Levels of Trace and Essential Elements in Sera of Chronic Renal FAilure Patients Before and After Dialysis

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Abstract

This study included a group of (15) chronic renal failure patients (CRF), an addition group of (15) healthy individual was concluded in this study for control. Trace and essential elements (Zn, Cu , Ca , K , Na) were measured by atomic absorption and flam analyzer in sera of CRF patients pre and post dialysis and control groups. The results showed a significant ($p < 0.05$) increase in Zn and k+ concentration in sera of CRF patients pre and post dialysis compared to the control group. While there is a significant decrease for copper concentration in sera of CRF patients pre and post dialysis compared to the control group.

There was no significant alteration ($p > 0.05$) in Ca and Na+ concentration in sera of CRF pre and post dialysis compared to the control group.

Introduction

Chronic renal failure (CRF) is syndrome, which results it's a strong progressive and an irreversible destruction of nephrons [1].

The destruction lead to the reduction of glomerulur filtration rate (GFR) [2]

Uremia often occurs as a symptom and complication of CRF , though some patients may be asymptomatic until the GFR falls below 5-10 ml /min, nephrous can regenerate and restore normal function after acute failure , but (CRF) requires a kidney transplant or hemodialysis [3]

Hemodialysis is not limited to the treatment of renal insufficiency it is also used in liver disease to remove wastes normally detoxified by the liver

Zinc is an essential trace element and is a required component of many enzymes [4]

Zinc exists in high concentration in kidney among other organs zinc which influences many body systems and function .Zinc as a cofactor for many metal enzymes ,it is transported in plasma mostly by albumin (60-70) %.Although serum or plasma were the usual specimen of assessment of zinc status, urine and leukocyte zinc level were also used .Copper is an essential element in biological system.

Copper is incorporated into several enzymes involved in hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross- linking of collagen, elastin and hair keratin [5].

A 70 k gm human, adult body contains approximately 80 mg of copper. Following absorption copper the main site of bounded Cu is cerruplasmine and is mainly deposited in liver hepatocytes with lesser amounts in the kidney.

Biliary excretion is the major route with small amounts secreted in the urine

Elevated serum copper level over 2.0 mg/l (31.5 mol/ l)can result from the use of oral contraceptive and estrogen therapy and are usual during the third trimester of pregnancy. Serum levels are also elevated in some patients undergoing renal dialysis Calcium is essential for both the physical structure of bone and for normal physiological function (e.g., nerve

conduction, muscle contraction, blood clotting membrane permeability, enzyme activation, and acetylcholine synthesis [6].

The average healthy adult body contains about 1200g of calcium 99%of which is found in bone and teeth, with remaining 1% in the extra cellular fluids, intracellular structures, and cell membranes Very large chronic intakes are associated with hypercalcemia and / or hypercalciuria. Other symptoms of calcium excess include renal failure and soft tissue calcification. High – calcium diets could increase the risk of kidney stones in susceptible individuals and reduce the bioavailability of zinc and iron

which Oxidation on the surface of the metal may form highly reactive superoxides , which can detonate the bulk causing spattering and skin and eye penetration .

The main trace element is K in the intracellular fluid, accumulating to a concentration about 30 times higher than in plasma. Potassium in plasma is involved in nerve transmission, muscle contraction and blood pressure homeostasis. The gastrointestinal absorption of potassium is nearly complete: plasma concentrations are kept within a narrow range by regulation of urinary excretion and by depletion of body stores in cases of low potassium intake [4]. Potassium appears to moderate the effect of increased sodium intake on elevating pressure probably by affecting renal sodium excretion. Sodium is the main element of extra cellular fluid and the primary regulator of extra cellular fluid volume [7].

Sodium also regulates osmolarity, acid –base balance and membrane potential and participates in active transport across cell membranes. Renal excretion of sodium maintains homeostasis over a wide range of intakes and losses, via aldosterone control of tubular excretion [6].

The aim of this study included the measurement of the trace elements (zinc, copper) and essentially elements (potassium, sodium and calcium) for pre and post dialysis chronic renal failure by using atomic absorption and flame analyzer.

Sampling

The samples were collected from (AL-kadhmeia teaching hospital and specialized surgical hospital)

They were classified into two groups as the following:

1.Control group: included [15] healthy individual from both sexes, with no previous disease, which may interfere with the parameters analyzed in this study.

2.Patients group: include [15] Chronic Renal Failure patients (CRF) (pre and post) dialysis

Samples and methods

Collection of blood

Ten ml venous blood was taken from the above groups , place in plane tube (no anti coagulant) left for (15 min) at room temperature , then centrifuged (at 300 rpm) for (20 min) to get serum ,which is stored at (-20 C) unless used immediately .

Experimental

Determination of (Zinc, Copper, Calcium, Sodium, & Potassium)Concentration in serum was performed by using atomic absorption spectrophotometer shchimadzu AA 670 (Japan) (, while the concentrations of (Na+ & K+) in serum samples were determined by flame analyzer (Gallen Kamp).[8]

Statistical analysis

Statistical analyses were performed by using Microsoft excel 2003.

Data presented were the means and standard deviations. Analysis of student - t - test was also made to compare the significance of difference in the mean values of any tow groups

($P< 0.05$) was considered statistically significant [9].

Result and Discussion

Serum zinc, copper concentration (□mol/ l) and serum calcium concentration (mmol/ l) of chronic renal failure and control groups were shown in table (1) and figure (1) .

From table (1) and fig (1) zinc and copper concentration shows a significant decrease in sera of (pre and post) dialysis in CRF group compared to normal control

no significant alteration in serum calcium level (pre and post) dialysis in CRF group compared to normal control [10].

Zinc deficiency was first described in human in the early 1960s research which has elucidated many of its specific metabolic interaction moreover the discovery of a variety of zinc –related clinical disorders has directly demonstrated the importance of Zn in human nutrition .The zinc metabolism is altered in chronic uremia, and it is not corrected by maintenance dialysis therapy [11].The cause of zinc deficiency associated with chronic uremia has not been elucidated increased the urinary zinc losses or decreased intestinal zinc absorption which may contribute to the presence of zinc deficiency in uremia. Previous studies performed in laboratory have shown a decreased renal tubular re –absorption of zinc both in chronic uremia patients and rat model of chronic uremia [12].

The low level of serum zinc concentration found in the present study consists with the reports of other investigators Ongajooth et al. (1996) [13] observed that plasma Zn was significantly lower in the hemodialysis (HD) patients than in the controls.

Some factors that may count for low serum Zn levels in CRF patients are restriction of protein diet , low dietary Zn intake, a specific Zn transport defect, and absence of intestinal Zn ligand. Zn supplementation was recommended when protein is restricted in CRF patients. The cause of zinc deficiency is not well known in uremic patients but malnutrition and malabsoption are most common, decreased bioavailability of zinc in the diet, dietary habits drug intra zinc and increased urinary excretion of zinc as factor underlying zinc deficiency was observed that zinc urea is directly connected to protein urea in patients with nephrotic has reported that they observed a relationship between zinc deficiency with CRF [14].

In some studies, serum Cu levels were higher in HD patients while in others, the serum cu levels in patients with CRF were within normal ranges or lower .

Serum Cu levels were significantly lower in the HD patients than in the controls. Our results are compatible with that reported value in CRF,. Although, this may seem to be and inconsistency with other study claimed that , the serum levels were also within normal ranges. Also study by, Krachler reported elevated plasma Cu content before and after HD and investigated kinetics of plasma cu during HD sensation revealed that plasma Cu is steadily increasing. Similarly, it was showed a higher concentration Cu in HD patients while showed no change during the dialysis treatment

Calcium is an important ion in the normal functioning and survival of animal cells. The human body is equipped with an efficient protection system against hypocalcaemia.

This system is composed of parathyroid glands bone, kidney, and intestine

By appropriate action of parathyroid hormone (PTH) and active vitamin-D, a small fall of extra cellular calcium ion concentration is instantly corrected. Thus, a defect of any step in this system results in the development of hypocalcaemia [16]

Overloaded calcium either from bone or intestine is efficiency excreted into urine

Thus hypercemia develops almost exclusively when a greater amount of calcium than the kidney can excrete is loaded . In chronic dialysis patients, either hypocalcaemia or hypercalcemia may develop because of defects in these two defense systems against calcium imbalance . Calcium accumulations in erythrocytes were associated with a wide range of toxic factors. Increased in intracellular ,calcium concentration of erythrocytes may cause decreased deformability and observed erythrocytes [17].

Many reports indicate that Ca pre- and post – HD remain higher than control The suggestion is that many factors, such as complement activation, shearing stress, and peroxidative damage of the membrane's lipid-may increase the erythrocytes membrane permeability during HD and favor calcium influx [18].

The potassium and sodium concentration (meq/l) in sera of studied groups were presented in table (2) and fig (2) .The results of potassium for pre and post –dialysis in CRF were (6.8429 ±1.506) meq / l (6.0 ± 1.600) meq /l respectively compared to the normal control (4.729 ± 0.6887) Potassium concentration was significantly increased for pre and post – dialysis compared to control Potassium (K) is the major determinate for the resting membrane potential of excitable cells [19].

The concentrations of potassium should be kept 3-5 mmol/L. Severe hypokalemia leads to pronounced hyper polarization of the cell membrane which causes ventricular arrhynias. Plasma K^+ levels higher than 7 mmol/L cause life-threatening cardiac events as well as blood pressure decreases. Michael and Hermiann (1999) reported that elevated plasma K concentration in HD patients decreased steadily during HD to level of healthy adult. Documented to the rapid fall ectopy in serum potassium concentration during dialysis ,our results are in an agreement with the reported value [20].

The development of intracellular acidosis in kidney from potassium deplete rats was demonstrated by ^{31}P NMR studies. The ^{31}P NMR study also showed that an infusion of KCl led to a rapid (30 minute) returned to normal pH in kidney from potassium deplete rats, suggesting the possibility of an interchange of (H^+) and (K^+) within an intracellular compartment. While severe potassium depletion induces an intracellular acidosis in muscle. Early studies associated with more modest study of potassium depletion failed to demonstrate an intracellular acidosis The decrease of plasma potassium concentration was prevented by the increase of K^+ concentration in the dialysis according to its predialysis plasma level One of the goals of periodic dialsate is the removal of K from the body that has accumulated over the two to three days between blood and dialysis potassium concentration [21].

Na is the representative of the extra cellular electrolytes that are substantial for maintaining the osmotic balance between extra-and intra cellular space. Moreover, Na is an important determinant in blood pressure control, and the plasma level of Na should be kept in the range of 135-145 mmol/L . High plasma Na concentrations (hypernatermia) give rise to elevated blood pressure, and consequently, lead to an increased preload of the heart.

Table (2) and fig (2) showed the results of sodium in sera of pre – dialysis , post-dialysis were (138.363 ± 4.148) (137.03 ± 3.448) respectively compared to control group (137.58 ± 7.858)

On along run, high plasma Na level leads to cardiovascular disease and hence adequate Na balance during dialysis is of major importance for the prevention of complication (20) . To keep the Na balance in patients, the required range was 135-145 meq/L. Our results (134-144) m mol/L is compatible with the reported value in HD for chronic renal failure. This balance

was established by an appropriate selection of the Na^+ concentration in the dialsate, and no ionic flow across the membrane occurred. Low sodium concentration (hyponatremia) possible causes of sodium deficiencies include prolong sweating, renal disease in which sodium is reabsorbed inadequately, adrenal cortex disorders in which aldosterone secretion is insufficient to promote the reabsorption of sodium and drink too much water. Possible effect of hyponatremia include the development of extra cellular fluid that is accompanied by Osmosis , the concentration of Na in plasma and dialysis fluid were almost identical and did not change during hemodialysis(21) .

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Table (1) :Concentration of Zn, Cu and Ca in sera of patient and control groups

	No.	Zn (□mol/l)	p	Cu (□mol/l)	p	Ca (mmol/l)	p
Control	15	10.102 ± 3.068		26.34 ± 7.558		2.52 ± 0.3545	
Pre-dialysis	15	16.54 ± 7.36	P < 0.05	23.329 ± 8.744	P < 0.05	3.1813 ± 0.163	p >0.05
Post-dialysis	15	17.075 ± 7.726	P < 0.05	22.00 ± 9.565	P < 0.05	2.9330 ± 0.328	p >0.05

Table (2): Concentration of K+, and Na+ in sera of patient and control groups

	No.	K+ (Meq/l)	p	Na+ (Meq/l)	p
Control	15	4.729 ± 0.6887		137.58 ± 7.858	
Pre- dialysis	15	6.8429 ± 1.506	P < 0.05	138.363 ± 4.148	p >0.05
Post-dialysis	15	6.0 ± 1.600	P < 0.05	137.03 ± 3.448	p >0.05

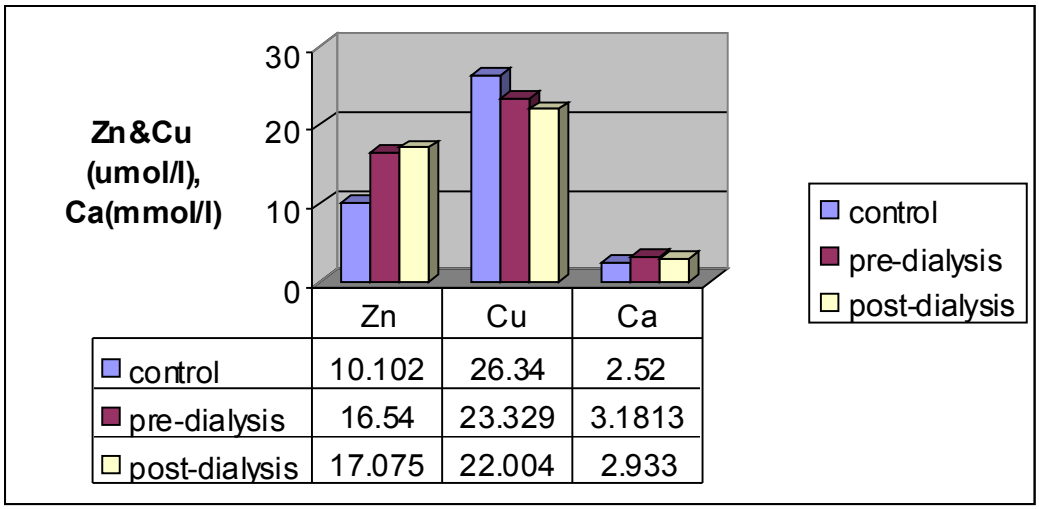

Fig. (1): Concentration of Zn, Cu and Ca in sera of patient and control g

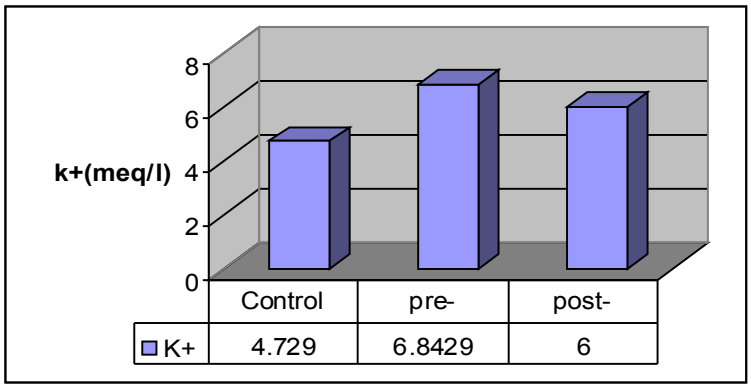

Fig. (2): Concentration of K+ in sera of patient and control groups

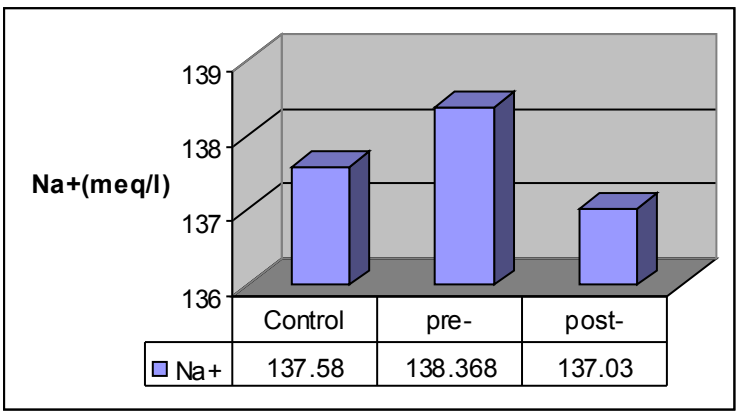

Fig. (3): Concentration of Na+ in sera of patient and control groups

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مستويات العناصر النزرة والاساسية في مصل دم مرضى الفشل الكلوي المزمن قبل وبعد الديلزة

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الخلاصة

تضمنت هذة الدراسة(15) مريضاً من مرضى الفشل الكلوي المزمن فضلا عن (15) فرداً من الاصحاء. العناصر الاساسية والنزرة (Zn, Cu, Ca ,K, Na) تم قياسها بواسطة الامتصاص الذري والمحلل اللهبي في مصل دم مرضى الفشل الكلوي المزمن قبل وبعد عملية الديلزة. وفي مجموعة السيطرة اظهرت النتائج الزيادة المعنوية ($p < 0.05$) في تركيز Zn و+K في مصل دم مرضى الفشل الكلوي المزمن قبل وبعد عملية الديلزة بالمقارنة مع مجموعة السيطرة، بينما كان هنالك نقصان معنوي في تركيزالنحاس في مصل دم مرضى الفشل الكلوي قبل وبعد عملية الديلزة بالمقارنة مع مجموعة السيطرة .