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CORRELATION OF SERUM POTASSIUM LEVEL WITH CHRONIC KIDNEY DISEASE(STAGE IV &V)-AN OBSERVATIONAL STUDY.

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ABSTRACT

Hyperkalemia with Chronic kidney disease(CKD) has possible implications for associated adverse cardiac outcomes. The present study was planned to evaluate the serum potassium levels and correlate them with glomerular filtration rate(GFR) in patients of CKD.The occurrence of hyperkalemia increase with CKD and increase the odds of mortality.

KEYWORDS : Chronic kidney disease; hyperkalemia; glomerular filtration rate mortality.

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INTRODUCTION

Chronic kidney disease(CKD) is a major health problem worldwide rising at an alarming rate. According to world health organisation global burden of disease project ,diseases of the kidney and urinary tract contribute to the global burden with approximately 850,000 deaths every year.CKD is 12th leading cause of death and 17th cause of disability[1]. The kidney disease outcome quality initiative (KDOQI) of the national kidney foundation (NKF) defined chronic kidney disease as: 'kidney damage for three or more months , as defined by structural or functional abnormalities of the kidney, with or without decreased glomerular filtration rate(GFR)[2], manifested by pathologic abnormalities or markers of kidney damage, including abnormalities in the composition of blood or urine or abnormalities in imaging tests and GFR <60 ml per minute per 1.73 m^2 for three months or more, with or without kidney damage[2]. Patients with CKD may be predisposed to hyperkalemia for a variety of reasons. Principal causes include their impaired glomerular filtration rate (GFR) combined with a frequently high dietary potassium intake relative to residual renal function, a commonly observed extracellular shift of potassium caused by the metabolic acidosis of renal failure and most importantly, recommended treatment with rennin-angiotensin aldosterone system(RAAS) blockers that inhibit renal potassium excretion[2.]

MATERIALS AND METHODS

The present study was carried out at department of biochemistry , shree Balaji Medical College And Hospital , chrompet. From all patients a written informed consent was obtained. A total of 45 cases of CKD on conservative treatment were selected. Patients with acute renal failure and acute tubular necrosis were excluded from the study. Patients were grouped into stages according to NKF classification of CKD depending on GFR in ml/min/1.73m^{2}of body surface area. After thorough clinical examination anthropometric measurements for body mass index (BMI) were recorded as body weight(kg) , height(m^2).GFR was calculated by the Cockcroft-gault equation[3,4.]

$$\text{GFR} = \frac{[(140\text{-age} \times \text{ body weight(kg)} \times 0.85 \text{ if female}]}{72 \times \text{ serum creatinine (mg/dl)}}$$

For biochemical investigations 3ml of blood was collected. Serum potassium done by ion electrode method, serum creatinine by enzymatic method.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS software,version 10. Continuous data are expressed as mean 2SD or median and categorical data expressed as percentages. A p value of < 0.05 is considered statistically significant.

RESULTS

A total of 45 patients was studied; out of which 24 were men and 21 were women. The mean age was 49.7± 21.4 years. Patients in stage IV and stage V chronic kidney disease (CKD) on conservative treatment were taken. The number of patients in stage IV CKD was 20 (44%) and 25 patients (56%) were in stage V . Table 1 shows that mean values of blood urea, serum creatinine and serum potassium are raised above normal in all CKD patients. Further these values are increasing from stage IV to stage V. The BMI value of the patient group is within normal range and it is slightly low in stage V than stage IV CKD patients.

Table 1
Parameters in all CKD patients

Parameters	Ref value	All patients	Stage IV	StageV
Age (yrs)	-	49.7± 21.4	43.65±22.36	54.48± 16
BMI(kg/m^{2}BSA)	18.5-24.99	21.8 ± 3.8	22.6± 3.8	21.17 ±3.6
Bl. Urea (mg/dl)	15-40	103 ± 48.4	93.7± 34.4	110± 54.24
Sr. Creatinine (mg/dl)	0.6-1.4	4.75±3	4.1± 1.2	5.3± 3.4
GFR(ml/min/m^2)	125	14.7 ± 8.12	18.5 ± 4.4	11.7± 4.8
Sr.Potassium (mEq/L)	3.5-4.5	6.14± 1.4	5.7± 1.1	6.5± 1

Table 2, demonstrates the correlation of various parameters with each other in stage IV patients. Serum potassium shows statistically significant (p=0.044) negative correlation (r=0.455) with GFR; but without statistically significant correlation with serum creatinine and BMI. Both serum creatinine and blood urea show statistically significant negative correlation with GFR. In stage IV CKD patients, as GFR decreases blood urea, serum creatinine and serum potassium levels increase significantly.

Table 2
Pearson coefficient of correlation testing - relation between various parameters in stage IV CKD patients

	GFR	Sr. Creatinine	Sr. Potassium	BMI
Sr.potassium	r = -0.455	r =0.034	-	r = 0.013
	p =0.044	P = ns*		p = ns
Sr. Creatinine	r = -0.598	-	r =0.034	r = -0.113
	p =0.044		p =ns	p = ns
BMI	r =0.338	r =-0.113	r =0.013	-
	p =ns	p =ns	p = ns	
Bl . urea	r =-0.483	r =0.709	r = -0.014	r = -0.121
	p =0.031	p =ns	p = ns	p =ns

: not statistically significant

\Patients from stage V CKD showed statistically significant negative correlation of serum potassium with GFR (r=-0.529/p=0.007) without any correlation with serum creatinine and BMI. Serum creatinine does not show significant correlation with GFR and serum potassium. Thus within stage V CKD , with decreasing GFR;serum potassium goes on increasing.

Table 3
Pearson coefficient of correlation testing - relation between various parameters in stage V CKD Patients

	GFR	Sr.creatinine	Sr.potassium	BMI
Sr.potassium	r =-0.529	r = 0.506	-	r =-0.212
	p =0.007	p =ns		p =ns
Sr.creatinine	r =-0.781	-	r =0.306	
	p =ns		p =ns	p =ns
BMI	r =0.306	Ns	r =-0.212	-
	p =ns		p =ns	
Bl. Urea	r =-0.352	r = 0.601	r =0.260	r =0.090
	p = ns	p =0.001	p =ns	p = ns

Table 4 shows a comparision of serum potassium in two stages and correlate them with GFR, serum creatinine and BMI. Mean serum potassium in studied patients was found to be elevated (mean 6.1±1.4mEq/L) (table 1). After applying unpaired t-test on the data, it is found that the increase in sr. Potassium level from mean 5.7 mEq/L in stage IV CKD to mean 6.5mEq/L in stage V CKD is statistically significant($p<0.01$).

Table 4
comparision of studied parameters in two groups

	Stage IV CKD	Stage V CKD
GFR (ml/min/m^2)	18.5±4.4	11.7±4.8
Sr.potassium (mEq/L)	5.7±1.1	6.5±1.2*
Sr.creatinine (mg/dl)	4.1±1.2	5.3±3.4*
BMI (kg/m^2BSA)	22.6±3.8	21.17±3.6

: statistically significant increase from stage IV to stage V CKD.

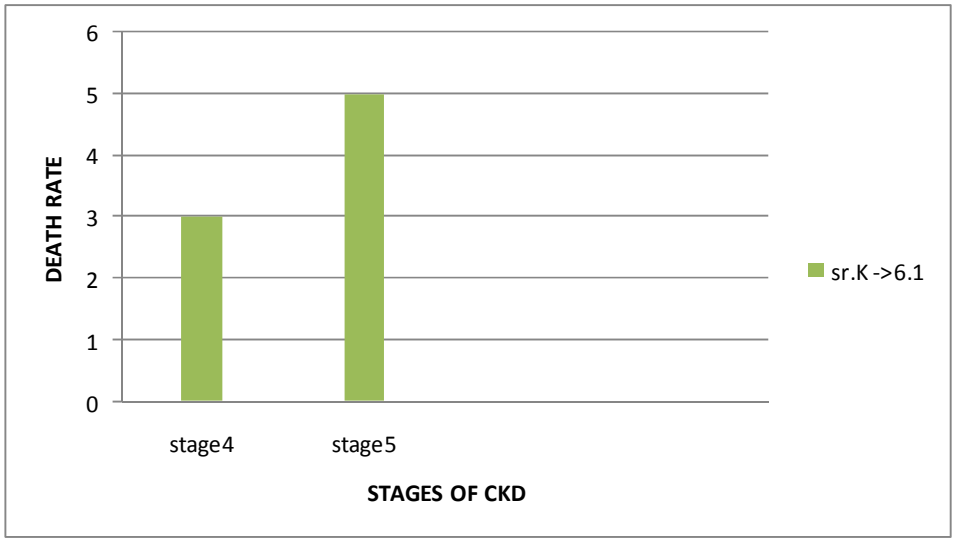
DISCUSSION

The primary exposure was the presence of CKD. Serum creatinine was used to measure renal function and glomerular filtration rate was used to classify subjects into 2 groups – CKD IV and CKD V [5,6,7.] Incidence of hyperkalemia was the primary outcome. Using previously defined thresholds for hyperkalemia, moderate hyperkalemia was set to be a serum potassium level greater than or equal to 5.5 mEq/L but less than 6 mEq/L with more severe hyperkalemia was set at greater than or equal to 6.1mEq/L[8.] Hyperkalemia event was chosen as the key adverse outcome. Prevalence of hyperkalemia were substancial in patients with non-dialysis dependent CKD and are associated with a significant increase in all-cause mortality[9,10,11]. In our study , we observed raised serum potassium levels in the patients of stage V CKD over those of stage IV CKD. Sustained hyperkalemia is always attributable to inadequate renal potassium elimination, as in individual with normal renal function, the kidneys are responsible for the elimination of about 95% of the daily potassium load with the remainder existing through the gut[12,13]. External potassium is maintained largely by modulating renal potassium elimination. Almost all the potassium excreted by the kidney comes from potassium secreted in the distal nephron (collecting tubule and collecting duct)[14]. Virtually all regulation of potassium excretion takes place at this site in the nephron, under the influence of two principle factors; the rate of flow and solute(sodium and chloride) delivery through that part of the nephron; and the effect of aldosterone[15,16]. Mineralocorticoid deficiency is often induced by drugs that interfere with the renin-angiotensin aldosterone axis and commonly causes hyperkalemia in patients with chronic kidney disease. As GFR declines serum potassium levels increase, as potassium filtration and secretion falls. When aldosterone or other kaliuretic factors fail to maintain potassium homeostasis, extracellular potassium may rise until it reaches a level sufficient to produce a sustained increase in renal potassium excretion [17,18,19]. Increased extrarenal potassium excretion through the gut is another adaptive mechanism which gradually develops in patients with chronic renal failure as kidney function declines[20.]

TABLE 5
Incidence of hyperkalemia with Renin Angiotensin Aldosterone System (RAAS) blocker treatment

RAAS Blocker treatment	Potassium ≥5.5mg/dl	Potassium ≥ 5.5 to 6.0mg/dl	Potassium ≥6.1mg/dl
Stage IV	5	10	2
Stage V	4	7	14

Compared to stage IV , 14 patients in stage 5 had serum potassium level ≥6.1mg/dl who were on RAAS treatment Alteration in the plasma potassium concentration have more serious effect on cardiovascular system[21.] Hyperkalemia depolarizes the cell membrane , slows ventricular conduction, and decreases the duration of action potential. These changes produce the classic electrocardiographic (EKG) manifestations of hyperkalemia including (in the order of usual appearance) peaked T waves, widening of the QRS complex, loss of the P wave, 'sine wave' configuration, or ventricular fibrillation and asystole[22,23]. So patients with hyperkalemia are reported to have a higher mortality rate and very commonly when associated with CKD. The high prevalence and incidence of cardiovascular disease –causing sudden death in CKD patients commonly occur in hyperkalemia [24,25,26.]



The above bar diagram shows the mortality rate among CKD population of our study, that was found to be high in stage V CKD patients with a serum potassium > 6.1 with statistically significant p<.044 with that of stage IV. Hyperkalemia is linked to increased odds of mortality[27,28] although the risk is lower in stage IV CKD patients versus stage V CKD patients. In order to reduce the mortality rate, conditions which induce hyperkalemia in these CKD patients should be stopped (angiotensin-converting enzyme inhibitors , angiotensin receptor blocker, potassium sparing diuretics) [29] . The effective and definitive but a invasive treatment for hyperkalemia is hemodialysis[30]. This study has several limitations.

CONCLUSION

Hyperkalemia is associated with increased mortality in CKD patients, and prevalence is more in stage V CKD patients than stage IV CKD patients. These finding suggest the role of disease management of patient's safety measure is complex. So while treating patients of CKD , metabolic disturbances specially hyperkalemia should be considered as a risk factor for mortality in CKD patients.

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