

**MAGNESIUM, ZINC, AND COPPER IN SERUM, ERYTHROCYTE, URINE AND
DIALYZATE FLUIDS OF HAEMODIALYSIS PATIENTS**

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ABSTRACT:

Copper (Cu) Zinc (Zn) and Magnesium (Mg) in serum, RBC, urine and dialyzate fluids were studied in 39 patients, who have been undergoing chronic haemodialysis treatment. They were divided in to polyuric , oliguric and anuric depending on their urinary output. Elevated serum and RBC Mg was observed before dialysis, while decreased serum and RBC level was noticed except serum Mg of polyuric patients. Before dialysis elevated serum and RBC Zn were observed. While after dialysis these parameters were increased. Normal RBC Cu value before dialysis was observed. While low serum Cu was noticed. After dialysis serum Cu showed raised value, while RBC level decreased in oliguric and increased in polyuric patients. Zn / Cu ratio found to be high in those patients. All these results were discussed in relation to urine content and also to the dialyzate fluid.

Key words: Trace elements, Haemodialysis, Renal failure

الخلاصة:

قيست تراكيز المغنيسيوم والخاصين والنحاس في مصل وكريات الدم الحمر وإدرار ومحلول الغسيل الناتج لدى تسعة وثلاثين مريضاً عولجوا بالإنفاز الدموي واللذين قسموا حسب كمية الإدرار المطروحة إلى غزيري وقليلي وعديمي الإدرار، ظهر ارتفاع في تركيز المغنيسيوم في مصل وكريات الدم الحمر قبل المعالجة في حين انخفض تركيزه بعدها، عدا مصل غزيري الإدرار، ارتفع تركيز الزنك في المصل وكريات الدم الحمر قبل وبعد المعالجة، وبقي تركيز النحاس طبيعياً في كريات الدم الحمر قبل المعالجة في حين انخفض تركيزه في المصل، وارتفع بعد المعالجة بينما انخفض في كريات الدم الحمر في مرضى قليلي الإدرار، وارتفع لدى مرضى غزيري الإدرار، وارتفعت نسبة الزنك إلى النحاس في جميع المرضى. نوقشت جميع النتائج على ضوء محتوى الإدرار ومحلول الغسيل من هذه العناصر.

INTRODUCTION:

In most dialysis units, little attention was given to the trace element contents of renal dialysis fluids or to the possibility of contamination of such fluids with trace metals. A number of considerations suggest that trace element disturbances might occur in dialyzed patients, must at least in part be ascribed to the dialysis treatments itself during which these constituents may either be transferred to or removed from the patients⁽¹⁾. Isolated cases of acute copper and zinc toxicity have occurred in haemodialysis patients as results of contamination of dialysis equipments or fluids with these metals⁽²⁾. Other reported hypozincemia in haemodialysis patients⁽³⁾. Previous study reported elevated Silicon and Aluminum in those patients⁽⁴⁾. The present study was intended to clarify levels of Serum Zinc (Zn), Copper (Cu), and Magnesium (Mg), according to the patient's urine output, erythrocytes Zn, Cu, and Mg and comparing them with control group. Also studying levels of these elements in the patient urine and the dialyate.

PATIENTS AND METHODS:**Subjects:**

Thirty-nine patients (25 males and 14 females), aged between 18 and 70 years, treated with haemodialysis (H.D), 17 were polyuric, 14 oliguric and 8 anuric, they were maintained with four hour session of (H.D). Twenty-five normal individuals (15 males and 10 females) aged between 18-64 years served as control group

Protocol:

Ten ml of venous blood was collected from each of the patients and control group. Serum was aspirated and kept in deep freeze (at -20 C°) until the time of assay. Serum Zn, Cu, and Mg were measured using an atomic absorption spectroscopy (PU- 9100 X Philips) by direct aspiration of the sample after being diluted with deionized water (1-10) for Zn and Cu, and (1-100) for Mg⁽⁵⁾ From the residual erythrocyte .Cu, Zn and Mg were determined according to Whitehouse *et-al*⁽⁶⁾ Urine Cu, Zn and Mg were determined following the same methods as in serum. Determination of these elements in the dialyate performed in the same method with out dilution. The statistical comparison were made using t-test the probability less than 0.05 were considered significant.

RESULTS:**Serum**

As shown in table 1. Mg increased ($P<0.05$) in all patients decreased after treatments ($P<0.01$) in unuric patients, while it increased in olig and polyuric patients ($P<0.01$).

Table 1. Serum Mg, Cu, Zn and Zn /Cu before and after haemodialysis.

Before Dialysis				
Cases	Serum Mg ⁺⁺ Mean \pm SD mg/100ml	Serum Cu ⁺⁺ Mean \pm SD μ mol/L	Serum Zn ⁺⁺ Mean \pm SD μ mol/L	S. Zn ⁺⁺ /S.Cu ⁺⁺ Mean \pm SD
Control N=25	1.6 +0.04	20.72 +3.22	14.3 +4.7	0.67 +0.20
Anuric Haemodialysis N=8	2.3** +0.6	19.68*** +9.87	27.64*** +6.79	1.42** +0.67
Oliguric Haemodialysis N=17	2** +0.02	17.98*** \pm 13.67	23.12*** \pm 8.48	1.29** \pm 0.33
Polyuric Haemodialysis N=14	2.4** +0.6	16.54*** \pm 7.78	24.12*** \pm 5.77	1.45** \pm 0.74
After dialysis				
Anuric Haemodialysis N=8	1.78* +0.3	39.86*** \pm 29.83	38.08*** \pm 9.87	0.95** \pm 0.91
Oliguric Haemodialysis N=17	2.3* +0.6	23*** \pm 6.77	24.13*** \pm 8.61	1.04** \pm 0.87
Polyuric Haemodialysis N=14	2.9*** +0.5	14.47*** \pm 3.89	35.61*** \pm 15.98	2.46** \pm 1.52

Cu decreased significantly ($P<0.001$) in all patients before treatment, and increased ($P<0.001$) in unuric and oliguric patient but it decreased ($P<0.05$) in polyuric patients after treatments.

Zn found to be increased ($P<0.001$) in all patients before and after treatment compared with control group. Zn/Cu ratio increased ($P<0.001$) in all patients and after treatment it decreased ($P<0.05$) in oliguric and unuric patients, while it increased ($P<0.05$) in polyuric patients RBCs

As shown in table 2. Mg increased ($P<0.05$) in patient group before dialysis while decreased ($P<0.01$) in oliguric and unuric patients and in polyuric patients after treatment. ($P<0.05$).

Table 2. Erythrocytes Mg, Cu, Zn and Zn/Cu before and after Haemodialysis

Before Dialysis				
Cases	Ery. Mg ⁺⁺ Mean ±SD mg/100ml	Ery. Zn ⁺⁺ Mean ±SD µmol/L	Ery. Cu ⁺⁺ Mean ±SD µmol/L	Ery. Zn ⁺⁺ /Cu ⁺⁺ Mean ±SD
Control N=25	4.5 +0.51	1412 +230	119.4 +0	11.8 +7.2
Anuric Haemodialysis N=8	5.3** ±0.28	1836*** ±154	81.14*** ±15.3	22.6*** ±13.2
Oliguric Haemodialysis N=17	6.2** +0.38	1898*** +165	118* +40.3	16*** +9.5
Polyuric Haemodialysis N=14	5.8** +0.29	1433*** +199	111.2*** +30.5	12.8*** +5.4
After Dialysis				
Anuric Haemodialysis N=8	5.6* +0.37	1965* +240	81.3 +15.5	24.16** +13.5
Oliguric Haemodialysis N=17	5.8* +0.25	1895* +157	114** +35.4	16.6* +12.6
Polyuric Haemodialysis N=14	3.3** +0.18	1543* +160	119.4** +45.9	12.9* +5.2

Cu decreased ($P<0.001$) in unuric patients before dialysis it increased ($P<0.05$) after dialysis in polyuric patients.

Zn increased ($P<0.001$) in all patients before dialysis and it increased ($P<0.01$) in all patients after dialysis.

Zn/Cu ratio increased ($P<0.001$) in all patient before dialysis, while increased in unuric ($P<0.01$) in olig and poly uric patients ($P<0.001$) after dialysis.

Urine

Table 3 showed that Cu, Mg and Zn increased ($P<0.001$) in olig and polyuric compared with control group.

Table 3. Mg, Cu and Zn levels in patients urine.

	Cu ⁺⁺ µ mol/day Mean ± SD	Zn ⁺⁺ µ mol/day Mean ± SD	Mg ⁺⁺ Mmol/day Mean ± SD
Control N=25	3.5±1.2	15.6±7.2	0.3±0.1
Polyuric Patients	58.4±30.5	35.56±15.9	4.9±0.95
Oliguric patients	15.5±2.5	29±12.3	183.9±77.5

Dialyzate solution

Dialyzate solution seems to be contained Cu, Zn and Mg before treatment, the higher amount of Cu found in unuric and polyuric patient after dialysis, while Zn increased in un uric and oliguric , Mg increased in polyuric patients only (table4).

Table 4. Mg, Cu and Zn levels in the Dialyzate .

	Cu ⁺⁺ μ mol/L Mean±SD	Zn ⁺⁺ μ mol/L Mean±SD	Mg ⁺⁺ Mmol/L Mean±SD
Use Solution for treatment	3.7±0.01	2.7±0.01	2.5±0.02
Solution of unuric patients	2±0.05	1.1±0.02	0.3±0.01
Solution of oliguric patients	0.6±0.02	1±0.02	0.4±0.03
Solution of Polyuric patients	1.3±0.2	0.9±0.25	0.43±0.1

DISCUSSION:

There are many sources of disturbances in metal ions during chronic renal failure, some of them are impairment of kidney to excrete most trace elements, restricted protein intake, and dialysis technique itself which aggravates the condition by transferring to or removing trace element from them^(7, 8). The results showed variable increase in serum and RBC Mg but still in the upper normal range (table 1, 2). This is in agreement with other studies^(3,4). The increase in Mg level may be due to the long use of phosphate binder medication or drinking water containing high Mg concentration. The lowest value of Mg appear in the oliguric patients could be due to the amount of Mg excreted in their urine (table3). After dialysis serum and RBC Mg levels were increased in oliguric and polyuric patients this could be explained in view of transferring Mg from the dialyzate solution (table 4) which showed that the dialyzing solution of polyuric patients containing a high amount of Mg comparing with the dialyzate from oliguric and anuric patients this also reported by other workers^(3, 9).

Moreover, there have been reports on the deleterious effect of dialysis on the free radicals and lipid peroxidation that added to the suffering of those patients⁽¹⁰⁾. This oxidative stress, particularly of the superoxid dismutase, directly affects some trace elements, particularly Cu. In this study, we found normal erythrocytic Cu (table 2), which may be due to intercellular binding with protein, and low serum Cu before dialysis (table 1).or due to high urine Cu (table 3). The lowest Cu value found in serum of polyuric patients and the highest value found in their urine, while the increase in serum Cu during dialysis could be explained by increase in the absorption of Cu during dialysis session⁽³⁾ {high level of Cu was found in the dialyzate (table4)}. Or the redistribution of Cu, which associated with cerululoplasmine (Carrier protein).

Serum Zn showed high values before dialysis (table 1). Which confirms other reports^(11, 12) while disagreed with others^(3, 9). This might be due to low urinary excretion as shown in table (3). The lowest value of urinary Zn found in oliguric patients while the highest was in polyuric patients, which reflects the variation in serum and RBC Zn (tables 1, 2).

Zinc was not effectively lost through dialysis thus elevated serum Zn was observed after treatments (table 1). Also most serum Zn is protein bound⁽¹³⁾ it will not be in equilibrium with Zn ion in the dialyzate. Zn may cross from the dialyzate to the plasma even when total Zn concentration in the latter is higher than the dialyzate concentration this finding reflects the highest amount of Zn in the dialyzate of anuric patients table (4). This may be due to accumulation of this ion in patients serum and the use of a huge amount of contaminated water through dialysis.

Zn/Cu ratio was found to be high (table 1). Which has been suggested predisposing factor in cardiovascular diseases^(14, 15). Along with other cardiovascular risk factors found in that patient⁽¹⁶⁾. They might be under high risk of cardiovascular diseases. So the correction of this ratio may affect positively in decreasing risk factors of cardiovascular diseases.

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