Electrocardiographic Patterns Amongst End Stage Renal Disease Patients in a Teaching Hospital in South-South Nigeria

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ABSTRACT

Chronic kidney disease (CKD) is a major health challenge affecting the world in general. Its devastating impact is more evident in developing countries such as Nigeria. The incidence of cardiovascular disease rises with reducing renal function and majority of patients with chronic kidney disease succumb to cardiovascular events before reaching end stage renal disease. The aim of the study is to correlate electrocardiographic abnormalities with renal function indices like PCV, eGFR amongst others.

We analyzed electrocardiographic patterns retrospectively over a period of 4 years amongst adult patients with end stage renal disease. We studied 150 patients, 63.3% males and 36.7% females with a mean age of 50 ± 17years. The mean packed cell volume, estimated glomerular filtration rate and QTc was 23 ± 5.4 %, 9.7 ± 5.8 ml/min and 444.9ms ± 20.2 respectively. Left ventricular hypertrophy was the predominant abnormality accounting for 82.7% and 81.3% using Sokolo-Lyon and Araoye criteria respectively. There was no significant correlation between eGFR and QTc (p – 0.1836 CI; -0.2-0.05). Left atrial abnormality and ischemic changes (strain pattern) was noted in 33.3% and 21.3% respectively.

Left ventricular hypertrophy is a common electrocardiographic abnormality amongst chronic kidney disease patients so efforts to identify these patients and prevent their progression to end stage disease is crucial.

Keywords: *Chronic kidney disease, Nigeria, Electrocardiography*

INTRODUCTION

Chronic kidney disease (CKD) is a major health challenge affecting the world in general.[1]Its devastating impact is more evident in developing countries such as Nigeria. Advances have been made over the years in various aspects of renal medicine but the morbidity and mortality of patients with CKD especially those with end stage renal disease is on the increase.[2] The problems peculiar to developing countries include inability to sustain the high cost of dialysis, inaccessibility to care and late referrals.[3]

The incidence of cardiovascular disease rises with declining renal function and majority of patients with end stage renal disease (ESRD) succumb to cardiovascular events.[4] There are wide spectrums of cardiovascular diseases which present in patients with chronic kidney disease. Some of which includes cardiac geometry abnormalities, arrhythmias, ischemic heart diseases and peripheral vascular diseases. The associated increase of atherosclerotic disease cannot be over-emphasized. Left ventricular hypertrophy is highly prevalent amongst patients with end stage renal disease and also prolongation of QT interval.[5, 6] These pathologies put them at risk of premature and sudden death.[7]

Non-invasive modalities available for assessing the extent of cardiac involvement in patients

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with CKD include electrocardiography (ECG) and echocardiography. They are relativity cheap, affordable and accessible to most patients.

The aim of this study was to describe various ECG abnormalities amongst ESRD patients, to determine the prevalence of ECG abnormalities (ECG-LVH, QTC,atrial abnormalities) among ESRD patients and to correlate estimated glomerular filtration rate (eGFR) and specific ECG abnormalities

MATERIALS AND METHODS

The study was done in Delta State University Teaching Hospital (DELSUTH), an ultramodern Specialist hospital located in Oghara. Oghara is a town in Ethiope West Local Government Area of Delta State, Nigeria. It is one of the major clans of the Urhobo ethnic group. The teaching hospital is the only tertiary health institution in Delta State, Nigeria and has the largest pool of renal cases in the state. The hospital receives referral cases from within the state and from neighboring states (Edo, Bayelsa and Anambra).

This study was hospital basedand retrospective. The study population included adult patients with end stage renal disease seen at the renal outpatient clinic from January 2011-January 2014.

We excluded patients withGFR> 15mls/min, pregnancy and primary cardiac disease.

A data collection sheet was designedand information was sourced largely from case files (socio-demographic data, health status of patient and etiology of renal disease). The first standard 12 lead ECG available in patients' files were studied and interpreted by two cardiologists. The Sokolo-Lyon criteria was defined as SV1+RV5> 3.5mv, while the Araoye criteria was defined as SV2+RV6>4mv (males>40years), SV2+RV6>5mv (males 15-29years) and SV2+RV6>3.5mv in females.[8]The estimated GFR (eGFR) was ascertained using the Modification of Diet in Renal Disease (MDRD) formula.[9]

DATA ANALYSIS

The data was analyzed using Statistical Package for Social Sciences (SPSS) version 22.0 software (SPSS Inc, Chicago, Illinois, USA). Descriptive analysis of the variables was performed and results expressed as frequency tables and percentages.Bivariate analysis was used to determine any association between eGFR on one hand and PCV,QTC, ECG-LVH on the other.

RESULTS

Medical records of 150 patients who presented to the nephrology clinics within the period of Jan 2010 – Jan 2014 and fully satisfied the inclusion criteria were reviewed. Among the total population, 63.3% were males and 36.7% females. The mean age was 50 ± 17years with a male: female ratio of 1.7: 1.

The main risk factors for chronic kidney disease established were from the study population includes, chronic glomerulonephritis (28.6%), essential hypertension alone (27.3%), diabetes mellitus (21.3%). However, hypertension in combination with other risk factors like diabetes, benign prostatic hypertrophy and NSAID induced nephropathy was seen in 57%. Other risk factors included HIV and Systemic Lupus Erythematosus (SLE). (Figure 1)

About 6% had greater than 2 sessions of hemodialysis per week, 82.7% had 1-2 session and the others (11.3%) had less than 1 session of HD per week. All the patients were receiving hemodialysis.

The mean packed cell volume, estimated glomerular filtration rate and QTc was 23 ± 5.4 %, 9.7 ± 5.8ml/min and 444.9 ± 20.2ms respectively. Left ventricular hypertrophy was the predominant abnormality accounting for 82.7% and 81.3% using Sokolo-Lyon and Araoye criteria respectively (Table 1). The mean Heart rate was 91.9 ± 16.99 (range 51-138beats per minute). Atrial fibrillation was found in 7% of the total population.

Most of the patients had normal axis (49.3%), and left axis deviation was noticed in 47.3% of the population (Table 2). There was no correlation between eGFR and QTc (p – 0.1836, CI: -0.2-0.05). Left atrial abnormality and ischemic changes (strain pattern) was noted in 33.3% and 21.3% respectively.Significant associations were found between PCV, eGFR and voltage criteria for LVH (P: <0.0001). Reduced eGFR and low PCV were independent predictors of LVH

TABLE 1: Heart Rates, Rhythm and Voltage Criteria of Patients According to Sex and Age.

PARAMETERS	SEX		AGE (In Years)					
	MALE (%)	FEMALE (%)	10-19 (%)	20-29 (%)	30-39 (%)	40-49 (%)	50-59 (%)	≥60 (%)
HEART RATE								
Tachycardia	23(15.3)	22(14.7)	0(0.0)	6(4.0)	4(2.7)	0(0.0)	13(8.70	22(14.7)
Normal	69(46.0)	33(22.0)	7(4.7)	10(6.7)	18(12.0)	24(16.0)	15(10.0)	28(18.7)
Bradycardia	3(2.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	2(91.3)	1(0.7)
TOTAL	**95(63.3)**	**55(36.7)**	**7(4.7)**	**16(10.7)**	**22(14.7)**	**24(16.0)**	**30(20.0)**	**51(34.0)**
HEART RHYTHM								
Atrial Fibrillation	4(2.7)	6(4.0)	0(0.0)	0(0.0)	2(1.3)	0(0.0)	0(0.0)	8(5.3)
Sinus	91(60.7)	49(932.7)	7(4.7)	16(10.7)	20(13.3)	24(16.0)	30(20.0)	43(28.7)
TOTAL	**95(63.3)**	**55(36.7)**	**7(4.7)**	**16(10.7)**	**22(14.7)**	**24(16.0)**	**30(20.0)**	**51(34.0)**
	P value = 2.512							
	Chi^2 = 0.113							
VOLTAGE CRITERIA								
Sokolo	77(51.3)	47(31.3)	7(4.7)	10(6.7)	18(12.0)	22(14.7)	26(17.3)	41(27.3)
	P value = 0.471							
	Chi^2 = 0.493							
Araoye	75(50.0)	47(31.3)	7(4.7)	10(6.7)	16(10.7)	22(14.7)	26(17.3)	41(27.3)
	P value = 0.972							
	Chi^2 = 0.324							

TABLE 2: Frequency of QRS Axis,Abnormal QTC and Atrial Abnormalities According to Sex and Age

PARAMETERS	SEX		AGE (In Years)					
	MALE (%)	FEMALE (%)	10-19 (%)	20-29 (%)	30-39 (%)	40-49 (%)	50-59 (%)	≥60 (%)
QRS AXIS ABNORMALITIES								
Left Axis Deviation	46(30.7)	25(16.7)	3(2.0)	8(5.3)	8(5.3)	13(8.7)	13(8.7)	31(20.7)
Normal	47(31.3)	27(18.0)	4(2.7)	6(4.0)	14(9.3)	16(10.7)	15(10.0)	19(12.7)
Right Axis Deviation	2(1.3)	3(2.0)	0(0.0)	2(1.3)	0(0.0)	0(0.0)	2(1.3)	1(0.7)
TOTAL	**95(63.3)**	**55(36.7)**	**7(4.7)**	**16(10.7)**	**22(14.7)**	**24(16.0)**	**30(20.0)**	**51(34.0)**
QTC AND ATRIAL ABNORMALITIES								
Abnormal QTC	63(42.0)	19(12.7)	7(4.7)	8(5.3)	14(9.3)	15(10.0)	19(12.7)	19(12.7)
Atrial Abnormality	30(20.0)	20(13.3)	3(2.0)	6(4.0)	8(5.3)	4(2.7)	13(8.7)	16(10.7)
TOTAL	**95(63.3)**	**55(36.7)**	**7(4.7)**	**16(10.7)**	**22(14.7)**	**24(16.0)**	**30(20.0)**	**51(34.0)**

TABLE 3: Frequency of Lipid Profile According to Sex and Age

LIPID PROFILE	SEX		AGE (In Years)					
	MALE (%)	FEMALE (%)	10-19 (%)	20-29 (%)	30-39 (%)	40-49 (%)	50-59 (%)	≥60 (%)
HDL								
Abnormal	15(10.0)	16(10.7)	1 (0.7)	6 (4.0)	4 (2.7)	6 (4.0)	4 (2.7)	10 (6.7)
Normal	53(35.0)	66(44.0)	6(4.0)	10(6.7)	18(12.0)	18(12.0)	26(17.3)	41(27.3)
	P value = 0.701				P value = 0.505			
	Chi^2 = 0.147				Chi^2 = 4.316			
LDL								
Abnormal	22(14.0)	16(10.7)	1(0.7)	8(5.3)	4(2.7)	6(4.0)	5(3.3)	14(9.3)
Normal	46(30.7)	66(44.0)	6(4.0)	8(5.3)	18(12.0)	18(12.0)	25(16.7)	37(24.7)
	P value = 0.072				P value = 0.186			
	Chi^2 = 3.240				Chi^2 = 7.507			
TAG								
Abnormal	19(12.7)	19(12.7)	2(1.3)	7(4.7)	4(2.7)	6(4.0)	6(4.0)	13(8.7)
Normal	49(32.7)	63(42.0)	5(3.3)	9(6.0)	18(12.0)	18(12.0)	24(16.0)	38(25.3)
	P value = 0.504				P value = 0.556			
	Chi^2 = 0.447				Chi^2 = 3.956			

DISCUSSION

Our study was aimed at highlighting the various ECG patterns that are found amongst ESRD patients. Notable among the findings was the significantly high prevalence of LVH (87.2%)as assessed by the Sokolo-Lyon voltage criteria and this persisted when assessed with the Araoyecriteria that has been validated in blacks to correlate with the standard Sokolo-Lyon criteria.

This finding is in consonance with previous studies done in Nigeria where a prevalence of 82.9% was reported in Maiduguri.[10] A study of dialysis naïve patients in stage 4 and 5 CKD done in Ilorin, Nigeria recorded a prevalence of 45%. The disparity between our study prevalence and the Ilorin study is because our patients where in stage 5 and they were already on hemodialysis.[11] Hemodialysis and severely reduced eGFR have been associated with increased risk of LVH.[6, 7]

In a study done by Rajiv et al, the prevalence found was far lower than what our study showed. They reported a prevalence of 11.2% amongst patients with severe reduction in eGFR and about 6% among patients with moderate reduction in eGFR. A Spanish multicenter study revealed a prevalence of 20.3% and majority of these patients were found to be in end stage renal disease and were elderly patients.[12]We also noticed a higher incidence of ECG-LVH amongst the elderly population in our study that accounted for a large group of the study population. The marked disparity in the prevalence of ECG-LVH noticed between our study and the other Caucasian studies confirms that LVH is more prevalent amongst black populations than Caucasian populations. However, inadequate haemodialysis, use of erythropoietin and consequently lower levels of hemoglobin, fluid overload and higher blood pressure levels may also contribute to this finding.

Most of our patients also had left axis deviation that can also occur from the increased left ventricular forces of the heart in patients with ESRD. These atrial abnormalities were also described in both studies done in Nigeria.[10, 11] Our study revealed that the GFR was an independent predictor of ECG-LVH using both criteria previously mentioned. Rajiv et al,[13]also demonstrated in their study that eGFR was an independent predictor for ECG-LVH but this was found using Sokolo-Lyon criteria.

Although prolonged QTc was present in 54.7% of the study population, our study did not show any correlation between eGFR and QTc. In a study done by Graham et al,[14] prolonged QTc was also reported in a large portion of the patient especially those with ESRD. They also showed the dependence of QTc on specific Echocardiographic indices (left ventricular mass index, E/A). This finding can be largely explained by the fact that most patients with CKD may have electrolyte abnormalities that are known causes of prolonged QTc. In addition, repolarisation abnormalities due to left ventricular

hypertrophy, coronary artery disease etc may contribute to QTc prolongation in these patients.

This study shows that severely reduced estimated GFR can be a surrogate for the presence of significant cardiac changes manifested on ECG. LVH is a recognized independent predictor for increased morbidity and mortality amongst patients with renal disease. Although certain drugs are known to cause reverse remodeling of the left ventricle in patients with end stage renal disease, however it is not clear if aggressive use of medications can fully revert left ventricular hypertrophy.[15] Our major limitation is the retrospective study design.

CONCLUSION

Estimated GFR is an independent predictor of ECG-LVH. Left ventricular hypertrophy is a very common electrocardiographic abnormality amongst end stage renal disease patients so efforts to identify and prevent progression during the early stages of CKD are key to reduction of morbidity and mortality.

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