Serum Potassium, Phosphate, and Calcium Levels and Their Correlation with eGFR in Patients with Chronic Kidney Diseas

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Abstract

A chronic kidney disease (CKD) is a persistent disease that is associated with kidney functions and the corresponding electrolyte homeostasis imbalance. The study was aimed to compare the serum background levels of potassium, phosphate and calcium in CKD patients versus healthy controls and provide the association between each and estimated glomerular filtration rate (eGFR). Seventy study participants were recruited including fifty CKD patients and twenty of controls. Serum electrolytes were identified with the help of traditional biochemical methods, eGFR was estimated with the help of CKD-EPI formula. The results indicated that the potassium and phosphate levels were very high and calcium was very low in CKD patients in comparison to controls ($p < 0.05$). Also, eGFR was negatively correlated with potassium and phosphate and positively correlated with calcium, which indicates that electrolyte imbalances increase with a decreating renal condition. These studies indicate that monitoring of electrolytes in serum ought to be done as an indicator of the degree of the disease and metabolic complications in CKD.

Keywords: CKD, eGFR, Potassium, Phosphate, Calcium

Introduction

The CKD is a progressive disease, i.e. the gradual loss of functionality of the kidneys, and, consequently, the build-up of the metabolic wastes in the body and the disequilibrium of electrolytes. As the activity of the kidney reduces, the ability to maintains serum electrolyte levels such as potassium, phosphate and calcium is impaired which results in cardiovascular, skeletal and metabolic systems complication. The estimated glomerular filtration rate (eGFR) is one of the most significant indicators that can be used to assess the renal performance and demonstrate the stages of CKD [1,2].

CKD patients are expected to experience serum electrolyte changes. Increased phosphate and potassium

are also associated with reduced renal loss and increased calcium is expected to fall due to mineral metabolism disturbance and secondary hyperparathyroidism. The abnormalities do not only indicate the degree of impairment of the kidney but also lead to the advancement of the illness and augment the morbidity (3,4).

The knowledge of eGFR-serum electrolyte relationship could help shed light on the pathophysiological alterations of CKD and help in the early detection and management of metabolic complications. Thus, the purpose of the study was to compare the levels of potassium, phosphate, and calcium in the serum of patients with chronic kidney disease and normal ones and to assess the correlations between the levels of these minerals and eGFR (5).

Materials and Methods

Design and participants of studies.

The case study is a case-control study, which was conducted in Baghdad Medical City (Al-Tibb City Hospital), Iraq, during the period of June to October 2025. The sample size was 70 participants consisting of 50 patients with chronic kidney disease (CKD) and 20 apparently healthy people that make the control group. The clinical assessment and laboratory results, which indicated that there was a persistent drop in the renal functionality defined the diagnosis of CKD. All the participants were age and sex matched as much as possible, so that the confounding factors were kept to the minimum **(6,7).**

Collection and preparation of the samples.

Each participant had 5mL of venous blood collected under aseptic conditions. Samples were left to clot in the room temperature and centrifuged at 3000 rpm at 10 minutes to get clear serum. The separated serum was tested immediately or kept at -20 C until the biochemical testing **(8).**

Biochemical analysis

The concentration levels of serum potassium (K +) and calcium (Ca 2 +) were measured by COBAS c111 analyzer (Roche Diagnostics, Germany), whereas phosphate (PO 4 -) was measured by VITROS 350 Chemistry Analyzer (Ortho Clinical Diagnostics, USA). Serum creatinine, age, and sex were used as parameters to calculate the estimated glomerular filtration rate (eGFR) by CKD-EPI formula. The entire process was conducted in the Central Laboratory in Baghdad medical city in accordance to the standard quality control measures **(9).**

Statistical analysis

All of the data were processed with the help of IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). The outputs were in the form of the mean and the standard deviation (SD). The data distribution was tested by the Shapiro-Wilk test which was employed to test the normality. The independent samples t-test was applied to compare the results of variables with normal distributions and the MannWhitney U test was applied to compare non-normally distributed factors between the CKD and control group. Pearson or Spearman correlation tests were used to determine the correlation existing between the eGFR and serum potassium, phosphate, and calcium levels. The p-value of less than 0.05 was found to be significant.

Ethical considerations

This study received ethical approval by the Research Ethics Committee of Baghdad Medical City, and informed consent was taken with all the participants before their enrolment **(10,11).**

Results

The current study involved a total of 70 subjects; 50 people with chronic kidney disease (CKD) and 20 seemingly healthy controls. The general aspects and demographic statistics of the two groups are shown in Table 1. The age of CKD patients was a little bit bigger than the control group. In both groups, male participants took the majority **(12).**

Table 1. Demographic characteristics of CKD patients and control group

Variable	CKD patients (n=50)	Controls (n=20)	p-value
Age (years, mean ± SD)	56.8 ± 9.5	44.6 ± 7.8	0.001*
Gender (Male/Female)	32 / 18 (64% / 36%)	12 / 8 (60% / 40%)	0.73
Total participants	50	20	—

*Significant at p < 0.05

Serum biochemical parameters showed noticeable differences between CKD patients and controls (Table 2). Mean serum potassium and phosphate levels were significantly higher in CKD patients, while calcium and eGFR values were markedly reduced.

Table 2. Comparison of biochemical parameters and their correlations with eGFR

Parameter	CKD patients (Mean ± SD)	Controls (Mean ± SD)	Median (CKD)	p-value	t-value	Correlation with eGFR (r)
Potassium (mmol/L)	5.3 ± 0.6	4.2 ± 0.4	5.2	<0.001*	6.12	−0.68*
Phosphate (mg/dL)	5.5 ± 0.8	3.7 ± 0.6	5.4	<0.001*	7.23	−0.72*
Calcium (mg/dL)	8.1 ± 0.7	9.3 ± 0.6	8.0	<0.001*	−5.89	+0.64*
eGFR (mL/min/1.73 m²)	38.5 ± 12.6	95.4 ± 15.2	40.0	<0.001*	−13.4	—

*Significant at p < 0.05

There was a strong negative correlation of eGFR with serum potassium (r = -0.68, p < 0.001) and phosphate (r = -0.72, p < 0.001) and positive correlation between eGFR and calcium (r = +0.64, p < 0.001). This implies that with the loss of renal function, the levels of potassium and phosphate increase whereas the levels of calcium become low.

Discussion

The current research study revealed that there were considerable changes in serum electrolyte levels in patients with chronic kidney disease relative to the healthy population. The increased levels of potassium and phosphates, seen in CKD patients, were as a result of the decreased capacity of kidney to excrete the ions, thus causing the retention of the elevated levels in blood. On the other hand, the low calcium levels indicate the disruption in the mineral metabolism due to the impaired vitamin D activation and secondary hyperparathyroidism, which are prevalent in CKD **(13,14,15).**

The significant negative relationships between eGFR and potassium and phosphate are confirmatory of the fact that electrolyte imbalance is amplified when kidney functioning worsens. These are in line with the other works done in the past that indicated the same relationships between hyperkalemia, hyperphosphatemia and the advancement of renal impairment. The fact that eGFR and calcium have a positive association proves the idea that the hypocalcemia is a disease indicator that manifests in the later stages **(16,17).**

Taken together, the findings indicate that routine checking of serum electrolytes on CKD patients is significant in controlling the disease. These biochemical abnormalities can be detected early and corrected to prevent the occurrence of complications, including cardiac arrhythmias, vascular calcification, and bone disorders to eventually enhance patient outcomes **(18,19,20).**

Conclusion

This was a research done in the Medical City Hospital in Baghdad that revealed that there were massive imbalances in serum electrolyte levels in chronic kidney disease patients as opposed to the healthy controls. The increase in the level of potassium and phosphates, as well as the decrease in the level of calcium and eGFR, indicate the gradual deterioration of the renal system and a violation of mineral balance. The correlations noted show that the biochemical parameters under observation are a good measure of the severity of the disease.

Electrolyte imbalances should be evaluated and corrected early in order to avert life-threatening complications and enhance clinical outcomes in CKD patients. The findings demonstrate the need to incorporate routine biochemical surveillance in the routine management of chronic kidney disease within the Iraqi health care environments.

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