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COMPARISON OF THE EFFECT OF ELECTROLYTE CHANGES ON ECGS OF PATIENTS PRESENTED IN EMERGENCY ROOM WITH RENAL FAILURE DURING PRE AND POST HAEMODIALYSIS AND THEIR CORRELATION

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Abstract

Cardiovascular disease is a most common reason for mortality and morbidity among patients on haemodialysis. It is responsible for up to 30% of sudden death among patients during and sometime after dialysis. [7] During the dialysis session the rapid changes in intracellular and extracellular electrolytes leads to Cardiac arrhythmias immediately after a dialysis. [2] Potassium (K^+) is the principle and most important intracellular cation. It is mainly regulated by the kidneys and excess potassium is excreted in urine and to a lesser extent from intestine. It plays an important role in maintaining the electrical potential across the cellular membrane and its blood level affects all types of neuromuscular activities. An alteration in the serum level of potassium may present with cardiovascular complications like cardiac arrhythmias and/or neuromuscular signs and symptoms [5]. Hyperkalaemia is a relatively common finding in patients with renal failure due to a consequence of tissue break down and decreased renal potassium excretion. [4] Severe Hyperkalaemia might occur in 10 -19% of haemodialysis (HD) patients [3]. Sudden shift and decrease in serum K^+ alters the resting membrane potential, which is potentially arrhythmogenic especially in patients undergoing dialysis [8]. Sudden death is common among dialysis patients and the annual death rate for these patients is 230 per 1000 patient per year, ischemic heart disease and rapid electrolyte shift are the most common causes during dialysis sessions [3].

Keywords: *Electrolyte, ECGs, Renal Failure, Haemodialysis*

INTRODUCTION

Typical electrocardiographic (ECG) manifestations include peaked T-waves in the precordial leads, and widening of the QRS-complex, both abnormalities of altered cardiac conduction. Flattening or absence of the Pwave, and a “sine-wave”

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appearance is associated with severe hyperkalemia. [5] HD has been reported to determine an increase in QTc interval which is risk factors that predispose to severe ventricular arrhythmias and sudden death [6].
The purpose of this study was to evaluate the pre and post dialysis serum electrolyte mainly potassium level and any associated ECG change patients with renal failure and without obvious cardiac disease.

METHODS

In this prospective study, 76 patients were recruited; all patients with Age > 18 years of renal failure, and all patients providing consent and undergoing first-time haemodialysis treatment were included. The mean duration for sessions of the dialysis was around 3 hours. Patients with Known case of arrhythmias on antiarrhythmic drugs, known case of IHD and Congenital long QT syndrome, Patients on drug that might have an effect on QT interval, Post CPR, Cardiac resynchronization therapy, Pacemaker, and an implantable cardioverter-defibrillator were excluded from the study.
The patients were normally treated with the following electrolyte concentration: K^+ 2.0mmol/L; Mg^+ 0.38 mmol/L; Ca^+ 1.55 mmol/L; Na^+ 138.35 mmol/L and $HCO3^-$ 32.7 mmol/L. The blood flow rate was 250–300 ml/minute with a dialysate flow of 500 ml/min. The patients were dialyzed using the Polysulfone-based dialysis membrane (Haemodialysis Apparatus Fresenius Medical Care 4008 B) in Civil Hospital, Ahmadabad. Blood samples were obtained from each patient just before the haemodialysis session and 10 minutes after the session for measurements of serum level of K^+ as well as serum level of urea and creatinine as described in the dialysis outcomes quality initiative guidelines [2]. Also, a standard 12-leads ECG recorded before dialysis and 20 minutes after the dialysis in supine position. Potassium and the rest of the electrolyte were analyzed and detected by an ion-selective (ISE) method by using the Roche Electrolyte analyzer. The patients were followed for 2 days to record any adverse outcomes. All our patients had a negative history of chest pain, absence of regional wall motion abnormalities, and gross left ventricular hypertrophy on echocardiography and had a normal left ventricular ejection fraction of >50%.
Electrocardiograms (ECG)
All ECGs were obtained at a paper speed of 25 mm/s after a five-minute resting period, with the patient lying comfortably in the supine position. While the reading of ECG parameters, three consecutive cardiac cycles were calculated and averaged. All ECGs were read and analyzed by one investigator without knowledge of the patient's laboratory results. The interpretation of ECG was performed by measuring the amplitude of the T and R waves, QT and R-R intervals.

STATISTICAL ANALYSIS

The data obtained were subjected to statistical analysis to find whether there was any correlation between serum potassium level and Electrocardiogram before and after haemodialysis. Results were made as mean ± standard deviation.

Figure 1 The Distribution of the Patients according to Sex.

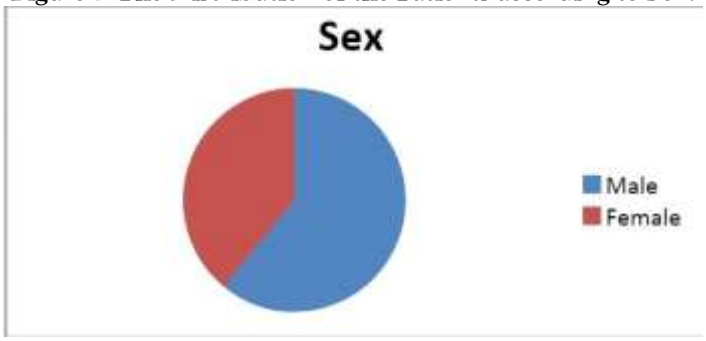

Table 1 Causes of Renal Failure

Co morbidity	Patients (%)
Chronic kidney disease	57 [74%]
Diabetes mellitus	27 [36%]
Hypertension	23 [30%]
Pyelonephritis	4 [6%]
Malignancy	1 [1%]
PLHA	4 [5%]
Cirrhosis of liver	6 [9%]

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Chronic obstructive pulmonary disease	1 [2%]
Autoimmune causes	3 [4%]
Obstetrics causes	2 [3%]
Septicemia	5 [%]

Table 2 Electrolyte and ECG Changes pre and post haemodialysis

ECG PARAMETERS	Pre-HD		Post-HD	
	Mean	SD	Mean	SD
PR interval	152.89	22.32	154.21	24.833
T wave	4.28	1.2632	3.02	0.7304
QTc interval	440.57	16.843	448.22	16.742
HR(min)	89.01	20.993	91.10	18.121
LABORATORY DATA				
Na^+ (mEq/L)	131.05	8.2209	134.02	5.0914
K^+ (mEq/L)	5.69	0.945	3.16	0.3074
BUN (mg/dl)	172.57	78.468	127.14	63.067
S.Creatinine (mg/dl)	11.8	20.79	6.73	3.1294

RESULTS

Out of 76 patients 46 were male and 30 were female. Atrial arrhythmias were seen more commonly than ventricular arrhythmias. 42 patients had pre-HD ECG changes; Out of them Sinus tachycardia was seen in 11 patients; 13 patients had atrial premature beats; 6 patients had ventricular premature contraction and 12 patients had ST-T changes were seen in ECG changes before HD. 12 patients without pre-HD ECG changes developed ECG changes post-HD. Total 23 patients had ECG changes after HD. Out of them Sinus tachycardia was seen in 10 patients; 8 patients had atrial premature beats; 3 patients had ventricular premature contraction and 2 patients had ST-T changes were seen in ECG changes after HD. The mean pre-HD K^+ was 5.69 ± 0.74 mmol/L and hyperkalaemia >5.5 mmol/L was recorded in 30 patients pre-HD and mean post-HD K^+ was 3.16 ± 0.82 mmol/L. Mean QTc interval preHD was 440.57 ± 30.2 ms and prolonged QTc was measured in 21 patients pre-HD. Mean post-HD QTc interval was 448.22 ± 26.1 ms and prolonged QTc was measured in 29 patients post-HD. Mean T wave amplitude pre-HD 4.28 ± 1.96 and mean post-HD T wave amplitude 3.02 ± 1.27 mm.

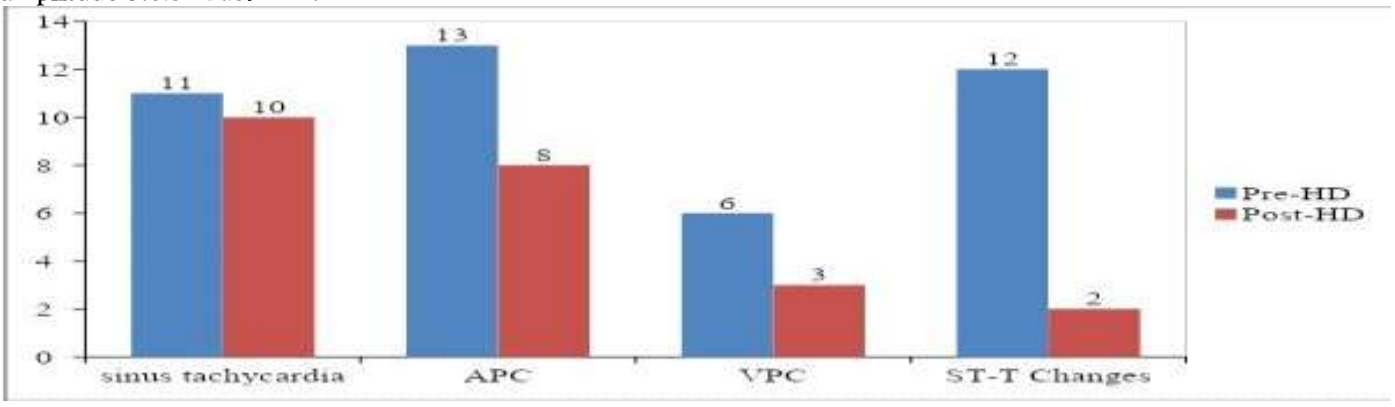

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Figure 2 The correlation between the pre-HD and post-HD ECG Parameters.

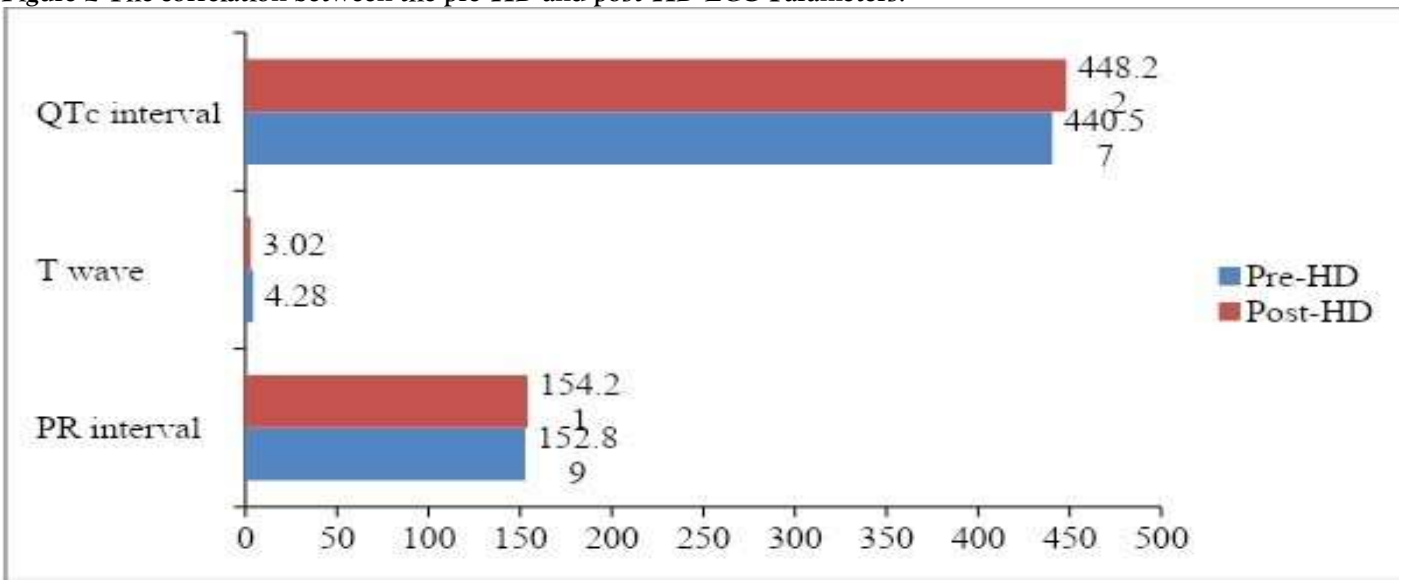

Figure 3 The correlation between the pre-HD and post-HD PR interval, T wave and QTc interval.

DISCUSSION

We observed the change of electrolyte mainly K+ during haemodialysis in patients with renal disease. These patients commonly came with elevated serum potassium. Alteration in serum potassium to danger level will leads to membrane instability and thus cardiac arrest or life-threatening ventricular arrhythmias. These require critical and emergency management [4]. During haemodialysis, there is a quick shift of serum K+ which leads to hypokalemia and this might lead to the ECG changes [3]. The main change is an increase of the QTc interval which is a marker of the ventricular repolarization and its prolongation has been associated with high risk of sudden death.

Several studies address the analysis of QT interval; this is often significantly changed by the end of the dialysis treatment. [6] Covic et al noted a prolongation of QTc duration post HD if pre HD serum K+ was low. Discrepancies between these studies may be attributed to population selection, methods of QT measurement and variables related to the dialysis technique [3]. In our study, the main significant ECG changes are the increase of QTc duration and decrease the amplitude of the T wave after dialysis. Our findings are compatible with a study done by Tarif et al [2]. There was a significant correlation between these ECG changes (i.e. QTc) and serum K+ level before haemodialysis but we could not obtain any significant association between all these parameter after dialysis. The most important influencing factor on the serum K+ level during haemodialysis is the concentration of K+ in the dialysate as well as the duration of dialysis, type of the dialyzer and blood flow rate.[8] Therefore, using standardized dialysate for all patients without considering the electrolyte values before the haemodialysis might have a serious effect. It is appropriate for the dialysate to be chosen as per patient pre HD K+ level. No deaths occur during the dialysis but it occurs after few hours. So that, it is tough to continuous monitor an ECG to find the cause of sudden death.

X- axis	**Y-axis [No of pts]**	
Class interval	**K+ level (mEq/L)**	**QTc (ms)**
1	<3.5 [0]	<440 [35]
2	3.6-4.5 [5]	441-445 [8]
3	4.6-5.5 [43]	446-450 [12]
4	5.6-6.5 [6]	451-455 [7]
5	6.6-7.5 [17]	456-460 [8]
6	>7.5 [5]	>460 [6]

Figure 4 The correlation between pre-HD K+ and pre-HD QTc interval.

CONCLUSION

There were significant changes in ECG parameters and serum electrolytes during haemodialysis. However, there was no obvious influence of serum K+ on the ECGs in a patient with renal failure, apart from the net change of serum K+ on the

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amplitude T wave difference, during haemodialysis. More evaluation with a larger sample to see the effect of electrolyte on ECG changes might be required. The prolonged QTc interval was weakly negative correlated with serum potassium. Post haemodialysis ECG would effectively identify patients whose repolarization substitute increase after dialysis sessions. In these individuals, a dialysis regimen can be selected which is rarely change ventricular repolarization.

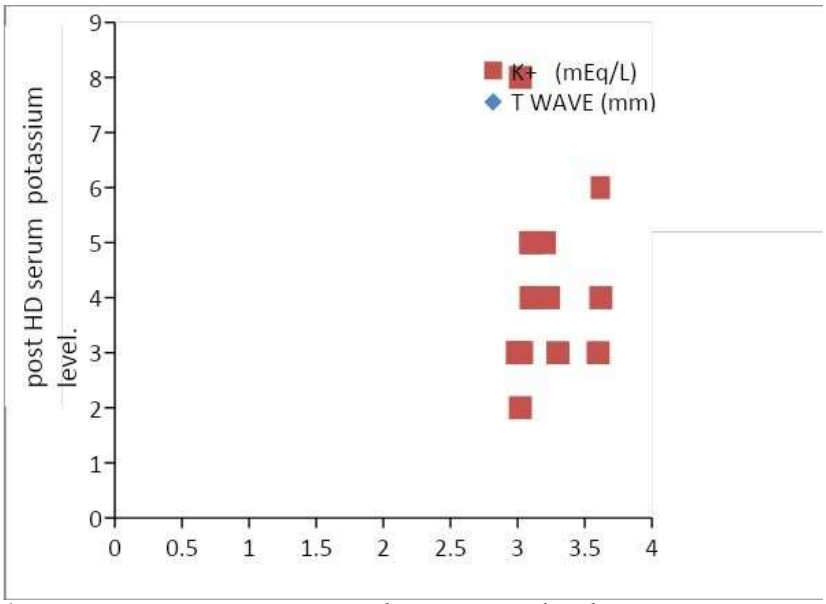

Figure 5 The correlation between post HD potassium and T wave amplitude

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