SERUM TRACE ELEMENTS IN CHILDREN ON MAINTENANCE HEMODIALYSIS

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Abstract- During dialysis some trace elements can accumulate while others may be removed from blood, leading to deficiency of some trace elements. For evaluating changes of serum trace elements in children on maintenance hemodialysis we measured copper (Cu), zinc (Zn), cobalt (Co), manganese (Mn), chromium (Cr) and nickel (Ni) in 3 groups of children: Group 1, children with CRF who were on regular hemodialysis; Group 2, children with CRF who were on conservative management, and Group 3, healthy children. For evaluating the impact of duration of dialysis on serum trace elements, group 1 patients were divided into two subgroups: A, patients who were on hemodialysis therapy for shorter than 18 months, and B, patients who were on hemodialysis therapy for longer than 18 months. The technique used for measurement of trace elements was PIXE (Proton Induced X-ray Emission). Mean serum levels of Zn, Mn, and Ni in group 1 were lower than group 2 and group 3. There were not significant differences in serum levels of Zn, Mn and Ni between group 2 and 3. The differences in serum levels of Cr, Co and Cu among 3 groups were not significant. The serum levels of Zn, Mn and Ni were significantly lower in subgroup B compared to subgroup A. Correlation test showed that there were an inverse linear relation between the period of hemodialysis and serum levels of Zn, Mn and Ni. Chronic hemodialysis leads to abnormalities of some trace elements in children, and these derangements increase with duration of hemodialysis.

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Key words: Chronic renal failure, trace elements, children, Zinc, Nickel, Manganese, hemodialysis

INTRODUCTION

Chronic renal failure may result in impaired renal excretion and accumulation of some trace elements in the body. During dialysis some trace elements can accumulate in the body because of dialysis fluid impurities and others may remove from blood to dialysate leading to deficiency of some trace elements in the body.

Altered blood levels of different trace elements have been described in patients with chronic renal failure (CRF) and especially in those treated by hemodialysis or peritoneal dialysis. Most of the studies have been done on adult patients. Because trace elements are components of many enzymes and proteins and they have many functions, their changes may have more profound effects on children who are during growth and developmental period.

We measured 6 trace elements and also evaluated the impact of duration of dialysis on serum trace elements.

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MATERIALS AND METHODS

We measured six trace elements: copper (Cu), zinc (Zn), cobalt (Co), manganese (Mn), chromium (Cr) and nickel (Ni) in three groups of children: group 1, children with CRF who were on regular hemodialysis (n = 40); group 2, children with CRF who were on conservative management (n = 31), and group 3, healthy children (n = 30).

All three groups were from 5 to 18 years old and were almost identical with respect to age and sex. Group 1 had end-stage renal disease (GER < 10 /min/1.73 m^2), were on regular hemodialysis 2-3 times/week and the duration of dialysis was between 3 to 52 months. Group 2 were children with CRF (mean creatinine clearance of 8.15 ± 6.6 mL/min/1.73 m^2), who had referred to our department before starting renal replacement therapy. Group 3 were healthy children, during health supervision visits of these children in our clinics for some of them blood samplings were done for purposes like checking Hb, Hct, metabolic screening and we used some of it for measurement of trace elements. For evaluating the impact of duration of dialysis on serum trace elements, group 1 patients were divided into two subgroups: subgroup A, patients who were on hemodialysis therapy for shorter than 18 months (mean: 8.85 ± 4.84 months, n = 20), and subgroup B, patients who were on hemodialysis therapy for longer than 18 months (mean: 33.1 ± 10.86 months, n = 20). Children with metabolic disorders that have effects on serum trace elements and those who had malnutrition were excluded from the study. We obtained informed consent from parents of all children.

All samplings were done in fasting condition, and for patients on regular hemodialysis at the start of dialysis session. The test tubes were made from polystrane to reduce interactions of blood with test tube. All syringes and test tubes before using had been washed with acid to remove contaminations. Water treatment system of our hemodialysis ward consists of depth filters, water softener, carbon filter and reverse osmosis.

The technique used for measurement of trace elements was PIXE (Proton Induced X-ray Emission). PIXE is a highly sensitive, accurate and relatively simple technique that can be used to identify and quantify trace elements ranging typically from Aluminum to Uranium and can determine concentrations of trace elements down to ppm (part per million) or sub ppm. PIXE is 100 times more sensitive than Electron Microanalysis systems. All measurements were done at Iranian Atomic Energy Organization.

The serum concentrations of trace elements are expressed as ppm (mean ± SD). Multiple comparison test of Bonferroni was used to compare the results between every two groups. The Pearson correlation test was used to identify correlation between the duration of dialysis and serum levels of trace elements.

RESULTS

Group 1 composed of 40 children (19 boys and 21 girls, mean age 11.75 ± 3.64), group 2 were 31 children (17 boys, 14 girls, mean age 10.56 ± 3.19), and group 3 were 30 children (16 boys and 14 girls, mean age of 12.02 ± 3.18).

The mean serum levels of trace elements in 3 groups and standard deviations are shown in table 1. This table shows that mean serum levels of Zn, Mn and Ni in group1 (hemodialysis group) were lower than group 2 (*P* value for Zn was < 0.001, for Mn and Ni were < 0.05), but there were not significant differences in serum levels of Zn, Mn and Ni between group 2 and 3. The differences in serum levels of Cr, Co and Cu among 3 groups were not significant (Table 1, Fig. 1).

The serum levels of Zn, Mn and Ni were lower in subgroup B compared to subgroup A (*P* values for Zn and Mn were < 0.001 and for Ni was < 0.05, Fig. 2). Correlation test showed that there was an inverse linear relation between the period of hemodialysis and serum levels of Zn, Mn and Ni (Table 2).

Table 1. Serum trace elements in three groups (ppm)*

Element	Group 1	Group 2	Group 3
Cr	0.053 ± 0.062	0.077 ± 0.102	0.077 ± 0.117
Cu	0.533 ± 0.231	0.62 ± 0.227	0.61 ± 0.333
Zn	0.35 ± 0.077	0.5 ± 0.073	0.5 ± 0.095
Co	0.028 ± 0.052	0.048 ± 0.106	0.05 ± 0.077
Mn	0.043 ± 0.075	0.081 ± 0.075	0.08 ± 0.147
Ni	0.027 ± 0.052	0.055 ± 0.062	0.056 ± 0.057

*Data are given as mean ± SD.

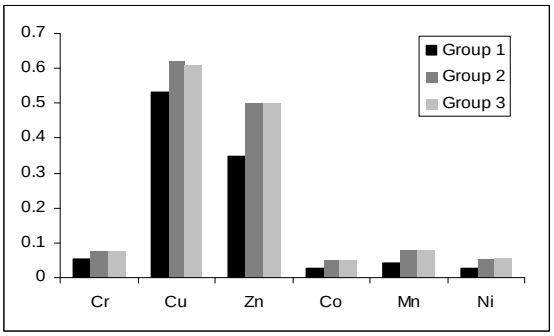

Fig. 1. Serum trace elements in three groups (ppm).

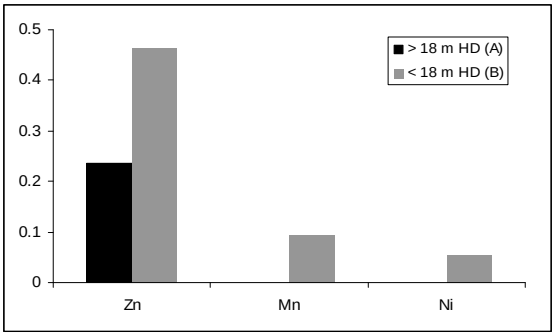

Fig. 2. Serum trace elements in two subgroups.

DISCUSSION

Chronic renal failure may result in impaired renal excretion and accumulation of some trace elements in the body. During dialysis some trace elements can accumulate in the body because of dialysis fluid impurities and others may remove from blood to dialysate leading to deficiency of some trace elements in the body.

Our study showed that there is not significant change in serum concentration of Zn, Mn, Ni, Cr, Co, Cu between healthy children and children with CRF, but serum concentrations of Zn, Mn, and Ni in children undergoing regular hemodialysis are significantly lower than children with CRF on conservative management or healthy children. Also, there is an inverse linear relation between duration of hemodialysis and serum levels of these 3 trace elements. So, hemodialysis produces deficiency of Zn, Mn, and Ni in children on regular hemodialysis treatment.

Other studies have shown that serum zinc level is decreased in patients undergoing chronic hemodialysis (1-8). Zinc is an essential trace element and has been received increasing attention because of the recently available evidence that its deficiency may have grave consequences in humans (9-11). More than 200 enzymes are Zn metalloenzymes; zinc is also an essential component of various proteins and biomembranes (6, 12).

It is required to maintain the normal structure and/or functions of multiple enzymes, including those that are involved in transcription and translation of genetic material and cell division (12).

Zinc deficiency leads to immune deficiency and susceptibility to infections (6, 11-13). The beneficial effects of zinc on various components of the immune system and its direct gastrointestinal effects has led to use of zinc in the prevention and treatment of diarrhea in children (12, 14). Some consequences of zinc deficiency are anorexia, growth retardation, disorders of neurodevelopment, hypogonadism, altered immune response and intercurrent infections and mental lethargy (12, 13, 15, 16). Most of these disorders are also seen in children with CRF and zinc deficiency may aggravate them.

Conflicting results have been reported regarding serum levels of nickel and manganese in hemodialysis patients. There are reports of low, normal or high levels of Nickel and Manganese in chronic dialysis patients (1, 2, 6-8, 17, 18). Dialysis fluid may be a source of increased Nickel level (18). Nickel deficiency may contribute to anemia in chronic dialysis patients (7) and deficiency of Mn may cause impaired growth, abnormal metabolism of glucose and lipids (6, 7). For serum levels of copper chromium and cobalt there has been conflicting reports (2, 3, 6, 18-21).

In conclusion, chronic hemodialysis leads to abnormalities of some trace elements. These derangements increase with duration of hemodialysis, deficiency of some trace elements especially zinc may contribute to various signs and symptoms of children undergoing chronic hemodialysis.

Table 2. Serum trace elements in two subgroups (ppm)*

Trace element	Subgroup A	Subgroup B
Zn	0.465 ± 0.0988	0.235 ± 0.0489
Mn	0.095 ± 0.0686	0
Ni	0.055 ± 0.051	0

*Data are given as mean ± SD.

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Conflict of interests

We have no conflict of interests.

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