EVALUATION OF SERUM ZINC LEVELS IN END STAGE RENAL DISEASE PATIENTS ON HEMODIALYSIS

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ABSTRACT

Patients with chronic kidney disease undergoing hemodialysis are potentially at risk of deficiency and toxicity of trace elements in the blood. Trace elements are the essential nutrients of human beings with a gamut of functions. Zinc is known to be essential for all highly proliferating cells in the human body. It is very important to know the zinc status in hemodialysis patients to prevent hypo or hyperzincemia. Serum zinc levels in 50 end stage renal disease patients undergoing hemodialysis were compared with 50 normal subjects. It was found that end stage renal disease patients undergoing hemodialysis had statistically lower serum zinc levels compared to normal subjects. The results include serum zinc (µg/dl) 57.42±17.87 vs. 101.48±18.08(Cases vs. Controls). It was determined that the results might be helpful in monitoring zinc status in patients undergoing hemodialysis in terms of insufficiency or excess. The study concludes that there is a deficiency of serum zinc in patients undergoing hemodialysis compared with normal subjects, which suggest supplementation of zinc may be helpful to improve the quality of life in patients undergoing dialysis.

Key words: Trace elements, zinc, end stage renal disease, hemodialysis.

INTRODUCTION

Chronic kidney disease is a process with multiple etiologies, resulting in a continuous decrease of nephron number and function leading to end stage renal disease. End stage renal disease is a condition in which there is an irreversible loss of renal function rendering the patient to depend permanently on renal replacement therapy (dialysis or transplantation).[1] The prevalence of patients with chronic renal failure in the adult population is 0.785% (785/million).[2]

Hemodialysis is the most common form of treatment for patients with end stage renal disease and is associated with considerable morbidity and mortality due to accelerated cardiovascular disease and infection. Hemodialysis removes the uremic toxins primarily by allowing equilibration of plasma and dialysate across a semi-permeable membrane. Substances that have lower concentrations in the dialysate than in blood tend to be removed by dialysis leading to depletion of biologically essential substances. Conversely, toxic trace elements present in dialysate but not in blood may accumulate and cause toxicity. Patients on hemodialysis are at risk of low dietary intake of such substances due to uremia related anorexia and dietary restrictions.

Patients on long- term hemodialysis are at risk of both deficiency and toxicity of trace elements depending on dietary intake, removal by dialysis, composition of source water used for dialysis and residual kidney function.[3],[4] A large number of studies have indicated that the concentration of trace elements is altered in hemodialysis patients. Muirhead N, Kertesz A et al[5] have studied the zinc metabolism in patients on maintanence hemodialysis and evaluated the prevalence of zinc deficiency and abnormalities of zinc metabolism in patients with end stage renal disease.

Zinc is the second most abundant trace element in the body next to iron. Zinc is an essential constituent of all six classes of enzymes as well as transcription and replication factors.[6], [7] It is also essential for normal spermatogenesis, sperm physiology, normal embryonic development, formation and function of immune system. Zinc plays a role in taste and wound healing. Zinc deficiency is the leading cause of disease in developing countries[8] and is associated with delayed wound healing [9] and immune deficiency [10] characterized by impaired cell proliferation, abnormal T – cell function, defective

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phagocytosis and abnormal cytokine expression, all of which might contribute to the risk of infection observed in patients undergoing hemodialysis. Trace element disturbances that are found associated with patients on hemodialysis should be treated to improve the quality and longevity of patient's life. The study was undertaken to evaluate the zinc status in end stage renal disease patients on hemodialysis.

MATERIALS AND METHODS

This is an age and sex matched, case control, double-blinded study of 100 subjects with 50 end stage renal disease patients undergoing hemodialysis two times/week between 10 years and 74 years of age as cases and 50 normal subjects as controls. The present study was conducted after getting approval from the ethical committee of Stanley medical college, Chennai.

5ml of Venous blood was collected just before dialysis from each subject and was analyzed for serum zinc, urea and creatinine and the results were analyzed based on the data collected. Serum zinc was measured colorimetrically with 2-(5-Bromo-2-Pyridylazo)-5-(N-Propyl-N-Sulfopropylamino)-Phenol (Greiner Commercial Kit) at 560nm. Blood urea was determined colorimetrically by Blood urea nitrogen – Glutamate dehydrogenase method [11] and serum creatinine with Jaffe's alkaline picrate method [12] in Microlab 200 semi-automated analyzer.

RESULTS

As shown in Table 1, 2 and 3, patients on hemodialysis had elevated blood urea and serum creatinine, which are signs of renal disease. In the present study, comparison of zinc status in patients with chronic kidney disease on hemodialysis with control group (Table 1) reveals significant changes in the zinc metabolism. This is evidenced by statistically significant decrease in serum zinc levels in the study group suggesting zinc deficiency. Comparison of serum zinc status between age and sex matched study and control group (Table 2 & 3) shows that there is no significant influence of age and sex on zinc levels.

Table No.1 : Mean values of Blood urea, serum creatinine and serum zinc in study and control group

Variable	Cases	Controls	P Value
	Mean ± SD	Mean ± SD	
Blood Urea (mg/dL)	142.56 ± 28.87	23.92 ± 5.80	< 0.001 significant
Serum Creatinine (mg/dL)	7.97±3.18	0.98±0.20	< 0.001 significant
Serum zinc (µg/dL)	57.42±17.87	101.48 ±18.08	< 0.001 significant

Table No.2 : Age group wise comparison of mean values of Blood urea, serum creatinine and serum zinc between study and control group*

Variable	Age <25 years		Age 25-40 years		Age 41-60 years		Age >60 years	
	Cases (n = 9)	Controls (n = 9)	Cases (n = 16)	Controls (n = 16)	Cases (n = 17)	Controls (n = 20)	Cases (n = 8)	Controls (n = 5)
Blood Urea (mg/dl)	122.2 ±33.61†	24.44 ± 5.41	149.1±26.37†	22.06 ± 5.92	148.8 ±26.46†	24.85± 6.29	139.1±26.76†	25.20 ± 3.56
Serum Creatinine (mg/dl)	6.57 ± 2.52†	0.96 ± 0.14	8.22 ± 3.20†	0.94 ± 0.19	9.01 ± 3.64†	1.00 ± 0.22	6.83 ± 2.17†	1.04 ± 0.23
Serum Zinc (µg/dl)	55.00 ±12.83†	106.44±17.1	56.9 ± 19.61†	102.3± 17.48	59.59± 17.42†	96.0± 17.29	56.63±22.57†	111.80±22.63

* Mean ± Standard deviation

† Significantly different from control values P<0.001 (Student independent't' test)

TABLE No.3 : Sexwise comparison of mean values of Blood urea, serum creatinine and serum zinc between study and control group*

Variable	Male		Female	
	Cases (n = 33)	Controls (n = 33)	Cases (n = 17)	Controls (n = 17)
Blood Urea (mg/dl)	143.76 ± 28.10†	24.42 ± 5.67	140.24 ±31.061†	22.94 ± 6.088
Serum Creatinine (mg/dl)	8.08 ± 3.38†	0.98 ± 0.19	7.75 ± 2.850†	0.96 ± 0.206
Serum Zinc (µg/dl)	57.95 ± 18.05†	100.97 ± 17.76	56.41 ± 18.021†	102.47 ±19.193

* Mean ± Standard deviation

† Significantly different from control values P<0.001 (Student independent't' test)

DISCUSSION

It is well known that patients on long term hemodialysis are at risk of developing changes in the trace element metabolism,[13] which can further induce different abnormalities in these patients. Recent studies have focused on the possible role of trace element depletion in the pathogenesis of uremic symptoms such as anemia, dysguesia and impotence. The low level of serum zinc in hemodialysis patients is explained by the removal of this element when the dialysate used contains sufficiently low concentration of zinc. In the present study, there is no significant influence of age and sex on serum zinc levels. This might be probably because of the small number of patients taken for the study.

Most authors have reported low serum zinc concentrations in hemodialysis patients. Lee et al [14] found that 78% of patients on hemodialysis had low serum zinc concentrations. Van Rentergham D et al [15] had reported low serum zinc levels in patients on hemodialysis. Yilmaz M Emin et al [16] had reported significantly low plasma zinc and copper levels in patients on hemodialysis compared with normal subjects. Zinc depletion in hemodialysis subjects contribute to anorexia, dysguesia, hyposmia, dysosmia, impotence and impaired immunity. A study has demonstrated that uremic hypoguesia, anorexia and deficient caloric and protein intake are ameliorated by zinc supplementation. [17]

Zinc deficiency in chronic kidney disease patients has been attributed to excessive loss in urine due to proteinuria. When patients on dialysis are given oral iron therapy (as ferrous sulphate), zinc absorption is reduced due to the competition of divalent trace elements for the Divalent metal ion transporter (DMT-1). This reduced absorption of zinc and the loss of zinc in the dialysis fluid results in zinc depletion and deficiency in patients on frequent dialysis. As zinc is a cofactor for - amino levulenic acid dehydratase in heme synthesis, zinc deficiency can interfere with hemoglobin synthesis and aggravates anemia in hemodialysis patients. Zinc deficiency may also be a representative of nutritional status and it correlates with signs of malnutrition in patients on hemodialysis.[18]

Some hemodialysis patients had high serum zinc levels due to the use of zinc oxide plasters that bind the coils of artificial kidney or to higher zinc content in the dialysate as a result of galvanized iron used in hemodialysis tank. Prehn [19] had reported increased serum zinc level after treatment using the hemodialysis membrane KN 401.

The present study shows that there is a depletion of zinc status in chronic kidney disease patients on hemodialysis. Zinc supplementation may be necessary to improve the morbidity and quality of life in patients on hemodialysis. Supplementation of zinc with other trace elements (such as iron and copper) in hemodialysis patients should be adequately spaced to avoid interference in their absorption from the intestine. Probably providing supplementation of zinc can improve the symptoms associated with uremia.

CONCLUSION

The present study shows that there is a disturbance in the metabolism of zinc in patients on chronic hemodialysis. However, as changes in serum zinc are affected by individual patient's metabolism and specific illness, future studies have to address more specific parameters including serum protein, enzymes and antioxidants as well as duration of hemodialysis and medication. Trace element concentration in the dialysate fluid can also be done to evaluate the possible consequences of contamination with the trace elements.

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