correlations with age, gender, BMI and duration of hemodialysis, this finding was agree with study done in Sudan 2018 by Fayza A Rahamtalla*et al* (22). The serum copper level in post hemodialysis had strong positive correlation with copper level in pre hemodialysis and weak positive correlation with serum zinc levels in pre and post dialysis, on the other hand, serum zinc level in post hemodialysis had strong positive correlation with their level in pre hemodialysis. These results indicated to decreasing in serum copper and zinc was affected by their concentration before hemodialysis.

Conclusions:

Serum copper and zinc levels were decreased after hemodialysis when compared to their levels before hemodialysis and control group. The levels of serum copper and zinc at post hemodialysis had positive strong correlation with serum copper and zinc at pre hemodialysis, respectively. Regular monitoring of serum copper and zinc levels in hemodialysis patients and minerals supplement (copper, zinc) are recommended after hemodialysis.

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