ORIGINAL ARTICLE

Electrocardiographic Changes During Haemodialysis

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Abstract

The current study was done to evaluate the ECG changes in patients of renal failure undergoing hamodialysis and study the association of various risk factors like age, gender , hypertension and diabetes with these changes . The study included 152 patients with end stage renal failure(ESRF) coming for routine haemodialysis. 12 lead electrocardiogram (ECG) was recorded in all patients before and immediately after haemodialysis and repeated after 6 and 12 hours of the session, respectively. Various statistical methods like Students' paired t-test and analysis of variance (ANOVA) were used and inferences were drawn. Out of 152 patients 103 were male patients and 49 females.Sinus tachycardia was seen in 25 patients. Atrial arrhythmias were seen more commonly than ventricular arrhythmia. Patients with end stage renal disease undergoing haemodialysis should be monitored for any impending cardiac arrhythmias .

Key Words

Electrocardiogram (ECG), Hemodialysis Arrhythmias, End stage renal disease(ESRD)

Introduction

The number of patients with end stage renal disease (ESRD) receiving maintenance haemodialysis has increased over the past few decades, all over the world. Likewise, the number of patients who are elderly and with conditions like diabetes and hypertension which are responsible for causing or accelerating renal failure have increased tremendously and cardiac problems are common in these patients.

Cardiovascular disease is the leading cause of mortality among patients on dialysis, It usually occurs suddenly, not only because of the high prevalence of traditional risk factors such as hypertension, diabetes, and ischemic cardiomyopathy, but also for reasons that remain unclear. When considering all causes of death, about 30% are classified as cardiac arrest, death of unknown cause or cardiac arrhythmia.When comparing the risk of fatal arrhythmia, it is higher in HD patients than in peritoneal dialysis (PD) patients (62‰ vs. 42‰) (1). It appears that hemodialysis itself is a risk factor for sudden cardiac death due to hemodynamic overload and inflammatory stress (2) Cardiac arrhythmias are frequent among patients on haemodialysis,with a greater propensity toward occurrence in the last 12 hours of the greater interdialytic period and in the 12 hours after a hemodialysis session (1,2).

The arrhythmogenicity depends on variable factors such as autonomic tone, ventricular anatomical structure, metabolism, advance age of patient, prevalence of ischaemic heart disease and uraemic cardiomyopathy, changes in blood volume and left ventricular hypertrophy (LVH), diabetes and hypertension as arrhythmogenic factors, dialysis induced changes in serum potassium level, inverse relation with duration of haemodialysis, high dialysate calcium digitalis therapy, use of acetate as a buffer, and increased parathyroid hormone (PTH) concentration among many cited in different studies . (3-12). The present study was undertaken to evaluate the ECG changes occurring in patients of renal failure undergoing haemodialysis. Further, the association of various risk factors like age, gender , hypertension and diabetes with these changes was also studied.

Material and Methods

One hundred and fifty-two subjects with ESRD, coming for routine haemodialysis were enrolled in the study. The study was done in Acharya Shri Chander College of Medical Sciences and Hospital, Sidhra, Jammu and in Government Medical College Jammu over a period of six months. All subjects were receiving twice weekly bicarbonate-based haemodialysis session lasting between three and four hours. All patients were dialysed using a

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ptember

flat plate dialyser incorporating a low density polyethylene membrane.Verbal consent was obtained in all cases after an explanation of the study.

Before the haemodialysis session, the subject was weighed and standard 12-lead ECG recorded. Blood was taken for measurement of plasma electrolytes. At the end of haemodialysis, blood was again taken and electrolytes measured. A further 12-lead ECG was immediately recorded and subject reweighed.12-lead ECG was repeated after 6 and 24 hours post-dialysis respectively also.

Stastical Analysis

Data was expressed as mean ± standard deviation. Student's paired t-test and anlaysis of variance (ANOVA) were used as statistical analysis. A value of $p<0.05$ was considered as statistically significant.

Results

Out of 152 patients, there were 103 (67.76%) male patients and 49 (32.34%) female patients. Majority of patients were in the age group of 41 to 60 years. Since tachycardia was seen in 25 patients undergoing dialysis. Out of 25, 10 showed persistent tachycardia when ECG was repeated after 6 hours and and after 24 hours , 5 patients were still having tachycardia while rate has returned to the baseline in the rest of the patients . 52 patients had evidence of rhythm disturbances in ECG taken during dialysis, out of which 35 had supraventricular premature beats and 17 showed the changes of atrial fibrillation. When ECG was repeated in these patients 24 hours after the completion of dialysis, only 4 patients had changes of atrial fibrillation and 6 patients were having ECG showing supraventricular premature beats.

Ventricular arrhythmias were seen in 34 patients and all 34 were having ventricular premature beats. When ECG was repeated after 24 hours, 10 patients were still having same changes in ECG. ST-segment and T-wave changes reflecting ischaemic damage to myocardium were observed in 43 patients. Majority of these changes were transient and 23 patients had complete resolution of ST-T changes. Three patients had evidence of ECG changes suggestive of acute myocardial infarction.

Mean age (± standard deviation) of patients with ECG changes was 61.3 ± 3.9 years while that without ECG changes was 47.6 ± 3.1. The difference between the two was statistically significant (p=0.00).

Table 1. Number of Patients Showing ECG Changes During Haemodialysis

Changes	Number of patients (%)
With ECG changes	67 (43.4)
Without ECG changes	85(56.6)
Total	152 (100.0)

In patients with hypertension as cause of renal failure, 19 had ECG abnormalities while 8 did not have any, the difference being statistically significant (p=0.002). In patients with diabetes as cause of renal failure, 24 had ECG changes and 11 had no ECG changes, the difference again being statistically significant (p=0.001).

Various biochemical parameters like urea, creatinine, sodium, potassium, calcium, uric acid, serum bicarbonate, haemoglobin, PO2, pH were measured immediately before and after the dialysis. Both groups had similar biochemical parameters and parameters were statistically not significant (p>0.05).

Discussion

Cardiovascular disease is the leading cause of death among patients on long-term maintenance haemodialysis, accounting for 40-60% of the reported 7-10 year mortality.. Upto 30% of the patients experience sudden death; suggesting that arrhythmia is the final event (3). It has been reported in many clinical studies that patients on maintenance haemodialysis show a high incidence of arrhythmias especially in the interdialysis period and also for sometime following the completion of the procedure (4, 8). The arrhythmogenic effect of standard haemodialysis procedure is mainly attributed to rapid changes in haemodynamics of body fluids and electrolytes and alterations in acid-base balance (7). It has been also reported that in about 27% of patients on haemodialysis, ischaemic symptoms are caused by non-atherosclerotic diseases (3, 13) associated with underlying cardiomyopathy. In the present study, it was found that among the patients undergoing haemodialysis, men had statistically higher rates of ECG changes as compared to women (48% versus 34%) and frequency of ECG abnormalities tended to increase with age. Many authors have reported in their studies regarding the impact of age and sex on the prevalence of ECG changes. Abe *et al.* (4) reported that men had higher rate of ECG changes than women (68% versus 53%) in their study. Also, the frequency of ECG abnormalities tended to increase with age. Similar findings were reported in other studies (2,14). In the present study, as per etiology of patients with renal failure coming for haemodialysis, diabetes accounted for largest number of patients followed by glomerulonephritis (18.62%) and hypertension (17.71%). The ECG was normal in 67 (44.7%) before the start of haemodialysis. Pateints with abnormal ECG recorded prior to dialysis showed sinus tachycardia in 30 patient, ST-T changes in 40, LVH in 46, RVH in 12 patients and arrhythmias like supraventricular premature beats, ventricular premature beats and atrial fibrillation in 30 patients. It may be noted that a majority of patients in this group had more than

Table 2. ECG Changes in all 152 Patients

Number of patients	Pre-dialysis	Inter-dialysis	Immediately post-dialysis	6 hours after dialysis	24 hours after dialysis
35	Normal	Normal	Normal	Normal	Normal
50	Normal	26 patients showed changes	26 patients showed changes	10 patients showed changes	6 patients showed changes
67	67 had changes	40 had new changes	40 had new changes	30 had new changes	18 had new changes

Table 3. ECG Change Seen in Patients in Interdialysis Period and Afterwards

Pattern	No. of patients showing ECG changes			
	During dialysis	Post-dialysis	6-hour after dialysis	24 hours after dialysis
Rate:				
(a) Sinus tachycardia	25	25	10	5
(b) Sinus bradycardia	None	None	None	None
Atrial arrhythmias:				
(a) Supraventricular premature beats	35	35	20	6
(b) Atrial fibrillation	17	17	17	4
(c) Atrial flutter	None	None	None	None
Ventricular arrhythmias:				
(a) Ventricular premature beats	34	34	34	10
(b) Ventricular fibrillation	None	None	None	None
(c) Ventricular tachycardia	None	None	None	None
(a) Ischemic changes (ST-T changes)	43	43	43	20
(b) Myocardial infarction	3	3	3	3

one abnormality in their ECG. When ECGs of these patients were further analyzed, it was found that elderly patients and those with diabetes and hypertension had higher incidence of abnormal ECG at the start of dialysis as compared to those in which cause of renal failure was chronic glomerulonephritis, pyelonephrites, etc.

Further, 66 (43.4%) patients showed new ECG (in both rate and rhythm) changes during haemodialysis More than one ECG abnormality was present in majority of the patients similar to the findings reported in two studies by Yetkin *et al*. (8) and Narula *et al.* (15) Finally ,ECG changes were noted more frequently in patients with previous abnormal ECG. Regarding the possible etiology of these changes ,it has been postulated that sudden and rapid changes of both intracellular and extracellular electrolytes during haemodialysis possibly act as arrhythmogenic factor and various studies have been undertaken to see the relationship between the two. Dialysis induced hypokalemia, hypomagnesemia and hypercalcemia have been thought to be important in generation of arrhythmias. Abe *et al.* (4) and Yetkin *et al.* (8) in their studies reported that post-haemodialysis serum potassium levels were significantly lower in patients with clinically important ventricular arrhythmias. On the other hand, in an another important study (16) it was reported that despite considerable drop in serum potassium concentration in first hour of dialysis, significant difference was not observed in potassium concentration between arrhythmia and non-arrhythmia group. Similar observations were made by Nishimura *et al.* (7) and Erem *et al.* (17) in their findings. Development of serious ventricular arrhythmia did not correlate with the post-dialysis serum potassium level. However it has been postulated that marked intracellular potassium depletion can exist despite a normal potassium concentration as uremic patients seems to have a decreased total potassium pool.(18) In order to counterbalance the interdialysis potassium load and avoid life-threatening hyperkalemia, potassium is removed by haemodialysis .Rambola *et al.* (6) reported that although ,their patients with and without arrhythmias did not differ significantly in their plasma potassium levels , but patients with arrhythmias have lower erythrocyte potassium than control subjects , indicating that some degree of

ptember

intercellular potassium depletion is there which might prove arrhythmogenic in these patients (4 ,5). The studies by Nishimura *et al*. (7) and Yetkin *et al.* (8) reported that increase in serum calcium concentration may be one of the important arrhythmogenic factor. On the other hand, Morrison *et al.* (5), Shapira and Bar-Khayim (1), Rambola *et al.* (6) found no difference in calcium levels in patients with and without arrhythmias.

Jassal *et al.* (11) in their study reported that there was a significantly increased incidence of arrhythmias in individual with abnormal blood pressure responses, heart rate responses and combined blood pressure and heart rate responses.Many studies have indicated possible relation between increase levels of PTH and incidence of arrhythmias. Similarly, hypomagnesemia and increase in serum free fatty acids have been postulated to be arrhythmogenic in dialysis patients (8, 19,20). In the present study, the statistically significant difference was not observed in serum potassium and calcium levels between the patients with arrhythmias and without arrhythmia. In this study, serum magnesium and PTH levels were not estimated. Similarly,no difference was seen in blood urea, creatinine, uric acid, serum bicarbonate levels, pH and haematocrit values between the groups with and without arrhythmias. .

Conclusion

Electrocardiograms are easily available ,non-invasive and affordable diagnostic tool to provide important information regarding cardiac electrical conduction, some of which has prognostic implications in terms of cardiovasculr mortality in patients of ESRD undergoing hemodialysis ,which are having a very high risk of potentially fatal rhythm disturbances

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