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Effect of Serum Potassium Level on Hemodynamic Stability during the Hemodialysis Session

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ABSTRACT

Potassium is the major intracellular cation with concentrations reaching 120-150 mEq/L. On the contrary, the extracellular fluid potassium concentration is much lower and kept within very narrow levels between 3.5-5.0mEq/L [(1)]. **Aim of the work:** this work aimed to assess serum potassium level in patients on regular hemodialysis and to determine its clinical impact on hemodynamic stability during the hemodialysis session.

Patient and method: serum (K) level of 30 patients on regular hemodialysis was measured before and after dialysis and the results were correlated with electrocardiographic (ECG) changes. Results: there was no change in P wave, PR interval or QT interval in all the patients, while QRS was found to be shortened in 3 patients (10 %) in the post-dialysis ECG and elongated in one patient (3.3%) in the post dialysis ECG, T wave showed dynamic changes in the form of reduction in the amplitude of T wave in 11 patients (36.7%). **Conclusion:** the absence of electrocardiographic changes in hyperkalaemic haemodialysis patients should be interpreted with caution.

Keywords: hemodialysis, potassium, hyperkalemia, chronic kidney disease.

INTRODUCTION

Potassium is the major intracellular cation with concentrations reaching 120-150 mEq/L. On the contrary, the extracellular fluid potassium concentration is much lower and kept within very narrow levels between 3.5-5.0 mEq/L [(1).] A predialysis serum potassium of 4.6 to 5.3 mEq/L was associated with the greatest survival in maintenance hemodialysis patients. Whereas, potassium <4.0 or >5.6 mEq/L was associated with increased mortality.Intermittent hemodialysis may result in fluctuating serum K levels, which at the extremes can reach pathologically high or low concentrations [(2).] It is not clear which range of predialysis serum K is most beneficial in maintenance hemodialysis patients. A high-normal serum K level could offer a survival advantage by being less arrhythmogenic.It is also unclear what the ideal dialysate K concentration should be. Indeed, dialysate baths with higher K concentration could be assumed beneficial by virtue of inducing less fluctuation in serum K levels. However, a high dialysate K concentration might be associated with more frequent episodes of hyperkalemia and its deleterious cardiovascular effects [(2).]The usual dialysate potassium level was 2 mmol/L.The lowest mortality has been associated with the use of 3 mmol/l potassium. Low dialysate concentrations, particularly those of 0 or 1 mmol/L should be avoided. If used, extreme caution should be exercised because the rapid decline in plasma potassium concentration, which occurs in the early stages of a dialysis treatment, is arrhythmogenic [(3).]A study showed a rapid decrease in the concentration of serum potassium during the initial stage of the dialysis following reduction of dialysate potassium translates into a decrease in systolic and mean blood pressure mediated by a decrease in peripheral resistance [(4).]

Hyperkalemia is defined as a serum K concentration-greater than 5.0mEq/L. The prevalence of hyperkalemia in hemodialysis (HD) patients was reported to be about 8.7-10%. Mortality related to hyperkalemia has been shown to be about 2-5% of deaths among patients with end stage renal disease (ESRD) and about 24% of patients with hemodialysis (HD) required emergency hemodialysis due to severe hyperkalemia [(5).] It was found that haemodialysis patients with a high predialysis serum potassium concentration (>5.5 mEq/L) did not manifest typical electrocardiographic (ECG) changes associated with hyperkalaemia and that total serum calcium concentration had an inverse relation with T wave amplitude .Also, there was no difference in T wave amplitude or T wave to R wave ratio between those with low or high pre-dialysis serum potassium concentration.Thus, the absence of electrocardiographic (ECG) changes in hyperkalaemic haemodialysis patients should be interpreted with caution [(6).]

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PATIENT AND METHOD

Serum potassium level of 30 patients on regular hemodialysis was measured before and after dialysis and the results were correlated with electrocardiographic (ECG) changes and this study was conducted in Abshaway Hospital ,El fayoum Governorate.

The following data were done to all patients:

1) Informed consent from all the patients who shared in the study.
2) Medical History: including history of cardiovascular diseases ,cause of end stage renal disease (ESRD),drug history ,diabetes mellitus ,type of dialyser used, dialysate bath and dialysate sodium and potassium concentration.
3) General examination, including: pulse, blood pressure and cardiological examination.
4) Measurement of predialysis serum potassium (K). Serum potassium was measured on clotted blood sample before any heparin or fluid administration.
5) Measurement of postdialysis potassium level.
6) ECG was done before and after dialysis.
7) ECG and plasma potassium sample were repeated upon any cardiac symptom:chest pain or palpitation durig dialysis.
8) Monitoring pulse and blood pressure hourly during the dialysis session.
9) Other laboratory measurements were included: complete blood count (CBC) and serum calcium and serum Magnesium.

The study was approved by the Ethics Board of Ain Shams University.

Statistical methodology

The patients were categorized according to QRS changes and T wave changes and were compared regarding: hemoglobin level, calcium level and degree of potassium changes.

Degree of potassium change from baseline was calculated from the following formula postdialysis K-predialysis K/predialysis K × 100 and subgroup analysis was done regarding different ECG changes.

RESULTS

Table 1 illustrated the recorded changes in heart rate per minute, systolic and diastolic blood pressure measured for the patients hourly during the hemodialysis session. It was found that there was a gradual decrease in systolic blood pressure over the 4 hours, being significant only during the last hour; mean systolic BP in the 3rd hour was128±21 mmhg and 4th hour showed 121±18 mmhg with P value 0.001.

There was also reduction in the diastolic BP over the 4 hours with the mean diastolic BP 78±12,76±11,76±10,74±9 during the 1st,2nd, 3rd and 4th hour of dialysis respectively.

The P value was insignificant. It was found that there was no significant change in the heart rate of the patients with the mean HR/minute during the 1st hour 82±7, during the 2nd hourit was 83±6,during the 3rd hour it was 82±8 and during the 4th hour it was 81±9 respectively. P value was 0.163 ,0.797 ,0.56 respectively.

Table 1: blood pressure and heart rate records during the hemodialysis session

	1st hour		2nd hour		3rd hour		4th hour	
	Mean	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**	**Mean**	**± SD**
Systolic BP (mmHg)	132	± 29	129	± 21	128	± 21	121	± 18
P Value			0.245		0.662		**0.001**	
Diastolic BP (mmHg)	78	± 12	76	± 11	76	± 10	74	± 9
P Value			0.161		0.813		0.326	
HR (BPM)	82	± 7	83	± 6	82	± 8	81	± 9
P Value			0.163		0.797		0.56	

Table 2: illustrated the electrolytes and complete blood count of the patients. It was found that the mean level of serum potassium of the patients before the session was 5.9 ±0.7 ranging from 4.5 to 7.3, while the mean level of serum potassium of the patients after the session was 4.2 ±0.8 ranging from 3 to 6. The degree of K change (%) was -28.5 ±12.2 %.as illustrated in **Table 2**

Table 2: electrolytes and complete blood count of the patients:

	Mean	SD
Ca (mg/dl)	8.6	1.1
Mg (mg/dl)	2.8	0.3
HGB (gm/dl)	10.3	1.7
TLC (x103/mm3)	6.0	2.2
Platelets ($x10^3/mm^3$)	207	58
K Before	5.9	0.7
K After	4.2	0.8
Degree of K change (%)	-28.5	12.2

Table 3 illustrated the electrocardiographic changes in the patients that was found before and after the session.There was no change in P wave, PR interval or QT interval in all the patients ,while QRS was found to be shortened in 3 patients (10 %) in the post-dialysis ECG and elongated in one patient (3.3%) in the post dialysis ECG, T wave showed dynamic changes in the form of reduction in the amplitude of T wave in 11 patients (36.7%).

Atrial fibrillation was detected before and after dialysis in one patient and 3 of the patients presented by PVCs before and after dialysis and one patient had PVCs only after dialysis.

Table 3: ECG changes of the patients during the hemodialysis session:

		No	%
P Wave Change	**No Change**	30	100.0%
PR Interval Change	**No Change**	30	100.0%
QRS Change	**No Change**	26	86.7%
	Shortened	3	10.0%
	Lengthened	1	3.3%
QT Interval Change	**No Change**	30	100.0%
ST segment change	**No Change**	30	100.0%
T Wave Change	**No Change**	19	63.3%
	Dynamic Change	11	36.7%
PVCs	**No**	29	96.7%
	Yes	1	3.3%

DISCUSSION

Our study aimed to assess serum potassium level in patients on regular hemodialysis and to determine its clinical impact on hemodynamic stability during the hemodialysis session. There is incomplete understanding of the electrophysiologic consequences of fluctuations in potassium concentration in end-stage renal disease (ESRD). However, it has been postulated that patients with ESRD have a tolerance for hyperkalaemia and that the usual cardiac and neuromuscular sequella of hyperkalaemia are less evident in ESRD patients than in those with normal renal function[7].

Haemodialysed patients with hyperkalaemia may not exhibit the usual electrocardiographic sequella of hyperkalaemia, possibly due in part to fluctuations in serum calcium concentration. Thus, the absence of electrocardiographic changes in hyperkalaemic haemodialysis patients should be interpreted with caution [6].The mean level of serum potassium of the patients before the session was 5.9 ±0.7 ranging from 4.5 to 7.3.

It was found that 23 patients (76.67%) of the study population were hyperkalemic before the session and 7 patients (23.33%) were normokalemic before the hemodialysis session. None of our patients were reported to be hypokalemic before the session. This findings did not match with **Choi and Ha**[5] who reported that the prevalence of hyperkalemia in HD patients was about 8.7-10%. and the precise prevalence of hypokalemia in maintenance HD patients was unknown but the prevalence was variable among different centers.The electrocardiographic changes in the patients that was found before and after the session were as following: there was no change in P wave, PR interval or QT interval in all the patients ,while QRS was found to be shortened in 3 patients (10 %) in the post-dialysis ECG and elongated in one patient (3.3%) in the post dialysis ECG, T wave showed dynamic changes in the form of reduction in the amplitude of T wave in 11 patients (36.7%). Atrial fibrillation was detected before and after dialysis in one patient and 3 of the patients presented by PVCs before and after dialysis and one patient had PVCs only after dialysis. No other arrhythmias were found because of the small sample size.These findings are matching with those of **Aslam *et al.*** [6] who reported that hemodialysis patients with hyperkalaemia may not exhibit the usual electrocardiographic sequella of hyperkalaemia, possibly due in part to fluctuations in

serum calcium concentration.Thus, the absence of electrocardiographic changes in hyperkalaemic haemodialysis patients should be interpreted with caution. Another study done by **Nemati and Taheri** [8] found that although hyperkalemia did not induce usual ECG changes in all HD patients, it significantly decreases T wave duration. Previous data have suggested that the rate of rise of serum potassium level was more relevant compared to its actual serum concentration**[6].**They explained that a slow elevation in serum potassium value, like in ESRD patients, permits compensatory mechanisms to minimize the effects of hyperkalemia.The mean total calcium of the patients was 8.6±1.1 ranging from 6.1 to 10.2 mg/dl. It was found that the mean calcium level in the patients (8.6) ±(1.1)mg/dl . According to NFK-KDOQI Guidelines [9] it was found that 46.6% of our study population was below the normal recommended range and 53.3% of the patients within normal range. The mean hemoglobin level of the patients was 10.3±1.7 , it was ranging from 7.3 to 14.3 gm/dl. According to **KDOQI Guidelines**[10] 60% of the patients were below the target hemoglobin level (11gm/dl), 33.33 % of the patients had hemoglobin level within target (11-13 gm/dl) and 6.67% of the patients had hemoglobin level above 13 gm/dl.

Hyperkalemia, a potentially life-threatening condition associated with ventricular arrhythmias and sudden cardiac arrest, is common in patients with chronic kidney disease, particularly those receiving maintenance dialysis. Maintenance hemodialysis patients, most of them have little to no residual renal function; rely almost exclusively on the intermittent potassium clearance provided by hemodialysis, supplemented in small measure by gut potassium excretion. Additional risks for hyperkalemia include non-adherence to dietary restrictions, metabolic acidosis, anemia requiring red blood cell transfusions and alterations in the intracellular/extracellular potassium distribution. As a result, many hemodialysis patients regularly experience wide variations in serum potassium levels [11].

CONCLUSION

It was found that 11 patients (36.7%) of the study population had a reduction in the amplitude of T wave in the postdialysis ECG; it was found also that 3 patients (10%) had shortening of the QRS complex in the postdialysis ECG. and one patient (1.7%) had lengthening of QRS complex in the postdialysis ECG. It was found that 3 patients had PVCs before and after dialysis while one patient had PVCS only after dialysis, also one patient presented with atrial fibrillation before and after dialysis, with no other arrhythmias detected. Thus, the absence of electrocardiographic changes in hyperkalaemic haemodialysis patients should be interpreted with caution as a high total serum calcium concentration was associated with a low T wave amplitude.

REFERENCES

1. **Eleftheriadis T, Leivaditis K, Antoniadi G *et al.* (2012):** Differential diagnosis of hyperkalemia:an update to acomplex problem. Hippokratia, 16: 294-302
2. **Kovesdy CP ,Regidor DL,Mehrotra R *et al.* (2007) :** Serum and dialysate potassium concentrations and survival in hemodialysis patients.Clin. J. Am. Soc. Nephrol., 2: 999-1007.
3. **Christopher T,Chan A, Covic J, Craig C *et al.* (2013**): Novel techniques and innovation in blood purification: a clinical update from Kidney Disease:Improving Global Outcomes. Kidney International, 83:359–371.
4. **Gabutti L, Salvade I, Lucchini B *et al.*(2011):** Haemodynamic consequences of changing potassium concentrations in haemodialysis fluids. BMC Nephrol., 12 :14-20.
5. **Hoon Y, Choi C and Sung K H (2013**): Potassium balances in maintenance hemodialysis. Electrolyte Blood Press, 11(1): 9–16.
6. **Shakil A, Eli A F and Onyekachi I (2002):** Electrocardiography is unreliable in detecting potentially lethal hyperkalaemia in haemodialysis patients. Nephrol. Dial. Transplant., 17: 1639–1642
7. **Tzamaloukas AH and Avasthi PS (1987):** Temporal profile of serum potassium concentration in nondiabetic and diabetic outpatients on chronic dialysis. Am. J. Nephrol., 7(2):101-109.
8. **Nemati E and Taheri S (2010):** Electrocardiographic manifestations of hyperkalemia in hemodialysis patients. Saudi J. Kidney Dis.Transpl., 21:471-477.
9. **National Kidney Foundation (K/DOQI (2003):** Clinical practice guidelines for bone metabolism and disease in chronic kidney disease. Am. J. Kidney Dis., 42:1-20.
10. **KDOQI Clinical Practice Guideline and Clinical Practice (2007):** Recommendations for anemia in chronic kidney disease: update of hemoglobin target. Am. J. Kidney Dis., 50: 471–530.
11. **Yusuf A A, Hu Y, Singh B *et al.* (2016):** Serum potassium levels and mortality in hemodialysis patients. Am. J. Nephrol., 44:179-186