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ISSN 2348-0416
USA CODEN: JASRHB

Journal of Applied Science And Research, 2016, 4 (5):61-66

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Changes in QT interval during hemodialysis

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ABSTRACT

Mortality cardiovascular and morbidity are high in chronic renal failure patients,the QT interval corrected for heart rate predispose to ventricular arrhythmias and sudden death.The aim of our work is to evaluate the effect of hemodialysis on interval QT and his dispersion in chronic hymodialysed patients.Fourty-seven chronic hemodialysis patients were assessed by a standard examination including blood pressure,body weight,heart rate,12-lead electrocardiogram and a serum electrolytes (Na+,K+,Ca++,phosphate) urea,creatinine,30min before and after hemodialysis. QT and QTc interval QTc=QT/√RR (in milliseconds [ms]) for each electrocardiogram were manually measuread by the same observer.The difference between the maximum and minimum QT was noted as QT dispersion (QT d).Our results confirm that metabolic changes during hemodialysis can lead to a substantial risk of cardiac arrhythmias.

INTRODUCTION

Mortality cardiovascular and morbidity are high in chronic renal failure patients,Cardiovascular death is responsible for up to 50% of deaths among subjects on dialysis (1).Cardiac arrhythmias are frequent among the haemodialysis population,particularly during and immediately after a dialysis session(6–7).These arrhythmias may be caused by the rapid changes in intracellular and extracellular electrolytes during the dialysis session.in hearts that are susceptible due to both myocardial ischaemia and intramyocardiocytic fibrosis(8-9).A reliable way of predicting subjects at risk of ventricular arrhythmias would be an extremely useful tool for the dialysis physician.The QT interval corrected for heart rate predispose to ventricular arrhythmias and sudden death.Among the non-invasive techniques that may be useful in predicting patients at risk of sudden death is the measuring of the QT interval with 12-lead ECG. The QT dispersion is simply the difference between the shortest and longest QT interval on a standard surface 12-lead electrocardiographThis is a non-invasive measurement of myocardial repolarisation inhomogeneity and hence predisposition to re-entry arrhythmias (10-11). The aim of our study is to evaluate the effect of hemodialysis on interval QT and his dispersion in chronic hemodialysed patients.

MATERIALS AND METHODS

Fourty-seven chronic hemodialysis patients were receiving thrice weekly bicarbonate based haemodialysis sessions lasting between three and four and a half hours. All subjects were dialysed using a flat plate dialyser incorporating a low density polyethylene membrane.The presence of a permanent cardiac pacemaker or atrial fibrillation at the time of the study were treated as exclusion criteria.Verbal consent was obtained in all cases after an explanation of the study.

Hemodialysis patients were assessed by a standard examination including blood pressure,body weight,heart rate,12-lead electrocardiogram and a serum electrolytes (Na^{+}, K^{+},Ca^{++}, phosphate),urea ,creatinine, 30 min before and after hemodialysis .QT intervals were measured manually in each ECG lead after photocopier enlargement. This was done in line with the recommendations of Higham and Campbell.The start of the QT interval was measured from the beginning of the QRS complex. The end of the QT interval was measured at the return to the TP baseline, or, when a U wave was present, at the nadir between the T wave and the U wave.In order to allow for changes in heart rate during dialysis, all QT intervals were corrected for heart rate by dividing by the square root of the R–R interval QTc = QT /√R-R ms (Bazett's formula). The mean QTc interval was calculated as the arithmetic means of QTc intervals measurable on a single ECG.The QTc dispersion was calculated as the maximum QTc minus the minimum QTc. In instances where the QTc was not measurable in every lead, the QTc dispersion was adjusted by dividing it by the square root of the number of leads with unanalysable QT intervals.

STATISTICAL ANALYSIS:

Statistical analysis was performed using SPSS for Windows(Statistical program for social sciences version 12.0, 2009).The means and standard deviations (SD) of all variables were calculated.The relationship of the mean of differences between intervals and dispersions in groups (pre-HD and post-HD)and differences among subgroups (ischemic heart disease, hypertension, gender, diabetes) were analyzed using ANOVA.Analysis employed the student's t-test for paired data to determine the significance of differences. Univariate correlation coefficients were examined to assess the effects of electrolyte, and BP changes, and on QT dispersion.A value of $P< 0.05$ was considered statistically significant.

RESULT AND DISCUSSION

Our study included 47 patients (26 women ; 21 men), mean age 42.5 ± 9.4 years,mean duration hemodialysis at the time of the study was 143 ± 47 months.The average RR space pre and post dialysis respectively was 854.22 ± 94.85 and 865.43 ± 88.45 ms,there were no significant differences ($p>0.05$).The average QTCmax corrected intervals is considerably increased from 418.45 ± 22.10 to 449.41 ± 28.25 ms ($p <0.05$) .The average QT dispersions and dispersions corrected QT intervals passsed respectively from 46.56 ± 10.45 to 58.21 ± 12.43 ms($p <0.05$) and 54.40 ± 13.58 to 63 , 33 ± 12.55 ms ($p <0.05$) . Pre dialysis potassium levels and serum calcium were associated with prolongation of the QT interval . the average serum potassium level increased from 5.59 ± 0.7 to 4.16 ± 0.34 mmol /L and the mean phosphate levels increased from 6.62 ± 1.39 to 4.57 ± 1.08 mg /L ($p <0.05$) and the average calcium level increased from 7.54 ± 0.7 to 7.92 ± 0.4 mg /L ($p <0.05$). the average serum sodium isn't significantly from 136.80 ± 1.81 to 137.03 ± 2.41 mmol /L (Table 1).

Table 1. The results of the measured variables before and after hemodialysis.

Variable	Pre-HD (Mean±SD)	Post-HD (Mean±SD)	P-VALUE
Na+ (mm/L)	136,79±1,81	137, 3±32,41	0,256
K+(mm/L)	5,29±0,7	4,16±0,5	0,000
Ca++ (mg/L)	7,54±0,7	7,92±1,04	0,001
Ph- (mg/L)	6,62±1019	4,57±1,08	0,000
Mg++ (mg/L)	2,03±0,90	1,86±0,14	0,000
Hemoglobin (g/dL)	8,51±1,12	9,01±1,42	0,026
Urea (g/l)	52,88±8,5	20,97±3,81	0,000
Creat (mg/L)	5,34±0,22	2,48±0,52	0,000
Systolic BP(mmhg)	136,38±22,08	143,40±22,69	0,043
Diastolic BP(mmHg)	89,26±6058	86,0±76,35	0,000
Heart rate(beat/min)	80±10	82±10	0,485
QT (msec)	407,14±15,34	452,30±14,30	0,034
QT max (msec)	452±22,13	464±25,9	0,354
QTc (msec)	384,13±13,55	442,15±20,1	0,018
Qtc max (msec)	418,43±22,10	449,41±28,25	0,000
QTd (ms)	46,56±10,54	58,21±12,43	0,05
Qt cd (ms)	54,40±11,58	63,33±12,55	0,016
R-R (ms)	854,22±94,8	865,43±88,45	0,151

The result of the comparison of different subgroups in multiple regression analysis found that increasing the QTc and QTcd interval after hemodialysis is independent of gender and hypertension .However,QTc ,QTD and QTcd intervals were significantly increased in pre and post hemodialysis in diabetic patients (Table 2) .

Table 2 :The results of QTc interval and QTc dispersion in subgroups of study patients.

Subgroups	QT interval (ms)		QT dispersion (ms)	
	Pré-HD	Post-HD	Pré-HD	Post-HD
Male(N=21)	390±16	405±23	36±17	54±20
Female (N=26)	421±31	40±17	40±14	59±18
Hypertensive(N=21)	420±22	433±18	39±11	53±16
Diabetes(N=17)	428±23	453±24	40±11	58±20
Non diabetes (N=30)	407±16	427±11	34±15	44±13

DISCUSSION

Holter monitoring has shown that the incidence of ventricular arrhythmias among haemodialysis patients is high**(12)**.These may be life threatening, although their predictive power for mortality in the haemodialysis population has not yet been shown **(6-10)**. Until recently,the only non-invasive way of assessing ventricular repolarisation was the measurement of the QT interval in a single lead. While this was useful in the diagnosis of the hereditary long QT syndromes **(6-13)**,its application in other areas was less fruitful.This may have in part been due to fact that there was no standardisation for measurement of the QT interval**(8)**. Abnormal and high risk range of QTc dispersion was 65 msec**(7)**.Our study like the result of others study showed an increase of QTc dispersion post hemodialysis which might increase the risk of lethal ventricular arrhythmias **(14)**. Because QT dispersion reflects a non-homogeneous recovery of ventricular excitability, the results suggest that dialysis patients may be at higher risk of reentrant arrhythmias, and that this risk rises in the immediate post dialysis period.The incidence of ventricular arrhythmias among HD patients has been shown to be elevated, which may be life threatening **(15, 16)**.

Hemodialysis is known as arrhythmogenic situation because the exchange of ion (especially Ca^{++} and K^{+}),can induce changes in the QTc interval **(1,5)**.The study of the QTc interval in the literature found especially its elongation during the HD session with a prevalence of 18 % to 56% **(3,4,5)**,according to the patient's baseline serum calcium and Ca^{++} concentrations of dialysat liquid.The resultat of Our study as the result of other studies showed an increase in QTc dispersion and after hemodialysis may increase the risk of deadly ventricular arrhythmias and diabetic patients had significantly QTc interval longer and greater QTc dispersion in pre and post HD,this group of patients could have more risk of ventricular fibrillation and sudden death **(2.5)**.

In diabetics,cardiac autonomic neuropathy is well known and is associated with QT prolongation and increased ventricular arrhythmogenicity, and is associated with the structural and functional properties of the myocardium **(17)**.

CONCLUSION

Our results confirm that metabolic changes during hemodialysis can lead to a substantial risk of cardiac arrhythmias and that QT indices increased in patients with chronic renal disease requiring HD. The prolongation of these parameters may be a further non-invasive markero f susceptibility to ventricular arrhythmias.

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