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Original Research Article

Electrocardiographic Abnormalities in Adults with Sickle Cell Anaemia

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Abstract

Introduction: Sickle cell anaemia is a monogeneic hereditary disease that manifests as a lifelong multisystemic disorder characterized by periods of relatively stable health punctuated by periods of acute ill health, mostly possibly reversible and an accumulation of chronic complications, mostly irreversible affecting various organ systems with an outcome of persistent morbidity, and the risk of premature mortality. The aim of this study is to identify electrocardiographic changes typical to patients with Sickle cell anaemia (SCA). ***Method***: Fifty three SCA patients and fifty three apparently healthy, age and sex matched adults HbAA subjects were recruited in this case control study. Individuals with other cardiovascular risk factors were excluded from the study. All recruited individuals were evaluated using electrocardiography. ***Result***: There was left and right atrial abnormality in 7.4% and 3.8% of the SCA patients respectively while shortened PR interval was identified in 1.9%. First degree atrioventricular block was noted in 3.8% while features of Right bundle branch block (RBBB) and left bundle branch block (LBBB) were found in 3.8% and 1.9% of SCA patients respectively. Both Left and Right Ventricular hypertrophy with significant ST-T wave changes in the anterior and inferior leads were also observed in the SCA patients (p=0.001). Prolonged QTc was also identified in 20.8% SCA patients (p=0.02).CONCLUSION: Varied ECG abnormalities are common in SCA patients which may contribute to sudden death. Early ECG findings make for timely intervention towards prevention of disease progression.

Keywords: Electrocardiographic, abnormalities, adults, sickle cell anaemia.

INTRODUCTION

Sickle cell anaemia (SCA) is a life threatening multisystem disease affecting mainly people of African descent with reports from many parts of Africa showing that the disease is more severe in this part of the world [1]. It is estimated that 6 million Africans will be living with SCA, given the present birth and mortality rate in Africa [2]. In Nigeria, one to 15% of patients are diagnosed in the first decade of life, with a death rate of 5% in the subsequent decade [3]. Fifty percent of these patients are expected to survive beyond 50 years of age [4]. The prevalence of sickle cell anaemia in Nigeria is reported as 2 – 3 percent of the population of 160 million [3,5].

Longevity in sickle cell anaemia in recent times, is increasingly presenting challenges of multiorgan chronic complications, including cardiac disease. Cardiovascular changes in sickle cell anaemia is a consequence of cardiopulmonary adaptation to lifelong chronic anaemia and persistent vasculopathy causing recurrent vaso-occlusion, ischaemia reperfusion injury, with accompanying sustained chronic endothelial inflammation and oxidative stress[5, 6]. Sickle cell cardiomyopathy in adults has been reported in studies to include left ventricular dilatation and hypertrophy, atrial abnormality, effects of pulmonary hypertension among others. Electrocardiographic evidence of the above and possible life threatening conduction abnormalities are readily obtainable, providing a unique window for early diagnosis, identification of risks for sudden cardiac death with the possible outcome of preventing morbidity and premature mortality in this patient group [6]. Electrocardiographic changes in SCA reported in literature commonly are biventricular hypertrophy, atria abnormalities, first degree atrioventricular heart block, prolonged QTc [5, 6].

This study aims to identify electrocardiographic changes typical to adult SCA patient in steady state.

METHODOLOGY

This was a cross sectional, case control study involving fifty three sickle cell anaemia patients in steady state and fifty three age- and sex-matched haemoglobin (Hb) genotype AA individuals aged 18-45 years. The study was performed in the Cardiology unit of the Department of Internal Medicine, while patients were recruited from the Haematology Department, both of the University of Port Harcourt Teaching Hospital (UPTH), a tertiary institution located in Port Harcourt, Rivers State, Nigeria. This institution serves as a referral centre for Rivers state and neighbouring states which include, Bayelsa, Abia, Akwa-Ibom and Imo state. Ethical approval was obtained from the ethical committee of the University of Port Harcourt Teaching Hospital, Port Harcourt.

Each subject's demographic and biometric parameters were obtained and the 6 channel electrocardiograph machine, Mac 1200 ST, MK0032-PH-001, was used to obtain electrocardiographs. Data analysis using SPSS version 20.0 statistical package was done and P– value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the subjects was 26 ± 6 years, (range 18-45years) and 27±7years, (range 19-45years), for the control group. The age group with the highest frequency was those within 18 – 27 years for both groups. The male to female ratio was 1.1:1 for both groups. The study population was entirely Nigerian with ethnic distribution reflecting the local population with the Ikwerres constituting the largest. The distribution of the socio-demographic and clinical characteristics of the study group is shown in table 1 and 2 respectively.

Table-1: Comparison of socio-demographic characteristics of subjects

VARIABLE	CATEGORY		SUBJECT	CONTROL	P-VALUE
			n (%)	n (%)	
AGE GROUP	18-22		18 (34.0)	17(32.0)	0.824
	23-27		18 (34.0)	17 (32.0)	
	28-32		9 (17.0)	9 (17.0)	
	33-37		2 (3.8)	5 (9.8)	
	38-42		5 (9.4)	3 (5.6)	
	43-47		1 (1.8)	2 (3.8)	
	TOTAL		53 (100.0)	53 (100.0)	
SEX	MALE		28 (52.8)	28 (52.8)	1.000
	FEMALE		25 (47.2)	25 (47.2)	
	TOTAL		53 (100.0)	53 (100.0)	
MARITAL	UNMARRIED		47(88.6)	33 (62.2)	
STATUS	MARRIED		6(11.4)	20 (37.8)	
	SEPERATED		0 (0.0)	0 (0.0)	
	WIDOWED		0 (0.0)	0 (0.0)	
	TOTAL		53 (100.0)	53 (100.0)	
RELIGION	CHRISTIAN		52 (98.2)	53 (100)	
	ISLAM		1 (1.8)	0 (0.0)	
	TRADITIONAL		0 (0.0)	0 (0.0)	
	OTHERS		0 (0.0)	0 (0.0)	
	TOTAL		53 (100.0)	53 (100.0)	
OCCUPATION	SKILLED		5(9.4)	8(15.1)	
	SEMI-SKILLED		6 (11.3)	12 (22.6)	
	UNSKILLED		42 (79.2)	33 (62.3)	
	TOTAL		53 (100.0)	53(100.0)	

Significant level < 0.05 *, <0.01**

Table-2: Comparison of the clinical characteristics of sca patients and control

VARIABLE	SUBJECTS N=53 MEAN±SD	CONTROL N=53 MEAN±SD	P-Value
WEIGHT(Kg)	59.5±10.4	64.0±7.9	0.01**
HEIGHT(cm)	167.3±8.6	165.9±10.9	0.464
BMI(Kg/m2)	21.2±3.0	23.6±3.8	0.01**
HEART RATE(Bpm)	76.8±11.5	70.9±8.9	0.01**
SYSTOLIC BP(mmHg)	112.26±11.205	113.8±10.8	0.465
DIASTOLIC BP(mmHg)	69.7±8.4	72.5±7.8	0.07
BSA	1.7±0.2	1.8±0.1	0.01**

Significant level <0.05 *, <0.01**

BP: Blood Pressure, BSA: Body surface area, BMI: Body mass index**,** Bpm: Beats per minute.

Abnormalities identified on electrocardiography were left and right atrial abnormality in 7.5% and 3.8% of the SCA patients respectively, shortened PR interval in 1.9%, with first degree atrioventricular block identified in 3.8% of the SCA patients and 1.9% of the control. Features of Right bundle branch block (RBBB) were identified in 3.8%, while left bundle branch block (LBBB) was found in 1.9% of SCA patients. A prolonged QTc was also found in 20.8% SCA patients (p=0.02).

Significant ST-T wave changes in the anterior and inferior leads were observed in the SCA patients in comparison to the control, (p=0.001). ST segment elevation was observed in the anterior leads in 11.3% , while T wave inversion was present in the inferior leads in 11.3% and the anterolateral leads in 3.8% of the of the SCA patients. These findings suggest significant repolarization abnormalities and ischaemic changes in the sickle cell anaemia patients. Left ventricular hypertrophy (LVH) was identified in 17.0% and Right ventricular hypertrophy (RVH) in 3.8% of SCA patients. The values for the controls are as reported on table 3.

Table-3: Comparison of ecg parameters between sca patients and control

VARIABLE	CATEGORY	CASE n (%)	CONTROL n (%)	X^2 (df)	P-VALUE
P-WAVE	SINUS RHYTHM	53 (100.0)	50(94.3)	3.087 (1)	0.079
	SINUS ARRYTHMIA	0(0.0)	3 (5.7)		
	TOTAL	53(100.0)	53 (100.0)		
LAA	PRESENT	4(7.5)	0(0.0)	4.157 (1)	0.04*
	ABSENT	49(92.5)	53(100)		
	TOTAL	53(100)	53(100)		
RAA	PRESENT	2(3.8)	0(0.0)	2.038 (1)	0.153
	ABSENT	51(96.2)	53(100)		
	TOTAL	53(100)	53(100)		
PR-INTERVAL	NORMAL	50 (94.3)	52 (98.1)	1.373 (2)	0.503
	SHORTENED	1 (1.9)	0 (0.0)		
	PROLONGED	2 (3.8)	1 (1.9)		
	TOTAL	53(100.0)	53 (100.0)		
QRS COMPLEX AND DURATION	NORMAL	50 (94.3)	52 (98.1)	2.422 (2)	0.298
	RBBB	2 (3.8)	1 (1.9)		
	LBBB	1 (1.9)	0 (0.0)		
	TOTAL	53(100.0)	53 (100.0)		
QTc	NORMAL	41 (77.4)	50 (94.3)	5.267 (1)	0.02*
	PROLONGED	11 (20.8)	3 (5.7)		
	SHORTENED	1 (1.9)	0 (100.0)		
LVH	TOTAL	53(100.0)	53 (100.0)		
	PRESENT	15(28.3)	2(3.8)	11.840(1)	0.001**
	ABSENT	38(71.7)	51(96.2)		
	TOTAL	53(100)	53(100)		
RVH	PRESENT	2(3.8)	0(0.0)	2.038(1)	0.153
	ABSENT	51(96.2)	53(100)		
	TOTAL	53(100)	53(100)		

Significant level <0.05 *, <0.01**,LAA, left atrial abnormality; RAA, Right atrial abnormality; RBBB, right bundle branch block; LBBB, left bundle branch block; QTc, corrected QT interval; LVH, left ventricular hypertrophy; RVH, right ventricular hypertrophy.

Table-4: Comparison of St-T Wave Parameters between Sca and Controls

VARIABLE	CATEGORY	CASE	CONTROL	X^2 (df)	P-VALUE
		n(%)	n(%)		
ST-T WAVE	NONE	34 (64.2)	52 (98.1)	15.647 (8)	0.001**
	STEAL	6(11.3)	0(0.0)		
	TWI-AL	6 (11.3)	0 (0.0)		
	TWI-INF	4 (7.5)	0 (0.0)		
	TWI-LAT	2 (3.8)	1 (1.9)		
	TWIALL	1 (1.9)	0 (0.0)		
	TOTAL	53 (100.0)	53 (100.0)		

Significant level <0.05*,<0.01**; STEAL, ST segment elevation in anterior leads; TWI, T wave inversion; AL, anterior leads; INF, inferior leads; LAT, lateral leads; ALL, anterolateral leads.

DISCUSSION

The electrocardiograph (ECG) is an expression of the integrity of the cardiac electrical system and sickle cell anaemia as a disease that affects most commonly the small vessels that supply the various organs is expected to manifest specific ECG changes. This present study which evaluated for comparative differences in the ECG abnormalities of SCA patients and healthy controls demonstrated significantly higher ECG abnormalities in the SCD patients in comparison with age- and sex-matched controls similar to the findings by other researchers [7, 8].

P wave changes indicating atrial abnormality may imply atrial dilation, atrial wall hypertrophy and/or elevated intra-atrial pressures. In this study specific changes involving the P wave were identified as left atrial abnormality (7.5%) and right atrial abnormality (3.8 %) which is contrary to the findings by Yau *et al*. in Kano, Nigeria [7]. Left ventricular hypertrophy and Right ventricular hypertrophy (17% and 4%) respectively in SCA as found in this study suggests the presence of elevated systemic and pulmonary pressures in SCA similar to the higher prevalence of LVH in comparison to RVH reported in previous study [8]. LVH is an established independent predictor of major cardiovascular events, whilst RVH, suggests elevated pulmonary pressures and pulmonary hypertension, this is an emerging complication of SCA and an indicator of premature mortality in SCA [1, 4, 9-12].

Short PR interval which indicates pre-excitation was observed in 2% while prolonged QTc was reported in 3.8%. RBBB was identified in <4% of patients. ST-T wave changes notably in anterior, lateral and inferior leads were non-specific and though T wave inversion suggesting myocardial ischaemia was noted in inferior leads (11.3%), anterolateral leads, (2%) and lateral leads (4%), ST –T wave changes in this patient group is likely due to repolarization abnormalities, in addition to normal variants identified in athletes, the young and black race due to increased vagal tone. Yau *et al*. also reported high rates of non-specific ST-T wave changes in their Kano study [7].

Prolonged QTc, representing abnormal ventricular repolarization and cardiac electrical instability, is a condition associated with potential morbidity, (tachyarrhythmias) and mortality, (sudden cardiac death). This abnormality appears to be common in SCA and was identified in 21% of SCA patients in this study. Similar values have been reported by other authors [9-13].

CONCLUSION

This study showed that significant ECG abnormalities are common amongst SCA patients. Bi-atrial abnormalities and myocardial hypertrophy of both the left and right ventricles including prolonged QTc and non-specific ST-T wave were found in this study. Early ECG findings make for timely intervention towards prevention of disease progression.

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