ISSN 2515-8260 Volume 9, Issue 3, Winter 2022

ORIGINAL RESEARCH

TO STUDY THE ELECTROCARDIOGRAPHIC FINDINGS IN PATIENTS OF CHRONIC KIDNEY DISEASE UNDERGOING HEMODIALYSIS

Dr.Balwant Singh Patle[1] ,Dr.Vikas Yadav[2], Dr.Krithika T T[3], Dr. O P Jatav[4]

[1]Senior Resident, Department of Medicine, Chinndwara Medical College, Chinndwara, Madhya Pradesh, India
[2]Senior Resident, Department of Medicine, GRMC, Gwalior, Madhya Pradesh, India
[3]Post Graduate, Preventive Medicine, RRMCH, Bangalore, Karnataka, India
[4]Professor and Head, Department of Medicine, GRMC, Gwalior, Madhya Pradesh, India

Correspondence:
Dr VikasYadav
Senior Resident, Department of Medicine, GRMC, Gwalior, Madhya Pradesh, India
E-mail:- vikaslove1985@gmail.com

ABSTRACT

Background

Chronic Kidney Disease (CKD) is recognized as a major medical problem worldwide. Electrocardiogram (ECG) remains an essential tool despite the development of modern technologies, for evaluation of cardiovascular disease.

Aim

To study the electrocardiographic findings along with the associations with the laboratory variables and prevalence of cardiac arrhythmias in patients of chronic kidney disease undergoing haemodialysis.

Method

The study was conducted on 100 in-patients who were undergoing Haemodialysis in G.R. Medical College, Gwalior. A standard 12 lead ECG was obtained just before and after the haemodialysis procedure. The electrocardiograms was reviewed on descriptive reports of variables: Rhythm, Heart rate , P wave abnormalities, LVH, QT interval/ QTc, ST segment changes. Patient was placed on the Holter monitor for 24 hours just an hour before the dialysis.

Result

In the study subjects , there were 51% of them who had serum creatinine of (5.1-10mg/dL) and 2% had serum creatinine of (> 20 mg/dL). There were 37% of the study subjects who were Smoking and 27% of them were Alcoholics, 81% were Hypertensives , 19% were having Diabetes Mellitus and 14 % were Obese. It was observed that 5% of the subjects showed Atrial Fibrillation on ECG after Dialysis and 95% of them showed a Sinus Rhythm. Changes in the ST segment and Tall T wave on ECG were observed in 25% and 35% of the study subjects. Supraventricular Ectopic findings were observed in 19% before dialysis and 48% during dialysis and 15% after dialysis respectively. On ECHO, 60% of subjects showed Left Ventricle Hypertrophy and 28% had Diastolic dysfunction.

Conclusion

In the study, it was observed that Left Ventricular Hypertrophy is the most common ECG finding in a CKD patient. The risk of arrhythmias in CKD patients who undergo

haemodialysis is very high. ECG is an important tool in CKD patients as it helps in better prognosis in terms of cardiovascular mortality as seen in End Stage Renal Diseases patients.

Key Words: ECG, CKD, Left Ventricular Hypertrophy.

INTRODUCTION

Chronic Kidney Disease (CKD) is recognized as a major medical problem worldwide. The Global Burden of Disease (GBD) study 2015 ranked chronic kidney disease as 17th among the cause of deaths globally (Age-standardized annual death rate of 19.2 deaths per 100,000 population).[1]

Chronic Kidney Disease is defined as the presence of kidney damage, manifested by abnormal albumin excretion or decreased kidney function, quantified by measured or estimated Glomerular Filtration Rate (GFR) that persists for more than three months.[2]

CKD is associated with increased risk of cardiovascular diseases and multiple risk factors are present in patients with CKD which increases the risk of Cardiovascular Mortalities.

Studies have shown that there is a strong association between CKD patients andcardiovascular abnormalities and that leading to Cardiovascular Mortalities[3].

Chronic haemodialysis patients have numerous complications such as Fluid retention, increase in Potassium levels, low Haemoglobin levels, and weak bones requiring pharmacologic therapy. Multiple medications are essentially required to control comorbid conditions like Hypertension, Diabetes Mellitus and Cardiovascular diseases. It can increase the cost of treatment and also pose a challenge for the treatment of patients with CKD.

ECG is important in detection of Cardiac rhythm abnormalities, Cardiac Conduction defects and detection of Myocardial Ischemia. Resting ECG abnormalities are common in patients with CKD and they independently predict future cardiovascular events.[4]

MATERIALS AND METHODS

A Cross sectional study was conducted in the Department of General Medicine, G.R. Medical College, Gwalior , Madhya Pradesh. The study period was conducted for 18 months. The Convenient type of sampling method was used and 100 in- patients undergoing haemodialysis in the Renal/Dialysis Unit were taken.After explaining the Objectives of the study, a written consent was obtained from all the study subjects. All the studysubjects were subjected to detailed clinical history, anthropometric measurements and clinical examination.Blood pressure measurements were taken in the pre-dialysis, intra-dialysis, and post-dialysis phases. Blood pressure was classifiedaccording to the JNC VIII.Blood Samples were taken and biochemical analysis were done onHaemoglobin, Blood Cell Counts, Blood Urea, Serum Creatinine, Sodium and Potassium.A standard 12 lead ECG (Electrocardiographs)was obtained just before and after the haemodialysis procedure.

The electrocardiograms were reviewed forthe following variables: Rhythm, Heart rate (<60 beats/min; bradycardia, >100 beats /min tachycardia), P wave abnormalities, Left Ventricle Hypertrophy (enlargement and thickening of theheart walls), QT interval (represents ventricular depolarization and repolarization)

The corrected QT interval (QTc) was used, as it is considered more accurate since it takes heart rate into consideration. QTc was calculated by applying the Bazett's equation ($QTc = QT/\sqrt{RR}$). The QTc was considered prolonged when it is greater than 440 ms and the ST segment changes. The study subjects were placed on 24 hour Holter monitoring (REVEALA-3, Digital Holter 3 channel) commencing 1 hour before the haemodialysis session and was be reviewed by a cardiologist with commercialized software. Trans–thoracic 2D echocardiography was also performed on these study subjects.

STATISTICAL ANALYSIS

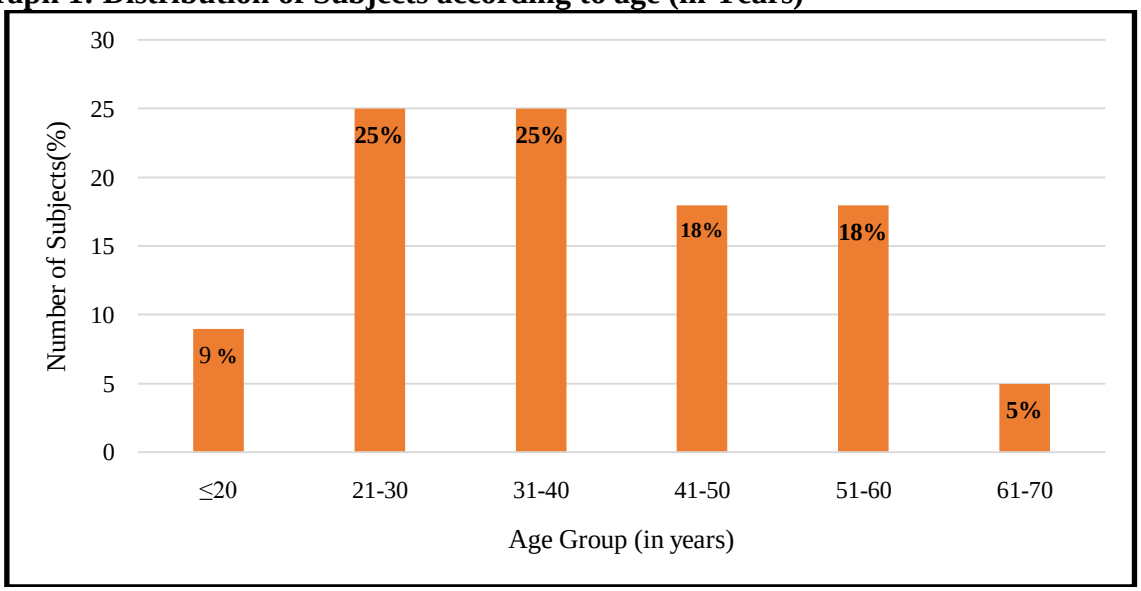
The data were analysed using IBM SPSS version- 20 software. Frequency distribution and cross tabulation was used to prepare the tables. Quantitative variables were expressed as the mean and standard deviation. Chi Square test was used to compare the categorical data. p-value of < 0.05 is considered as significant. Pearson correlation was used to predict the association between the quantitative parameters.

RESULTS

A total of 100 patients were assessed, who were all of age18 years and above and who were undergoing haemodialysis in the Dialysis/Renal Unit of GRMC, Gwalior. In the study, out of 100 study subjects, 25 (25%) were female subjects and 75 (75%) were male subjects. Majority of the subjects belonged to the age group 21 to 30 years (25%) and 31 to 40 years (25%). Whereas 5% of them belonged to age group 61 to 70 years(Graph 1).

In the study, 37% subjects were Smokers and 27% were consuming Alcohol. There were 81% subjects having Hypertension, 19% were having Diabetes Mellitus and 15% were Obese.

Graph 1: Distribution of Subjects according to age (in Years)



The Baseline parameters of study subjects were tabulated (Table-1). Age ranged from 19 to 70 years had Mean = 38.78 and Standard Deviation =14.08. Mean serum creatinine were 10.13 mg/dL (3 – 26, ± 4.33), mean serum sodium were 133.93 mmol/L (111 – 146, ± 6.31), mean serum potassium were 5.02 (3 – 7, ± 1.22) and mean serum calcium were 9.29 (6 – 11, ± 0.85).

The Serum Creatinine was ranged in all the subjects. Majority of subjects (51%) having serum creatinine in the range of 5.1 to 10 mg/dL followed by 28 subjects (28%) having in the range of 10.1 to 15 mg/dL.

Majority of the patients having serum potassium level ranged between 3.6 to 5 mEq/L which comprise of 51 % of the total study subjects. This was followed by the range between 5.1 to 6 mEq/L in 26 % of the subjects.

Varied degree of ECG abnormality (In Table 2) was seen in the subjects and the comparison of ECG changes before and after Dialysis was done. Heart rate was significant in both the observation before and after Dialysis (84.41±3.25 and 94.83±12.56, p=0.01). It was seen that

Atrial fibrillation were present in 5% of subjects after Dialysis and 95% of subjects were having sinus rhythm (p<0.001).

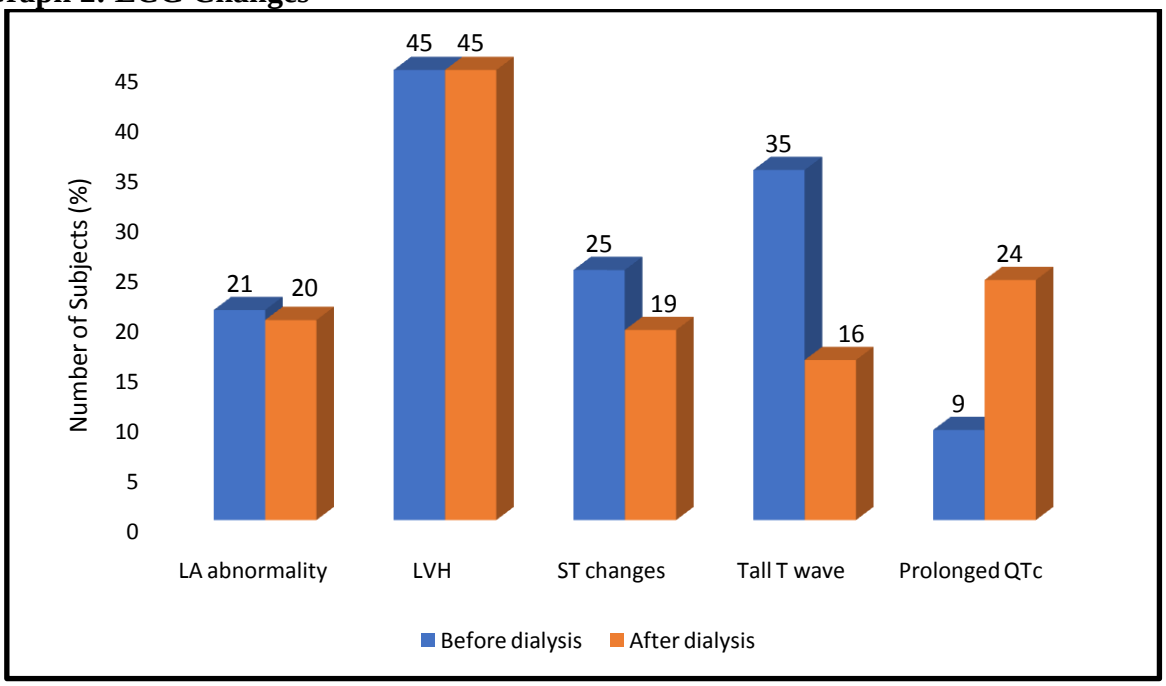
Table 1: Distribution of Subjects according to baseline parameters

Baseline parameters	Minimum	Maximum	Mean	Standard. Deviation
Age (years)	19	70	38.78	14.08
Serum Creatinine (mg/dL)	3	26	10.13	4.33
Serum Sodium (mmol/L)	111	146	133.93	6.31
Serum Potassium (mEq/L)	3	7	5.02	1.22
Serum Calcium (mg/dL)	6	11	9.29	0.85

Table 2: Comparing ECG changes before and after Dialysis

ECG Abnormality		Before dialysis (Mean + SD)	After dialysis (Mean + SD)	p - value
Heart Rate (bpm)		84.41±3.25	94.83±12.56	**0.01**
Rhythm	Sinus	100	95	0.67
	Arial Fibrillation	0	5	**<0.001**
LA abnormality		21	20	0.87
LeftVentricleHypertrophy		45	45	1.00
ST changes		25	19	0.26
Tall T wave		35	16	**0.02**
Prolonged QTc		9	24	**0.002**

Graph 2: ECG Changes



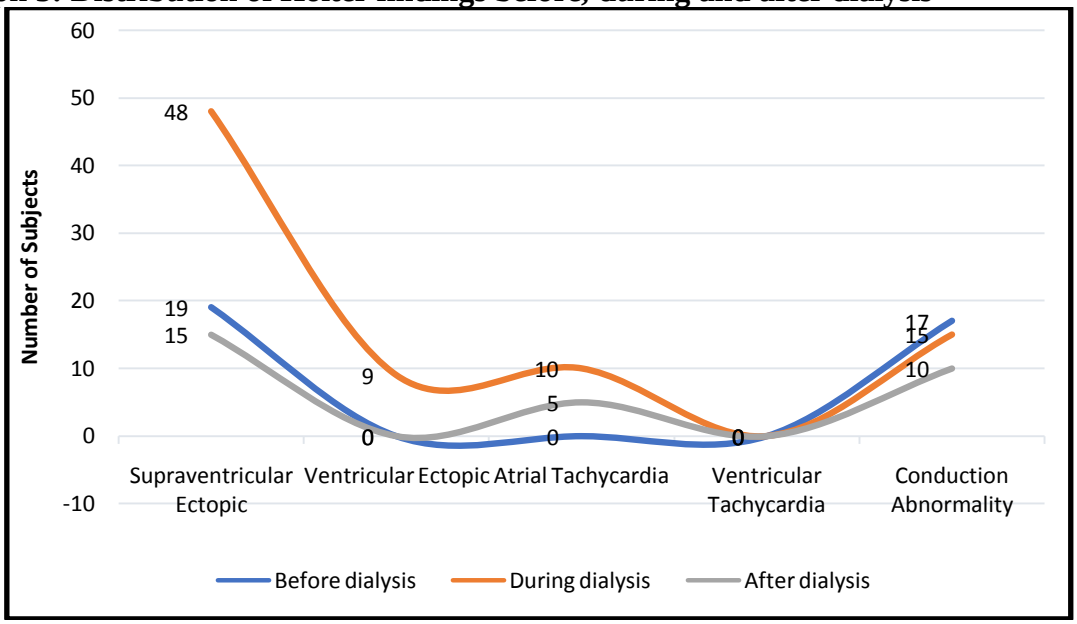
Recording from **Holter (**In Table 3) were varied in nature. Supraventricular Ectopic beats were found in 19 subjects before Dialysis which were increased to 48 subjects, but after Dialysis it decreased to 15 subjects (p<0.001). Atrial Tachycardia was absent in subjects

before Dialysis but was seen in 10 subjects during Dialysis and went down to 5 subjects after Dialysis (p=0.003). Impulse conduction abnormalities were seen in 17 subjects before Dialysis which came down to 15 subjects during Dialysis. This further went down in 10 subjects after Dialysis (p=0.02) (Graph- 3).

Table 3: Distribution of Holter findings before, during and after dialysis

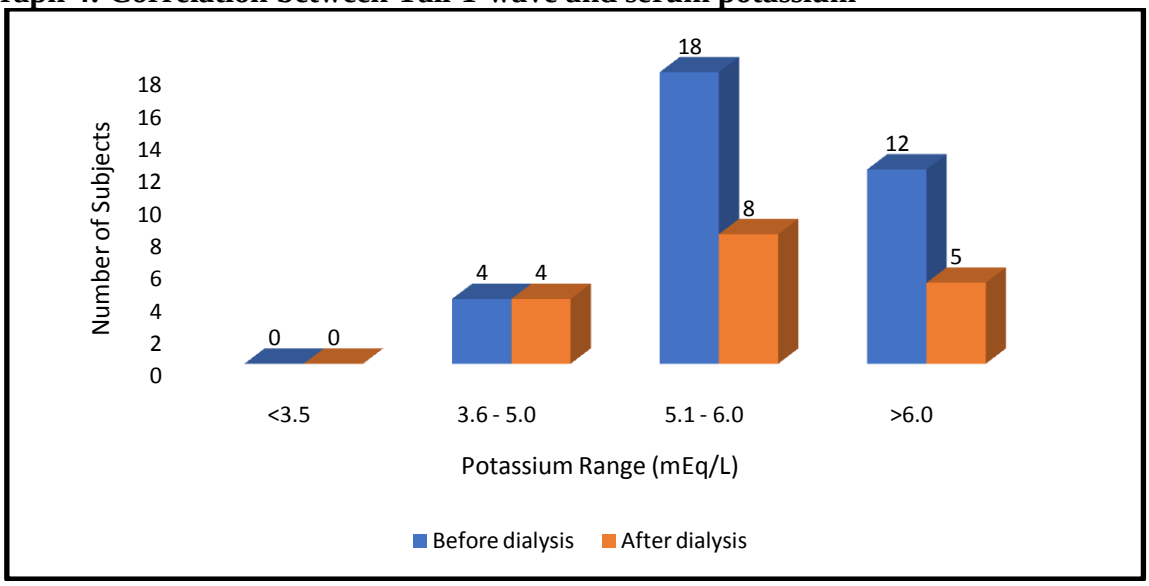
Findings	Before dialysis	During dialysis	After dialysis	P value
Supraventricular Ectopic	19	48	15	**<0.001**
Ventricular Ectopic	0	9	0	0.67
Atrial Tachycardia	0	10	5	**0.003**
Ventricular Tachycardia	0	0	0	NA
Conduction Abnormality	17	15	10	**0.02**

Graph 3: Distribution of Holter findings before, during and after dialysis



In **Graph-4,** Serum potassium level is responsible for tall T wave in ECG and ranged in the subjects. It was found that before Dialysis, 18 (52.9%) subjects were having serum Potassium level between 5.1 to 6 mEq/L which went down in 8(47.05%) subjects after Dialysis. This was followed by Serum Potassium level >6 mEq/L in 12 (35.3%) subjects before Dialysis which went down to 5 (19.4%) subjects after Dialysis. Serum potassium level between 3.6 to 5 were constant in 4 subjects before and after Dialysis. This change was highly significant in the groups with p value <0.001 **Before and After** Dialysis.

Graph 4: Correlation between Tall T wave and serum potassium



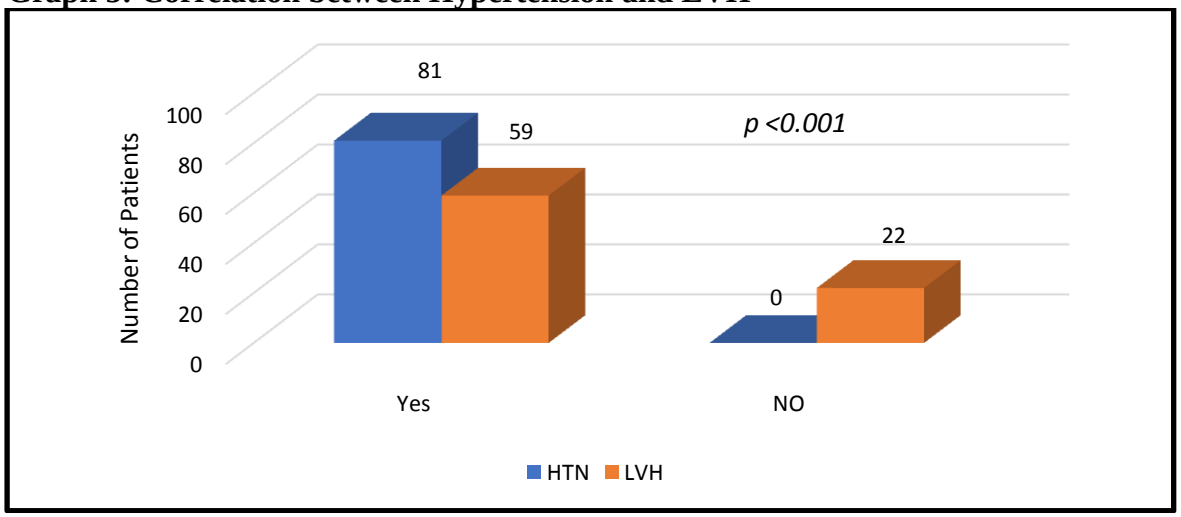
In Table 4- 2D echocardiography were carried out in all the subjects. It was seen that 8% of subjects were having Systolic Dysfunction, 28% of subjects were having Diastolic Dysfunction, 56% patients were having Left Ventricular Hypertrophy (LVH) and 8% of subjects were having Pericardial Effusion

Table 4: Distribution of Subjects according to 2D echocardiography findings

ECHO findings	Number of Subjects	Percentage
Systolic dysfunction	8	8 %
Diastolic dysfunction	28	28 %
LVH	56	56 %
Pericardial effusion	8	8 %

Hypertension and Left Ventricular Hypertrophy (LVH) were highly significant to each other (Graph-5). It was found that a total of 81 subjects in study had Hypertension among which 59 subjects were having left ventricular hypertrophy concomitantly (p <0.001). There were 22 subjectswith no LVHandHypertension.

Graph 5: Correlation between Hypertension and LVH



DISCUSSION

Patients with CKD and who are undergoing Haemodialysis (HD) have a high prevalence of electrocardiograms (ECG) abnormalities. Cardiovascular disease(CVD) is a major cause of mortality and morbidity in patients with Chronic Kidney Diseases.

In present study, age of subjects were ranged from (19 to 70) years with the Mean age of (38.78 ± 14.08 years.) Most of the subjects included, ranged from (21 to 30) years were 25 subjects and (31 to 40) years were 25subjects followed by (41 to 50) years were 18 subjects and (51 to 60) years were 18 subjects. Below 20 years were 9 subjects and age group of (61 to 70) years were 5 subjects. This is seen in a study done by Goornavar[5]et, al, age of the subjects ranged from (18 to 80) years. Majority of subjects (44%) belonged to the age group of 41to 60 years.

In present study age ranged from (19 to 70 years) with the Mean age (38.78 ± 14.08 years). Mean serum Potassium were 5.02(3 to 7, ± 1.22) mEq/L.

Mean serum Calcium were 9.29 (6 to 11, ± 0.85) mg/dL. In A similar study by Bignotto[6] et al, the mean age (years) was 58.5 ± 14.7 and mean serum Potassium was (5.04 ± 0.99) mEq/L andmean serum Calcium were (9.0 ± 1.1)mg/dL.

In present study, serum Creatinine was ranged in all the subjects. Majority of subjects (51 %) having serum Creatinine in therangeof (5.1to 10) mg/dL followed by 28 subjects (28%) having in the rangeof (10.1 to 15) mg/dL. There were 10 subjects havingserum creatininebetween(2.1 to5) mg/dL, 9 subjects having in the range of (15.1 to 20)mg/dLand 2subjectshad more than 2mg/dL. This is seen is study done by Noor[7] et al, serum Creatinine level was higher than normalrange(up to1.4mg/dl) inCKD patients undergoing dialysis. Most of the patients have serum creatinine level between(7.6-12) mg/dL(57 %) and(12-15) mg/dL (27%)before Dialysis. Dialysis has positive impact on serum creatinine level and reduced its level towards normal value. The patients (58%) had serum creatinine below I7 mg/dL after dialysis.

Similar in a study done by ShafiS[8] etal, out of the CKD patientsrecorded, themean serum creatinine were(7.2±3.4) mg/dL.

In Present study, 37% of subjects were smokers and 27% of subjects were consuming alcohol. Similarly, in the study of Bignotto[6] et al out of 179 patients, 43% patients were smokersand 13% were consuming alcohol.

Present Study, Varied degree of ECG abnormality was seen in the subjects. Heart rate was significant in both the observations, before and after dialysis (84.41±3.25)beats per minute and (94.83±12.56) beats per minute, (p=0.01). All the subjects were having sinus rhythm before dialysis(p=0.67). The changes in heart rate might be a compensation mechanism in response to fluid removal, electrolyte and pH changes, or Haemodialysis -induced Myocardial Ischemia/stunning. Though the heart rate at peak stress is still within normal limits, and the association between the change of heart rate and long-term survival is not yet clear, investigators have found that lower heart rate variability during Haemodialysis is a predictor for cardiovascular events and death[9].

In the present study, it was seen that Atrial fibrillation were present in 5% of subjects after Dialysis and 95% of subjects were having sinus rhythm ($p<0.001$).

LA abnormality was seen before and after dialysis in 21 and 20 subjects respectively with no significant difference. Left ventricular hypertrophy was same across the groups(45 subjects). ST segment changes were seen less after dialysis but was not statistically significant(p=0.26).Tall T wave(35 subjects and 16 subjects) and QTc were prolonged (9 and 24 subjects) before and after the dialysis (p= 0.02 and 0.002).

In a study done by Shapira[10] et al, recorded that all patients exhibited ECG changes in first two hours of dialysis. The most frequent changes seen were, decrease in T wave amplitude and increase in T max time (for all patients), an increase of QRS amplitude (61%), shortened

or prolonged QTc interval (61%) and Ischemic like : ST – T changes (23% and 39%) respectively.

Similarly in study by Yadla[11] M et al, there was one ECG abnormality observed in 87(72.5%) patients. The most common ECG abnormality was found to be LVH and ECG abnormalities were found in 72% of the dialysis population studied.

The QT interval reflects the repolarisation of the ventricles. Moreover, when at peak stress, the QTc was significantly longer than the baseline. These results are in accordance with other studies done by Valentin B[12], et al, 47 patients underwent ECG tests before, during, and after a haemodialysis session. The maximum QTc interval and QTc dispersion increased after dialysis. And the difference was significant for both.

Prolong ventricular Depolarisation and repolarisation, assessed from resting ECG, predict cardiovascular events in the general population. Among individuals who are at higher baseline there is more chances of cardiovascular risk. ECG abnormalities may be particularly strong predictors of cardiovascular events among people with CKD, as a result of their considerable Baseline cardiovascular risk. Association of resting ECG markers with clinical cardiovascular events could promote the 12 lead ECG as a useful clinical tool for cardiovascular risk stratification in the CKD setting, for which reliable markers of subclinical cardiovascular diseases are otherwise lacking[13].

In this study the, Recording from Holter were varied in nature. Supraventricular Ectopic beats were found in 19 subjects before Dialysis which were increased to 48 subjects, but after Dialysis it decreased to 15 subjects ($p<0.001$). Atrial Tachycardia was absent in subjects before Dialysis but was seen in 10 subjects during Dialysis and went down to 5 subjects after Dialysis ($p=0.003$).

In a study done by Genovesi[14] et al, used 24 hour Holter electro cardiography in a cohort of 122 prevalent haemodialysis patients. The mean QTc was estimated in three periods; during dialysis treatment for four hours, four hours after dialysis treatment and the remaining 16 hours after dialysis treatment. After the median follow-up of 3.9 years, QTc prolongation was found to be independently associated with a SCD (heart rate = 8.33, 95% CI 1.7 1– 40.48; p-0.0009).

In the present study, Atrial tachycardia was absent in subjects before dialysis but was seen in 10 subjects during dialysis and went down to 5 subjects after dialysis. $p = 0.003$. Ventricular ectopic beats were absent before and after dialysis, but was seen in nine subjects during dialysis. $p= 0.67$. The impulse conduction abnormalities were seen in 17 subjects before Dialysis which came down to 15 subjects during dialysis. This further went down to 10 subjects after dialysis with $p= 0.02$.

In a study done by Shapira[10] et al Clinically significant arrhythmias occurred in 12 subjects (31%) of which 8 were supraventricular, three were combined ventricular and supraventricular and one was pure ventricular.

In a study done by Ioana[15] M et al, It is reported that the ventricular Arrhythmia is the main cause of sudden cardiac death in patients with renal diseases, undergoing or not undergoing haemodialysis or renal transplant.

Present study showed that 2D echocardiography was carried out in all the subjects. It was seen that 8% of subjects were having Systolic Dysfunction, 28% of subjects were having Diastolic Dysfunction, 56% patients were having Left Ventricular Hypertrophy (LVH) and 8% of subjects were having Pericardial Effusion.

In the study, Hypertension and left ventricle hypertrophy will highly significant to each other. It was found that a total of 81 subjects in the study have Hypertension among which 59 subjects were having LVH concomitantly with the p - value < 0.001. There were 22 subjects not having left ventricle hypertrophy in hypertension group. Similarly in a study done by Yadla[11] et al, reported that most common ECG abnormality was found to be left ventricular

hypertrophy where hypertension was prevalent in 79 (65.8%) patients, which indicates strong correlation between the hypertension and left ventricle hypertrophy.

CONCLUSION

The use of conventional electro cardiogram (ECG) parameters is severely limited by the influence of fluid and electrolyte shifts on their measurements. The study shows that the ECG abnormalities are very common in chronic kidney disease patients. Left ventricular hypertrophy is most common ECG of abnormality. Larger and more comprehensive studies are required including those assessing the evolution of electrocardiographic changes from CKD to haemodialysis and the relation of these changes to cardiac mortality. Thus focus of patient care in earlier Chronic Kidney Disease (CKD) stages should be directed to the prevention of cardiovascular complications.

REFERENCES

1. Wang H, Naghavi M, Allen C, Barber R, Bhutta Z, Carter A, et al. Global, regional and national life expectancy, all-cause mortality and cause-specific mortality for 249 causes of death, 1980–2015: A systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2019.
2. KDOQI Clinical Practice Guidelines and Clinical Practice Recommendations for Anemia in Chronic Kidney Disease. Am.J.Kidney Dis. 2006;47:S11–S145.
3. Bargman JM, SkoreckiK.Chronic Kidney disease. In; Longa DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscal J, editors. Harrison's principles of Internal medicine, 18th ed New York: MCgrawhill. 2012 p. 2308-21.
4. Deo R, Shou H, Soliman EZ, Yang W, Arkin JM, Zhang X, et al. Electrocardiographic Measures and Prediction of Cardiovascular and Non-Cardiovascular Death in CKD. J Am SocNephrol 2016;27(2):559–69.
5. Goornavar SM, Pramila Devi R, Ashoka RM. A study of echocardiographic changes in patients with chronic kidney disease. December 2015, Volume 4 - Issue 2.
6. L. H. Bignotto, M. E. Kallas, R. J. T. Djouki et al., "Electrocardiographic findings in chronic hemodialysis patients," JornalBrasileiro de Nefrologia, vol. 34, no. 3, pp. 235–242, 2012.
7. Noor ul Amin, Raja TahirMahmood, M. JavaidAsad, MudassarZafar, and AsadMehmood Raja. Evaluating Urea and Creatinine Levels in Chronic Renal Failure Pre and Post Dialysis. Journal Of Cardiovascular Disease, 2014; 2(2): 2330-4596.
8. Salman Shafi, Mohammad Saleem, RoshinaAnjum, Wajid Abdullah, TahirShafi. ECG Abnormalities In Patients With Chronic Kidney DiseaseJAyub Med Coll Abbottabad 2017;29(1):61–4.
9. Badarau S, Siriopol D, Drugus D, Dumea R, Hogas S, Blaj M, et al. Electrocardiogram abnormalities and heart rate variability in predicting mortality and cardiovascular events among hemodialyzed patients. IntUrolNephrol. 2015; 47(10):1703–1708.
10. Oz M. Shapira, Yaacov Bar-Khayim, ECG changes and cardiac arrhythmias in chronic renal failure patients on hemodialysis, Journal of Electrocardiology, Volume 25, Issue 4, 1992, Pages 273-279, ISSN 0022-0736.
11. ManjushaYadla, KumaraswamyPoosa. Resting ECG Abnormalities in Patients on Maintenance Hemodialysis – A Clinical Study. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 2017; 16(8): 62-64.
12. Valentim B, Pereira A, Coelho P, Pereira T. Study of Ventricular Electrical Systole in Patients with End-Stage Kidney Disease on Hemodialysis. Arq Bras Cardiol. 2013 Mar; 100(3):261–8.

13. Flueckiger P, Pastan S, Goyal A. et al. Associations of ECG interval prolongations with mortality among ESRD patients evaluated for renal transplantation. Ann Transplant 2013; 19: 257–268.
14. S. Genovesi, C. Dossi, M. R. Viganò et al., "Electrolyte concentration during haemodialysis and QT interval prolongation in uraemic patients," Europace, vol. 10, no. 6, pp. 771–777, 2008.
15. I. Mozos, C. Serban, and R. Mihaescu, "Late ventricular potentials in cardiac and extracardiac diseases," in Cardiac Arrythmias-New Considerations, F. R. Breijo-Marquez, Ed., In Tech, 2012.