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Research Article

Hemodialysis induced trace elements level variations among chronic renal failure patients

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Abstract: Renal disease is a common cause of death and disability in many countries throughout the world. End-Stage Renal Disease (ESRD) is the final stage of CRF characterized by progressive, irreversible deterioration in renal function and body fails to maintain fluid and electrolyte balance resulting in uremia. Accumulation of excess amount trace elements causes imbalances in metabolic process. Hemodialysis is implicated to correct the metabolic disturbances as complications have been observed. The main is to investigate trace elements levels in chronic renal failure patients before and after hemodialysis. The study was carried out in 25Patients who are on hemodialysis .The blood samples were collected before and after hemodialysis sessions. Parameters like Zinc (Zn), Copper (Cu), Magnesium (Mg) Selenium (Se), and Aluminum (Al) were estimated by atomic absorption spectrophotometry in chronic renal failure patients before and after Hemodialysis session. In results Zinc (Zn) Copper (Cu), Magnesium (Mg) Selenium (Se) level was found to be increased in post dialysis when compared to pre dialysis. Aluminum (Al) level was found to be decreased in post dialysis when compared to pre dialysis. Which is found to be statically significant? In conclusion Alterations in trace elements leads to acid-base balance leads to acidosis which can alter the binding, transport and excretion of these elements. Dialysis fluid containing salts of trace elements may have also contributed to this alteration of trace element levels.
Keywords: Chronic renal failure, Hemodialysis, Trace elements, uremia

INTRODUCTION

End-Stage Renal Disease (ESRD) is the final stage of CRF characterized by progressive, irreversible deterioration in renal function and body fails to maintain fluid and electrolyte balance resulting in uremia. ESRD is characterized by a decrease in GFR and evidence of less than 10% nephron function remaining [1]. During hemodialysis (HD) essential kidney functions, such as the elimination of water and metabolic wastes aswell as the correction of the electrolyte and acid/base state, are replaced by the artificial purification system. Elements such as Na^+, K^+, Ca^{++}, Mg^+, Cl^-, and H^+ must be kept in a rather narrow physiological range, otherwise life-threatening events may occur [2]. Moreover, renal impairment, anemia and other clinical complications in hemodialysis patients may be commonly related to increased cellular uptake and toxicity of aluminum. Trace elements play an important role in the structure of proteins, enzymes and complex carbohydrates to participate in biochemical reactions. It also involved in a number of metabolic activities, including nerve conduction, transport excretory processes and serving as cofactors for enzymes. The cells of the proximal renal tubule have an important role in the homeostasis of essential metals, and the kidney is a target site for metal toxicity [3]. Zinc and copper are two of the most intensively investigated and metabolically important trace metal nutrients. For this reason, and because of their close chemical similarity and extensive biological interaction, they are often considered together. In recent years; intermittent hemodialysis has been successful in extending the life span of chronic renal failure patients. However, 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 move from blood to dialysate leading to deficiency of some trace elements in the body [4].

MATERIALS AND METHODS

This study involved 25Hemodialysis patients among them 12 were female and 13 male who were treated in nephrology ward of MAPIMS. The mean age of the patients was 50.26 ± 16.36 years. All patients

were dialyzed three times a week and each session was at least four hours. They were dialyzed with polysulfone dialyzing membrane. The duration of dialysis ranged from 2-8 years. Subjects suffering from diabetes, acute renal failure, cardiovascular disease, hepatic disease, pregnancy and any chronic or acute inflammatory illness were excluded from the study. All participants gave written informed consent and this protocol was approved by the ethical and human research committee. Blood samples were taken from the hemodialysis patients prior before and after hemodialysis. Five trace element levels; Selenium (Se), Zinc (Zn), Copper (Cu), Magnesium (Mg), and Aluminum (Al) in serum were determined by flame atomic absorption spectrophotometer with deuterium background correction.

Statistical Analysis:

All values are expressed as mean ±SD. Student t- test was used to estimate the significant difference between the groups. The level of statistical significant was set at $p<0.001$. SPSS for windows 13.0 was used for statistical analysis.

RESULTS

Zinc (Zn) Copper (Cu), Magnesium (Mg) Selenium (Se) level was found to be increased in post dialysis when compared to pre dialysis. Aluminum (Al) level was found to be decreased in post dialysis when compared to pre dialysis. Which is found to be statically significant (Table-1).

Table 1: Shows the pre and post hemodialysis data of trace elements in chronic renal failure

Trace elements (n=5)	Pre dialysis (n= 25) Mean ±SD	Post dialysis (n= 25) Mean ±SD	P value
Zn (µg/dl)	79.08 ±7.5	84.90±5.2	0.001 ***
Cu (µg/dl)	68.12±7.8	71.67±3.2	0.001 ***
Mg (mg/L)	18.32±3.2	24.89±5.3	0.001 ***
Al (µg/dl)	42.45±2.9	39.34±8.9	0.001 ***
Se (µg/dl)	83.16±4.8	85.24±7.3	0.001 **

***p<0.001 and **p<0.001,** highly statistically significantly compared to pre and post dialysis

DISCUSSION

Hemodialysis patients are at risk for deficiency of essential trace elements and excess of toxic trace elements, both of which can affect health. Though trace elements occur in very low concentrations in the body, their role in the maintenance of undisturbed biological functions is nonetheless highly important. In renal failure, patients have disturbances in acid-base balance and blood pH is acidic, therefore low zinc levels in these patients are believed to be due to the shift of zinc into red cells under acidic conditions [5]. Manifestations of zinc deficiency, including skin lesions and poor wound healing, have been observed in these patients. Zinc present in serum is combined with plasma proteins, especially with albumin. Proteinuria in renal failure leads to excessive excretion of zinc along with protein hence continued urinary loss of zinc might ultimately lead to low serum zinc levels [6]. In renal failure patients the renal capacity for excreting excess copper diminishes, which leads to accumulation of this element in the body causing toxicity with neurologic, hepatic and corneal lesions. Copper, iron and zinc were present at the highest concentrations. Hence this could reflect the wide range of trace metal concentrations in such patients. In the process of hemodialysis, plasma actively takes up both copper and zinc from the dialysis fluid even against a concentration gradient, and since zinc binds actively to albumin, it is not refluxed back to the dialysis fluid. Acidosis may favor trapping of copper from dialysis salt by sialic acid to synthesize ceruloplasmin, which may Lead to increased concentrations of copper in serum. Hence our results indicate that dialysis causes changes in the serum zinc and copper levels in these patients [7]. In a present study, we observed serum Cu level is significantly decreased in pre and post dialysis when compared to healthy controls. There was also significant difference between the pre and post dialysis patients.

In general serum Mg concentrations have been reported to elevate in hemodialysis patients because of decrease of the Mg excretion in a kidney [8]. In hemodialysis patients, accumulation of Aluminum (Al) has been reported. Al encephalopathy and aluminum-related bone disease are important trace element related complications. Dialysis itself might be an important cause of Al accumulation. The accumulation of high Al levels in hemodialysis patients is the use of Al containing drugs e.g. aluminum hydroxide. Therefore most of the patients are bound to take this drug and develop high level because use large amount of Al are absorbed in the gastrointestinal tract [9, 10].

CONCLUSION

Trace elements are being increasingly recognized as essential mediators of the development and progression of kidney disease. On theoretical grounds, trace elements may be protective against oxygen free radicals in the development of chronic renal failure disease. In recent years, intermittent hemodialysis has been successful in extending the life span of chronic renal failure patients. However, 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.

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