SERUM ELECTROLYTES AND ALKALINE PHOSPHATASE LEVELS IN POST-DIALYSIS SUBJECTS: A HOSPITAL BASED STUDY FROM EASTERN INDIA

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ABSTRACT

BACKGROUND

Frequent haemodialysis is required for the patients with End-Stage Renal Disease (ESRD) to maintain non-toxic levels of serum urea and creatinine. During haemodialysis, increase in 24-hour ambulatory systolic blood pressure (SBP), diastolic blood pressure and blood pressure (BP) load was observed by researchers and that has been explained as high sodium concentration in dialysis solution. Post-dialysis increase in serum alkaline phosphatase level has been reported and this is associated with higher risk of hospitalisation and death.

AIMS AND OBJECTIVES

Since very little information is available from study on Indian population, our aim was to determine pre and post-dialysis serum alkaline phosphatase and sodium concentrations in subjects of ESRD attending Medicine department of the hospital for haemodialysis at regular intervals with an object to compare our results with available reports from different sources.

MATERIALS AND METHODS

The study was conducted in a tertiary care teaching hospital in eastern India by selecting 33 patients suffering from ESRD and they attended the dialysis unit of the hospital for undergoing haemodialysis. Serum sodium, potassium, urea, creatinine and alkaline phosphatase levels were measured.

RESULTS

Post-dialysis serum urea and creatinine values were lower than pre-dialysis result (p value < 0.001 and < 0.001 respectively). Significant decrease was observed in post-dialysis serum potassium level (p value < 0.001). Increase in serum sodium and alkaline phosphatase levels were observed in post-dialysis subjects (p value < 0.004 and < 0.001 respectively).

CONCLUSION

In the study, we observed a significant increase in serum sodium and alkaline phosphatase concentrations in patients of ESRD after haemodialysis.

KEYWORDS

ESRD, Haemodialysis, Sodium, Potassium, Alkaline Phosphatase (ALP), Systolic Blood Pressure (SBP), Diastolic Blood Pressure.

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INTRODUCTION: The kidney eliminates different molecules and ions which include urea, creatinine, potassium, hydrogen and phosphate ions as well as a group of poorly defined solutes collectively known as middle molecules having molecular weight ranging from 500 to 5000 da.[1,2] In renal failure, β_2 microglobulin is deposited as amyloid and symptoms appear after 5-10 years of dialysis. Guanidine, Phenols, Indoles.[3] and few hormones.,[4] especially parathormones are also considered as toxins.[5]

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These molecules with wide ranges of molecular sizes, lipid solubility and protein-binding behaviour act differently across the dialysis membrane. Therefore, the comparative study of certain known and still unknown particles may have immense role to assess the success of dialysis and prognostic fate of such patients.[5] Noor ul Amin et al reported significant decrease of blood creatinine level after haemodialysis.[6] Kidney plays a critical role in regulating electrolyte balance. A high sodium dialysate causes salt load in 50% of patients and results in hypertension whereas low sodium dialysate results intradialytic disequilibrium.[7] Klen M L reported about interrelationship between interdialytic weight gain, blood pressure and sodium adjustment in dialysing fluid.[8] Significant decrease in serum potassium level after haemodialysis has been reported.[9]

Significant decrease in plasma glucose level has been reported by different researchers.[10] Post-dialysis rise in serum alkaline phosphatase concentration has been reported by different investigators, and this has been considered as a marker for cardiovascular and bone disorder.[11]

MATERIALS AND METHODS: A hospital based cross-sectional study was conducted in the department of Biochemistry in collaboration with the department of Medicine, MGM Medical College & LSK Hospital, Kishanganj, Bihar, India, from July 20012 to June 2013. Prior ethical permission was obtained by Institutional ethics committee and informed consents were obtained from all the participants of the study. The patients of End-Stage Renal Disease (ESRD) undergoing dialysis on a weekly basis were selected as subjects of study. Total 33 patients attended dialysis unit for haemodialysis during study period. The patients were on haemodialysis for one year. Haemodialysis was performed for 4 hours and blood samples were collected before haemodialysis and after 2 hours of haemodialysis. Serum sodium, potassium, alkaline phosphatase, urea and creatinine concentrations were estimated before and after dialysis.

The biochemical investigations were performed in full-auto analyser Selectra Pro-S-System and serum electrolyte analysis was done in Ion Selective Electrodes. 5 mL blood was collected in plain vials for estimation of sodium, potassium, urea, creatinine and alkaline phosphatase. Serum urea was estimated by.[11] Berthelot's method. Creatinine was estimated.[12] by modified Jaffe's kinetic methods. Serum alkaline phosphatase estimation.[13] was performed by para nitrophenyl phosphate (PNP) method.

RESULTS: The present study was conducted with 33 patients of ESRD receiving haemodialysis for one year at regular intervals. The parameters mentioned above were estimated before and after dialysis. Serum Urea level before and after dialysis were 126.75±58.53 and 45.54±27.90 respectively with significant p value of <0.001. Serum creatinine level before and after dialysis were 7.55±2.94 and 3.11±1.34 respectively with a significant p value of < 0.001. Serum Sodium level before and after dialysis were 134.21±4.90 and 137.50±5.30 respectively with a significant p value of <0.004. Serum Potassium level before and after dialysis were 5.08±1.13 and 3.90± 0.90 respectively with a significant p value of <0.001. Pre-dialysis and post-dialysis Alkaline Phosphatase level were 383.03±34.56 and 414.87±35.05, and the results were statistically significant with p value <0.001.

Parameters	Before Haemodialysis. Mean±SD	After Haemodialysis Mean±SD	P. Value
Urea	126.75 + 58.53	45.54 + 27.90	P<0.001
Creatinine	7.55 + 2.94	3.11 + 1.34	P<0.001
Na^+	134.21 + 4.90	137.5 + 5.3	P<0.004
K^+	5.08 + 1.13	3.90 ± 0.90	P<0.001
ALP	383.03 + 34.56	414.87 + 35.05	P<0.001

Table 1: Results Obtained Before and After Haemodialysis

DISCUSSION: Haemodialysis removes waste and water from circulating blood outside the body through an external filter, called dialyser, which contains a semipermeable membrane. The blood and the dialysate flow in opposite direction. The counter current flow of the blood and the dialysate maintains a maximum concentration gradient of solutes between the blood and dialysate that helps to remove more urea and creatinine from blood. The dialysing fluid resembles normal plasma concentration of glucose, lactate sodium, potassium, magnesium, calcium, chloride and bicarbonate but does not contain protein, urea and creatinine. During haemodialysis, proteins and blood cells are retained in the blood and excess of solutes diffuse from blood into the dialysing fluid and the blood is free from toxic molecules.[14] In the present study, following parameters of 33 ESRD patients were estimated before and after haemodialysis:

Urea: We observed significant decrease in serum urea concentration after haemodialysis. Noor ul Amin et al reported significant post-dialysis decrease of blood urea level.[6] Owb WF Jr et al observed decrease in serum urea concentration after haemodialysis.[15]

Creatinine: Our study revealed a significant decrease in serum creatinine level after haemodialysis. Noor ul Amin et al reported significant decrease of blood creatinine levels.[6]

Serum Sodium: We observed significant increase in serum sodium level after dialysis and still the levels were within biological reference intervals. The increased level in serum sodium might be affected by a high-sodium dialysis solution. A high serum sodium more than 138 milliequivalent (mEq) per litre may result in a positive dialysate to serum sodium gradient in most patients undergoing dialysis. Daugirdas, Blake and Ing commented in their book that any attempt to correct high sodium level by haemodialysing against a low sodium dialysis solution would be dangerous because this may lead either to cerebral oedema due to entry of water into cells from the dialysed blood or there may be increased tendency to develop muscle cramp.[16]

It has been reported after using dialysis solution with different sodium concentration, a higher sodium concentration of 147 mEq per litre during haemodialysis resulted in higher 24-hour ambulatory SBP, Diastolic BP and BP load whereas with standard sodium dialysate of 140 mEq per litre resulted in intradialytic hypertension and inadequate removal of sodium in dialysate may lead to overall poor BP control.[17] High sodium concentrations in dialysis solution have been used to reduce intradialytic disequilibrium like hypotension, muscle cramp and nausea.[18] but the problem with high sodium dialysate is that there lies chance of fluid overload and hypertension.[8] Hwang et al reported that online haemodiafiltration might have the ability of sodium lowering effect to a large extent and high-flux haemodialysis helps to stabilise both pre and post-dialysis SBP.[19]

Serum Potassium: Serum potassium level before and after dialysis were 5.08±1.13 and 3.90±0.90 respectively. I. A. Checherita et al reported a significant decrease in serum potassium level after haemodialysis.[9] Zehnder C et al also reported a low potassium concentration after haemodialysis with a control diet containing low potassium and Glucose prior to haemodialysis.[20]

Alkaline Phosphatase: Our study indicates that Alkaline Phosphatase levels were increased in all subjects undergoing haemodialysis. Margaret J Blayney et al reported a significant increase in alkaline phosphatase level after haemodialysis.[10] Elevated serum alkaline phosphatase levels are associated with an increase in risk of ESRD and all-cause mortality in non-dialysis dependent patients of chronic kidney disease and Taliercio et al reported that alkaline phosphatase may be used as a maker for high risk of mortality and/or progress of ESRD, and confirmed the association of alkaline phosphatase with mortality.[21] Among the various sources, the enzyme is predominantly present in liver, biliary duct, bone and placenta. Tissue-nonspecific alkaline phosphatase inactivates pyrophosphate, an endogenous inhibitor of hydroxyapatite formation and results in medial arterial vascular calcification.[22] Calcifications in coronary and carotid arteries, superficial femoral artery and aorta have been associated with high alkaline phosphatase levels and therefore, alkaline phosphatase is considered as a surrogate for arterial stiffening.[23,24]

In conditions like hypertension, ageing, diabetes and chronic kidney disease, vascular cells undergo osteoblastic differentiation and express several bone-associated proteins including alkaline phosphatase. This differentiation leads to mineralisation of the endothelium, arterial stiffening and vascular calcification which ultimately ends in cardiovascular disorder and chronic kidney disease.[25] M J Blaney et al reported association of high serum alkaline phosphatase with higher risk of hospitalisation and death in haemodialysed subjects and that was independent of serum calcium, phosphate and parathormone levels. They conducted their study on North American Haemodialysis patients and compared with Japanese and European patients and observed that high ALP was strongly associated with higher overall mortality risk in both baseline and time dependent models. Dialysis Outcome and Practice Pattern Study (DOPPS) was performed in haemodialysis patients across 12 countries and detailed information about cause of hospitalisation and death inspired the workers to assess relationship between ALP levels with cause specific morbidity and death.[10]

CONCLUSION: In the study, we observed significant decrease in blood urea, creatinine and potassium levels with significant increase in serum alkaline phosphatase and sodium concentrations in ESRD patients after haemodialysis. Interdialytic high serum sodium level may cause associated symptoms and can be controlled by much better dialysis technique providing modification in sodium concentration of the dialysis solution. In patients of ESRD, serum alkaline phosphatase level reflects the bone metabolism and vascular calcification and so a high ALP should always be considered alarming and a better management could help better survival of the patients.

LIMITATION OF THE STUDY: We performed the study with small sample size. A large sample size would help for better assessment of serum sodium and alkaline phosphatase level to establish relationship between other variables and that could be compared with the severity of the symptoms develop. We could not study the relationship between post-dialysis serum alkaline phosphatase level and bone disorder or cardiovascular complications. Bone specific alkaline phosphatase estimation would be more predictable which we could not include in our study.

Future Direction of the Study: We plan for a study in future with large number of sample size for correlation between the observed parameters in pre- and post-dialysis patients for prediction of prognostic value. Our future plan is to compare the outcome of high ALP in respect to cardiovascular and orthopaedic complications in ESRD subjects.

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