ORIGINAL RESEARCH PAPER

Biochemistry

KEY WORDS: Estimated glomerular filtration rate (eGFR), Serum electrolytes, Chronic Kidney Disease (CKD)

EVALUATION OF ELECTROLYTES IN PATIENTS WITH CHRONIC KIDNEY DISEASE

Rakshit Gupta Student, Amity University

Reetika Shrivastava Demonstrator, S.N. Medical College, Agra

Dr. Kamna Singh* Associate Professor & Head, Department of Biochemistry, S.N. Medical College, Agra *Corresponding Author

ABSTRACT

Introduction: Chronic kidney disease is a global health concern that affects millions of people. Electrolyte imbalances are a typical CKD consequence that contributes to disease progression. The purpose of this study was to determine the extent of electrolyte imbalance and their relationship to CKD progression. **Material and Methods:** Total 89 clinically confirmed CKD patients aged between 20-75 years of both sexes were taken in this study. Serum samples were analyzed for electrolyte such as sodium, potassium and ionized calcium and biochemical parameters urea and creatinine. ANOVA and correlation were used to assess the statistical analysis. The p value less than 0.05 was considered as statistically significant. **Result:** The mean level of urea, creatinine and potassium were found to be significantly increased with the subsequent stages of CKD while calcium was significantly decreased, and sodium showed non-significant changes. **Conclusion:** Thus the assessment of electrolyte in CKD patients is necessary to prevent the consequences such as cardiac arrythmia, bone mineral abnormalities and metabolic acidosis in CKD patients.

INTRODUCTION

Chronic kidney disease is a major global public health concern affecting 5–10% of the world's population [1]. Over 500 million individuals worldwide suffer with CKD [2,3]. According to the Global Burden of Disease 2015 report, renal failure claimed the lives of almost 1.2 million people and became the 18th leading cause of mortality worldwide. According to recent research, the number of disability-adjusted life years caused by CKD increased from 19 million in 1990 to more than 41 million in 2019. Furthermore, it has been estimated that the age-adjusted incidence rate of end-stage renal disease in India is 229 per million people, and every year over 100,000 new patients enroll in renal replacement programs [4]. In India, the incidence of end-stage renal disease is 150 to 200 per million population whereas the estimated prevalence of chronic kidney disease is 800 per million [5].

Regardless of the etiology, chronic kidney disease is defined as presence of kidney damage or an estimated glomerular filtration rate of less than 60 ml/min/1.73 m^2 persisting for three months or more . CKD is frequently accompanied by nonspecific symptoms like fatigue and loss of appetite. Generally, CKD is diagnosed during screening of high-risk patients like those having diabetes, hypertension, cardiovascular disease, or a family history of chronic kidney disease [6].

Electrolyte homeostasis is vital for proper functioning of various metabolic processes and organ function in humans. Kidney plays an important role in the maintenance and regulation of electrolyte homeostasis. In CKD as kidney function declines, an increase in imbalance in the equilibrium of minerals and electrolytes occurs. If these abnormalities are not identified and treated appropriately, they may worsen renal function, cause alterations in the cardiovascular system, and raised morbidity and death rates. The most common electrolyte imbalances associated with renal failure include anomalies in the levels of potassium, sodium, magnesium, phosphorus, and calcium that can lead to a serious consequences like muscular atrophy, vascular calcification, bone demineralization, and even in the worst situations, death occur [7,8]. Potassium is the most prevalent intracellular cation therefore the patient with chronic kidney disease who have impaired regulatory mechanism are susceptible to hyperkalemia. While Sodium is the primary extracellular cation, maintains nerve and muscle function and aids fluid equilibrium in the body. Therefore, the aim of this study is to assess the level of electrolyte and its correlation with CKD progression.

MATERIAL AND METHOD

The present study has been carried out in the Department of Biochemistry, S.N Medical College Agra. Total 89 clinically confirmed patients of chronic kidney disease with different stages aged 20-75 years of both sexes from the OPD of medicine were taken in this study. Patients with acute renal injury, chronic liver disease, ischaemic heart disease, hyper-hypothyroidism, gout were excluded from this study. 4ml of venous blood samples were taken from these patients and collected in plain vial under all aseptic conditions. The serum was separated after centrifugation for 10-15 minutes at 3000 rpm and analyzed for electrolytes such as sodium, potassium, ionized calcium and biochemical parameter urea and creatinine. Electrolytes were measured through Innolyte machine using ion electrode method. Urea and creatinine were estimated through standard kit method by fully autoanalyzer.

Calculation of eGFR

Diagnosis of chronic kidney disease was established by measuring serum creatinine using CKD-EPI equation which measure eGFR that helps to determine the stage of CKD.

The CKD-EPI equation for female:

141 * min (creatinine/ κ, 1) ^ α * max (creatinine/0.7, 1) ^-1.209 * 0.993^age * 1.018,

The CKD-EPI equation for male:

141 * min (creatinine/ κ, 1) ^ α * max (creatinine/0.9, 1) ^-1.209 * 0.993^age * 1.

Where:
Scr is serum creatinine,
κ is 0.7 for females and 0.9 for males,
α is -0.329 for females and -0.411 for males,
min indicates the minimum of Scr/κ or 1 and
max indicates the maximum of Scr/κ or 1. [9]

Statistical Analysis:

All the variables were expressed as mean ± SD. The Python Programming was used to analyses the data. An ANOVA test was done to see any significant difference in electrolyte and biochemical parameters level among CKD stages. A

correlative study was done to find out correlation of electrolytes and biochemical parameter with CKD progression. The p value less than 0.05 was considered as statistically significant.

RESULT

This study analyzed 89 CKD patients with different stages, ranging from 1 to 5.Table 1: - Showed that with the decrease in eGFR range stage of CKD increases. Table No2 (i-ii) showed comparative analysis of electrolyte, urea and creatinine level across different stages of CKD and it was observed that there will be a significant difference in the mean level of potassium, creatinine and urea among different stages of CKD while sodium and calcium were found to be non-significant. Additionally, a correlative study showed serum creatinine, urea and potassium levels increased with CKD stage, indicating a strong correlation with disease progression.With correlation coefficients of 0.86, 0.55 and 0.79, respectively, serum creatinine, urea and potassium showed substantial positive correlations with CKD stage in the correlation matrix, suggesting a strong relationship between these biomarkers and CKD progression. The study reveals statistically significant correlations (p-value < 0.05), indicating that these associations are unlikely due to random chance. While the calcium shows a negative correlation (r value of -0.28 and p value of 0.05) with CKD stage.

Table No-1: showing eGFR range and CKD stage

eGFR Range	CKD Stage
93.84-123.88	1
61.72-87.33	2
32.15-58.27	3
20.62-28.93	4
7.06-14.39	5

Table No2 (i): Showing the comparative analysis of electrolytes among CKD stages

Parameter	Stage I	Stage II	Stage III	Stage IV	Stage V	F	P-Value
Sodium (Na^+) Mean±SD	140.99 ± 11.85	145.58 ± 13.03	141.98 ± 10.80	136.90 ± 10.47	135.35 ± 4.63	0.73	0.58^{NS}
Potassium (K^+) Mean± SD	4.01 ± 0.38	4.52 ± 0.5	5.3 ± 0.5	6.56 ± 0.14	7.43 ± 0.59	20.79	0.00^{***}
Calcium (iCa^{++}) Mean ±SD	1.72 ± 1.13	1.31± 0.34	1.24± 0.22	1.16 ± 0.03	1.08 ± 0.10	1.46	0.23^{NS}

Table No2 (ii): Showing the comparative analysis of biochemical parameters among CKD stages

Parameter	Stage I	Stage II	Stage III	Stage IV	Stage V	F	P-Value
Urea Mean ±SD	43.34 ± 18.01	53.43 ± 11.77	51.44 ± 28.08	119.95 ± 46.55	133.91± 53.78	11.76	0.00^{**} *
CreatinineMean± SD	1.08 ± 0.21	1.32 ±0.22	1.64 ±0.28	3.02 ± 1.01	4.55 ± 1.07	81.44	0.00^{**} *

^{NS} Non significant, ***Highly significant at p value <0.001

Table No3: showed correlation of electrolyte and biochemical parameters with CKD stages

S.No	Parameters	CKD stages r value
1	Sodium (Na^+)	-0.13^{NS}
2	Potassium ($K^{+)}$	0.79***
3	Calcium (iCa^{++})	-0.28**
4	Urea	0.55***
5	Creatinine	0.86***

^{NS} Non significant, **Significant at p<0.05, ***Highly significant at p <0.001

DISCUSSION

The present study was done with the aim of studying serum electrolyte level and biochemical parameters in CKD patients. In this study, the mean level of urea and creatinine were found to be higher than normal range in CKD patients as well as the urea and creatinine were also found significantly increased (p value < 0.001) with the stages of CKD which suggest that the extent of kidney damage assessed by the urea and creatinine as the disease progressed.These findings were according to the study of Singh et al., 2018 [10]. The mean level of potassium was also found to be high while sodium and calcium were found in normal range which is similar to study of Sharma et al., 2022 [11]. Furthermore, a correlative study showed that as the stages of CKD progressed, sodium levels was found to be decreased, but the difference was statistically insignificant (p value = 0.35) while the calcium was found to be statistically significantly decreased (p value = 0.05) as CKD stages progressed. In contrast, potassium was found to be increased with the stages of CKD, and it was statistically significant (p value < 0.001) which corresponds to Poudel et al., 2011 [12]. The potassium level was increased due to decreased renal excretion as kidney function declined, resulting in potassium buildup in the blood. Additionally, metabolic acidosis, the use of specific drugs such as ACE inhibitors or ARBs and dietary potassium consumption can all contribute to hyperkalemia in CKD patients. Sodium and calcium levels, on the other hand, stay stable due to homeostatic mechanisms, dietary control, and medical management, such as the use of phosphate binders and calcium supplements, which aid in maintaining balance despite declining kidney function.

CONCLUSION

Our study found that electrolyte abnormalities particularly raised potassium and lowered calcium levels in CKD patients and worsen with disease progression. Hyperkalemia, a risk factor for cardiac arrhythmias, and hypocalcemia, which is frequently associated with bone mineral abnormalities, are major issues in CKD treatment. While the sodium levels did not significantly decrease with CKD progression. Based on our findings, we suggest that early assessment of serum electrolyte is critical for managing CKD patients. Early detection and correction of electrolytes can improve the prognosis of CKD by preventing serious complications. This strategy can aid in disease monitoring and the early deployment of therapies to prevent future worsening of kidney function and related consequences. The study emphasizes the significance of routine electrolyte monitoring in CKD patients, even in the early stages of the disease, to ensure appropriate therapy and better patient outcomes.

REFERENCES:

1. Amato AA, Santos GM, de Assis Rocha Neves F. Thyroid hormone action in chronic kidney disease. Curr Opin Endocrinol Diabetes Obes. 2008;15(5):459-65.
2. Hill NR, Fatoba ST, Oke JL, Hirst JA, O'Callaghan CA, Lasserson DS, Hobbs FDR. Global prevalence of chronic kidney disease – A systematic review and meta-analysis. PLoS One. 2016;11(7):e0158765.
3. Nasri H. World Kidney Day 2014; chronic kidney disease and aging: a global health alert. Iran J Public Health. 2014;43(1):126-127.
4. Agarwal SK, Srivastava RK. Chronic kidney disease in India: challenges and solutions. Nephron Clin Pract. 2009;111(3):197-203.
5. Tangri N, Stevens LA, Griffith J, et al. A predictive model for progression of chronic Kidney disease to kidney failure. JAMA. 2011;305(15):1553-59.
6. Ghelichi Ghojogh M, Salarilak S, Taghezadeh Afshari A, Khalkhali HR, Mohammadi-Fallah MR, Mkhdoomi K. The effect of body mass index on patient and graft survival rate in kidney transplanted patients in Iran. Nephrourol Monthly. 2017;9(4):e14386.
7. Zeba Z, Fatema K, Sumit AF, Zinnat R, Ali L. Early screening of chronic kidney disease patients among the asymptomatic adult population in Bangladesh. J Prev Epidemiol. 2020;5(1):e10.
8. Mahajan C, Tiwari V, Divyaveer SS, Patil MR, Banerjee A, Bagur V, et al. Spectrum of renal biopsies; a three-year data from a tertiary care centre of eastern India. J Nephropharmacol. 2020;9(2):e20.
9. Kimura K, Hosoya T, Uchida S, Inaba M, Makino H, Maruyama S, et al. Febuxostat therapy for patients with stage 3 CKD and asymptomatic hyperuricemia: a randomized trial. Am J Kidney Dis. 2018;72(6):798–810.

10. Raut K. Estimation and comparison of serum levels of sodium, potassium, calcium and phosphorus in different stages of chronic kidney disease. Nepal J Epidemiol. 2011;1(5):160-167.
11. Sharma PK, Kulkarni PA, Yadav MK. Status of minerals, urea, uric acid, and creatinine in chronic kidney failure in a tertiary care teaching hospital. Int J Acad Med Pharm. 2022;4(5):411-415.
12. Singh S, Bhatta S. Biochemical and hematological parameters in chronic kidney disease. J Manmohan Mem Inst Health Sci. 2018;4(1):4-11.