The Impact of Age on Electrocardiographic Findings of Stroke Patients: A Cross-Sectional Analytic Study

The Impact of Age on Electrocardiographic Findings of Stroke Patients: A Cross-Sectional Analytic Study

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Abstract

Purpose: To evaluate differences in ECG abnormalities in stroke patients in relation to age groups (less than forty, forty to sixty-five and greater than sixty-five years) in the University of Benin Teaching Hospital (UBTH)

Methodology: This was a cross-sectional analytical study carried out at the University of Benin Teaching Hospital (UBTH), Benin. The study subjects consisted of consecutive one hundred and twenty admitted stroke patients who met the inclusion criteria. History and physical examination were carried out for all patients with laboratory investigations and electrocardiographic examinations also performed on all patients. The data was analyzed using SPSS version 21 software with a P-value of less than 0.05 considered significant for all comparisons.

Result: In this study, stroke was more in those under sixty-five years (n = 84, 70.00%) than in those above sixty-five years (n = 36, 30.00%). All (100.00%), 56 (77.78%) and 24 (66.67%) of cases less than forty, forty to sixty-five years and greater than sixty-five years respectively in this study had ECG abnormalities, this was significant (p = 0.021).

Unique Contribution to Theory, Policy and Practice: Left ventricular hypertrophy predominates in less than forty years old cases while left axis deviation predominates in older than forty years cases. Some ECG abnormalities in certain age groups

Keywords: *Stroke, Cerebrovascular accident, Electrocardiography, Ischaemic heart disease.*

INTRODUCTION

Stroke according to the World Health Organization (WHO) is a neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours. Stroke is currently the second leading cause of death ranking after heart disease worldwide.

Stroke can be classified into two major categories: ischaemic and hemorrhagic [1-3].

Stroke is a well-recognized feature of some cardiac arrhythmias, especially atrial fibrillation. Atrial fibrillation and other ECG abnormalities are common in Nigeria. A review of the literature shows that lots of ECG abnormalities also occur as a consequence of stroke and not only as a cause of stroke. Furthermore, documented evidence has shown that ECG changes after stroke are more common in hemorrhagic stroke, right cerebral stroke and elderly patients with stroke [4].

These ECG changes are attributed to increased sympathoadrenal tone, resulting from damage to cortical areas involved in cardiac and autonomic control. Also, experimental evidence indicates that the insular cortex plays a principal role in stroke-related cardiac changes. Goldstein DS found the prevalence of ECG abnormalities in stroke patients to be ninety-two percent [5].

Most of the studies on ECG `abnormalities in stroke patients were carried out outside Nigeria except an isolated report by Familoni et al which found prolonged QT $_{cmax\ i}$ in 43.8%, STdepression in 29.7%, T wave inversion in 21.8% and U- wave in 9.3% [6].

There are no records available showing any comparison of ECG abnormalities between the age groups of stroke in Africa to date. Hence, this study sought to determine if there are differences in electrocardiographic abnormalities between cases less than 65 years and greater than 65 years of age. ECG was done on the stroke patients within the first twenty-four hours of presentation.

Knowledge of ECG abnormalities and the age group of strokes is useful in making sound clinical judgments and in assessing the risk of morbidity from post-cerebrovascular accidents. This knowledge will also be essential in developing management protocols that can be locally adapted to patients based on findings. Considering the paucity of knowledge on neither ECG abnormalities nor studies that compared stroke age groups, this study is essential towards enhancing knowledge in this subject area.

Stroke, according to the World Health Organization (WHO) is an acute neurological deficit of cerebrovascular origin that persists beyond twenty-four hours or is interrupted by death within twenty-four hours [1]. It has been projected that stroke could soon be the most common cause of death worldwide as it is currently the second leading cause of death in the world, ranking after heart disease [2-8].

EPIDEMIOLOGY

About eight hundred thousand (800,000) people in the United States have a stroke each year, and one hundred and thirty thousand (130,000) of them die each year [3]. The incidence of stroke increases exponentially from 30 years of age, and the etiology varies with age. Advanced age is one of the most significant stroke risk factors, the majority of stroke cases occur in people aged 45 years and above, two-thirds of stroke occurs in those over the age of 65 years [9].

TYPES

Stroke can be classified into two major cases; Ischaemic Stroke and Hemorrhagic Stroke [2].

Ischaemic stroke

Ischaemic stroke occurs as a result of an obstruction within a blood vessel supplying blood to the brain. It accounts for about 87% of all stroke cases. The underlying condition for this type of obstruction is the development of fatty deposits lining the vessel wall. This condition is called atherosclerosis. These fatty deposits can cause obstruction mainly as shown below;

Hemorrhagic stroke

Hemorrhagic stroke arises from bleeding within the brain parenchyma or intra-ventricular spaces. They constitute about 15% of stroke cases. They result in tissue injury by causing compression of tissue from expanding hematoma or haematomas. This can distort and injure tissues. In addition,

the pressure may lead to a loss of blood supply to the affected tissues with resulting infarction, and the hemorrhage appears to have direct toxic effects on brain tissue and vasculature. Inflammation also contributes to secondary brain injury after hemorrhage [10,11].

Kocan found that patients at the highest risk for the development of ECG changes after stroke include those with hemorrhagic stroke, those with stroke involving the right cerebral hemisphere and elderly patients with stroke [4].

Studies have stated that stroke whether ischaemic or hemorrhagic induces cardiac damage by non-ischaemic mechanisms. The evidence was derived from autopsy studies and investigation of ECG, cardiac enzyme changes and plasma catecholamine changes after stroke which showed that increased sympathoadrenal tone resulting from damage to cortical areas involved in cardiac and autonomic control is the likely cause, and recent experimental evidence indicates that the insular cortex plays a principal role in stroke–related cardiac damage [12,13].

Oppenheimer et al showed that microstimulation of the rat posterior insular cortex in phase with the ECG R-wave elicits pure cardiac effects unaccompanied by a change in blood pressure or respiration, this successfully demonstrates cardiac chronoscopic organization and arrhythmogenesis within the insular [12]. Another study also stated that pathways exist linking the insular cortex with the lateral hypothalamic Area (LHA) and also stated that the LHA has been shown to mediate the sympathetic and blood pressure effects of insular cortex stimulation

[13].

Goldstein [5] reviewed electrocardiographic records of one hundred and fifty patients with acute stroke along with one hundred and fifty age and sex-matched controls. To assess the relative frequency of ECG abnormalities among the pathophysiologic categories of stroke and to distinguish new abnormalities at the time of stroke from those noted on prior tracings. Of the one hundred and fifty patients with stroke, ninety-two percent showed ECG abnormalities. The most common abnormalities were QT prolongation (45%), ischaemic changes (35%), U- waves (28%), tachycardia (28%) and arrhythmia (27%). Patients with Cerebral embolism had a significantly increased frequency of atrial fibrillation (47%), while those with subarachnoid hemorrhage showed an increased frequency of QT prolongation (71%) and sinus arrhythmia (18%). Familoni et al studied 64 acute ischaemic stroke patients and found prolonged QT_{cmax} in 43.8%, ST-depression in 29.7%, T wave inversion in 21.8%, U wave in 9.3% [6]. Ogun et al

[14] and Imarhiagbe et al [15] found that when CT scan is not available or its use is limited by distance, the WHO criteria for acute stroke syndrome at the Benin Stroke Score are respectively useful.

AIMS AND OBJECTIVES

To determine the difference in electrocardiographic abnormalities between age groups of stroke patients

METHODOLOGY

STUDY AREA/DESIGN: This study was carried out at the University of Benin Teaching Hospital (UBTH) which is one of the six first-generation hospitals in Nigeria that offers secondary and tertiary care to patients in Edo and neighbouring states. This was a descriptive study that assessed the difference in electrocardiographic abnormalities between ages lesser than and greater than sixty-five years old CVA cases.

SAMPLING METHOD: A simple non-randomized sampling method was used in selecting patients recruited for this study. 120 patients presented for the first time with clinical features and imaging findings of stroke (CT brain scan was performed in all cases) and were admitted into the UBTH medical wards. They had a detailed history and physical examination finding entered into the data acquisition sheet. ECG was performed on the stroke patients within the first 24 hours of presentation.

INCLUSION CRITERIA /EXCLUSION CRITERIA

Inclusion criteria: Cases recruited for this study were

(a) Patients that have first ever occurrence of stroke.

(b) Patients that are 18 years old and above.

(c) The patients that remained alive for at least 7 days post presentation

Exclusion criteria: Patients excluded from this study were -

(a) Patients that have two or more occurrences of stroke (recurrent stroke).

(b) Patients less than 18 years of age.

(c) Stroke resolved within 24 hours, as evidenced by resolution of presenting complaints.

(d) Patients that died within 7 days of presentation

(e) HIV-positive patient

(f) Patients with malignancies.

(g) Patients on immunosuppressive therapy *(h)* Patients with electrolyte abnormalities.

DATA ANALYSIS

Anthropometric measurement and data collected using the preformat were collated and analyzed using the International Business Machines Statistical Product and Service Solutions (IBMSPSS) version 22. Data were presented using tables and charts. Frequencies and percentages were used to present categorical data while continuous data were expressed as mean (standard deviation). Frequencies were compared using Pearson's Chi-square test while means were compared using the independent t-test. Where the data were skewed, continuous data were expressed as mean (interquartile range) and compared using the Mann-Whitney U test. Significant chi-square

comparisons were further tested using a binomial logistic regression where applicable. A p-value of less than 0.05 was considered significant for all statistical comparisons.

RESULTS

Table 1 shows ECG observations in ages less than 40 years. 40-65 years and greater than 65 years old CVA cases

	<40	40-65	>65	P value	P value	P value
	N (%)	N (%)	N (%)	<40/40-65	<40/>65	40-65/>65
MEAN AGE (years)	35.00 ± 5.01	56.83 ± 10.19	72.78 ± 8.02	0.002* ±	<0.001#	0.01 8*#
MALE	8(66.7)	32(44.4)	16(44.4)	0.154	0.182	
						>0.05
FEMALE	4(33.3)	40 (55.6)	20(55.6)	0.154	0.182	>0.05
NO ABN	0)	16(22.2)	12(33.3)	0.070	0.021#	0.214
ABN	12(100.0)	56(77.8)	24(66.7)	0.070	0.021#	0.214

SINUS TACHY	4(33.3)	4(7.1)	4(16.7)	0.011*	0.257	0.193
ATRIAL FIB	0	4(7.1)	8(33.3)	0.340	0.023#	0.003*#
LAD	4(33.3)	28(50.0)	16(66.7)	0.294	0.058	0.170
RAD	0	0	0	0		
T INVERSION	1(8 3)	9(16.1)	4(16.7)	0.492	0.496	0.947
PROLONG	4(33.3)	4(7.1)	0		0.003#	0.179
QT	3(25.0)	21(37.5)	8(33.3)	0.011*	0.609	0.722
ST DEPRESSION	4(33.3)	12(23.1)	0	0.411	0.003#	0.014*#
LAE				0.378		
BAE	0	4(7.1)	0	0.340		0.179

In Table 1 above, stroke was seen in 12 (10.00%), 72 (60.00%) and 36 (30.00%) cases less than forty, between forty to sixty-five and greater than sixty-five years old respectively. Stroke was more in those less than sixty-five years, 84 (70.00%) than above sixty-five years, 36 (30.00%) in this study. The mean age of the cases less than forty, between forty to sixty-five years was 35.00 (+/-5.01), 56.83 (+/-10.19) and greater than sixty-five years was 72.78 (+/-8.02) and the difference was significant, p < 0.05.

Stroke was more in males less than forty (66.7% vs. 33.3%), more in males between forty and sixty-five years (55.62% vs. 44.38%) and older sixty-five (55.62% vs. 44.38%) than in females, respectively. This difference was not significant, p >0.05. None, 16 (22.22%) and 12 (33.33%) of cases less than forty, between forty to sixty-five years and greater than sixty-five years respectively in this study had no ECG abnormalities. 12 (100.00%,) 56 (77.78%) and 24 (66.67%) of cases less

than forty, between forty to sixty-five years and greater than sixty-five years, respectively, had ECG abnormalities, this was not significant except for those between less than forty and greater than sixty-five, p = 0.02.

RATE. Sinus tachycardia was present in 4 (33.33%), and 4 (7.14%) of cases less than forty, and between forty to sixty-five years and in 4 (16.67%) of cases greater than sixty-five years, this was not significant except for less than forty and between forty to sixty-five years p = 0.011

RHYTHM. Atrial fibrillation was present in none, 4 (7.14%) of those less than forty, between forty to sixty-five years and eight (33.33%) of those greater than sixty-five years. This was significant except for less than forty and between forty to sixty-five, p > 0.05.

AXIS. Left axis deviation was present in 4 (33.33%), 28 (50.00%) and 16 (66.67%) of cases less than forty, forty to sixty-five years and greater than sixty-five years respectively. This was not statistically significant p > 0.05. No right axis deviation was present in the various groups in this study.

P WAVE: 86ms to 134ms with a mean of 111.10ms (+/-10.44ms), 80ms to 130ms with a mean of 108.10ms (+/-10.30ms) and 78ms to 122ms with a mean of 98.58ms (+/-10.28ms) for patients less than forty, forty to sixty-five years and greater than sixty-five years respectively. The difference was not significant, p > 0.05.

QRS COMPLEX: 78ms to 118ms with a mean of 91.62ms (+/-9.89ms), 80ms to 130ms with a mean of 90.92(+/-15.31ms), 78ms to 140ms with a mean of 90.22ms (+/-19.32ms) for patients less than forty, forty to sixty-five years and greater than sixty-five years respectively, No significant difference, p >0.05.

T WAVE INVERSION: 1 (8.3%), 9 (16.1%) patients less than forty, forty to sixty-five years and 4 (16.7%) of greater than sixty-five years have this ECG abnormality. This difference is not significant, p >0.05.

PR INTERVAL: 118ms to 194ms with a mean of 158.26ms (+/-16.68ms), 116ms to 188ms with a mean of 150 (+/-16.00ms), 114ms to 182ms with a mean of 146.86ms (+/-15.66ms) for patients less than forty, forty to sixty-five years and greater than sixty-five years respectively. The differences in the groups are not significant, p > 0.05.

QT INTERVAL: Prolonged QT in 4 (33.33%), 4 (7.10%) patients less than forty, forty to sixty-five years and none in greater than sixty-five years. This is significant as p <0.05.

ST SEGMENT DEPRESSION: (25.00%), 21 (37.50%) and 8 (33.3%) of patients less than forty, forty to sixty-five years and greater than sixty-five years respectively. This difference is not significant, p>0.05.

OTHER OBSERVATIONS: 4 (33.33%), 12 (23.10%) and none of cases less than forty, forty to sixty-five years and greater than sixty-five years respectively had left atrial enlargement, the

difference is significant with p<0.05. None, 4 (7.10%) and none of cases less than forty, forty to sixty-five and greater than sixty-five years respectively had bi-atrial enlargement, this was not significant with p >0.05. Left ventricular hypertrophy was present in 8 (66.67%), 8 (14.20%) of cases less than forty, forty to sixty-five years and 12 (50.00%) of cases greater than sixty-five years, respectively. This achieved statistical significance, p <0.05. No right ventricular hypertrophy was seen in the various groups in this study.

Premature atrial complex and premature ventricular complex in none, 4 (7.10%) none of the cases less than forty, forty to sixty-five years and greater than sixty-five years, respectively. This was not significant as p>0.05. Low limb lead voltage in none, none and four (16.67%) of cases led than forty, forty to sixty- five and greater than sixty-five years, respectively. This was significant as p<0.05. Nonspecific intraventricular block in none, none and 4 (16.67%) of cases less than forty, forty to sixty-five and greater than sixty-five years respectively. This was significant as p <0.05.

DISCUSSION

Findings from our study revealed that stroke occurred more in the age group 40-65 years as compared to the age group of greater than 65 years, this finding is consistent with that of Tandur et al which showed that the incidence of stroke was more common within the 5th and 6th decade [16]. However, Akyea et al observed a mean age at an incident stroke to be 74.3 years, although males had an incident stroke at a younger age compared to females [17].

We discovered that ECG abnormalities were more common in patients less than 65 years, with all patients less than 40 years presenting with ECG abnormalities, this finding of ours is buttressed by that of Pirinen et al who identified that many young adults with stroke had major ECG abnormalities [18], and Yu et al which stated that middle-aged men had a significantly higher prevalence of major ECG abnormalities compared to middle-aged white men [19]. In contrast, studies have reported a high prevalence of ECG abnormalities in elderly patients [4,19-21] with older aged patients (at least 60 years old) having significantly increased odds of having atrial fibrillation/flutter, left ventricular hypertrophy, complete left bundle branch block (LBBB), complete right bundle branch block (RBBB), atrial/junctional/ventricular premature beats, Mobitz Type 1 Atrioventricular conduction defect, and nonspecific intraventricular conduction delay (IVCD) [19].

Our study revealed that left ventricular hypertrophy predominates in the age group less than 40 years while left axis deviation was seen more in patients older than 40 years. Left ventricular hypertrophy is an established component of the Framingham stroke risk profile [22], it is then unsurprising to observe its high prevalence in our study. However, it is alarming to know that approximately 67% of patients less than 40 years presented with left ventricular hypertrophy, and this might have predisposed these individuals to have a stroke. Pirinen et al noted that within the general population, left ventricular hypertrophy on ECG was linked to an increased risk of ischemic stroke [23]. Pirinen et al discovered that left ventricular hypertrophy and several P-wave

abnormalities were independently associated with cardioembolic stroke, they also identified left ventricular hypertrophy to be associated with small vessel disease which also is a risk factor for stroke [23]. Findings from Yu et al showed that older patients (60 years and above) had left axis deviation with low voltage [19], this is consistent with that of our study which revealed that left axis deviation was prominent in patients older than 40 years.

Pirinen et al observed some common ECG abnormalities in young adults with an ischemic stroke which were T-wave inversion, left ventricular hypertrophy, prolonged P-wave, prolonged QTc interval, they also noted atrial fibrillation, atrial extrasystole, ventricular extrasystole, LBBB, RBBB, 2nd-degree atrioventricular block. Tandur et al reported prolonged QTc interval, T-wave inversion, ST segment changes, sinus tachycardia, U-waves, and bradycardia [18], while Asadi et al reported findings such as normal sinus rhythm, inverted T-wave, sinus tachycardia, atrial fibrillation and pathologic Q-wave [24].

In this study, atrial fibrillation, bi-atrial enlargement, left fascicular block, premature atrial complex, premature ventricular complex, low limb lead voltage and non-specific intraventricular block were not seen on the ECG in patients less than 40 years old. Similarly, left anterior fascicular block, low limb lead voltage, and nonspecific intraventricular block were not seen on ECG in patients within the age group 40-65 years. Prolonged QT interval, left atrial enlargement, bi-atrial enlargement, premature atrial complex and premature ventricular complex were also absent in patients within the age group greater than 65 years. Among common ECG abnormalities observed in patients with stroke, atrial fibrillation/flutter is known to be a critical risk factor for cardioembolic stroke, older age and cardiovascular diseases are factors associated with atrial fibrillation/flutter [19], the Framingham Study revealed that there was an approximately 5-fold excess of stroke in individuals with atrial fibrillation compared to those without atrial fibrillation after 34 years of follow up [25]. It is not uncommon to have these ECG abnormalities in elderly patients presenting with stroke, this was also reiterated by Yu et al, as they emphasized that older patients had an increased likelihood of having atrial fibrillation/flutter approximately 8 times [19].

On multivariate analysis, we observed differences existing between haemorrhagic and ischaemic stroke in this study. History of headache, fever, vomiting, loss of consciousness, young age, right cerebral stroke, multiple ECG abnormalities and left atrial enlargement were predictors of hemorrhagic stroke. Studies have shown prolonged QT interval to be seen more frequently in hemorrhagic stroke than ischemic stroke [26,27], T-wave changes have also been associated with hemorrhagic stroke [28]. ST segment changes have been seen to be associated with ischemic stroke, with new Q-wave and U-wave seen in both ischemic and hemorrhagic stroke subtypes [29-31]. Although, we found ischemic stroke cases had only facial nerve palsy and left cerebral stroke as predictors.

Presently no specific ECG abnormality type has correlated with any area of the brain but the findings in this study may help distinguish the age group in relation to ECG findings in stroke,

which can aid in management strategies employed specifically to patients, especially in relation to the treatment of stroke cases.

CONCLUSION

Differences exist between age groups in this study, as some ECG types are absent in certain age groups and should be further studied to see if this can be used to some degree of certainty to predict the age group.

RECOMMENDATION

There is a need to do similar studies using a multicenter, larger number of patients and for a longer duration to look at the ECG in stroke patients.

LIMITATIONS OF THIS STUDY

This is a single-centre study thus the sample size though adequate can be improved upon. A larger sample size would involve a large multicenter study which will take more time and resources beyond that available for this research.

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