Influence Of Co-Morbid Hypertension and Diabetes Mellitus on Electrocardiographic Abnormalities in Stroke Cases

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Abstract- ***Stroke or cerebrovascular accident according to World Health Organization (WHO) is a focal or global neurological deficit of vascular origin lasting more than twenty-four hours or resulting in death before twenty-four hours. In sub-Saharan Africa as well as around the globe, stroke is the second leading cause of death worldwide after ischaemic heart disease with the victims mainly in the productive age ranges.***

Notably, strokes are preceded by modifiable risk factors such as hypertension, diabetes mellitus, obesity, smoking and alcohol ingestion. The use of electrocardiography (ECG) in addition to controlling these risk factors would reduce the occurrence, morbidity and mortality of stroke in at-risk patients as ECG is both a preventive and prognostic tool. The knowledge of data regarding abnormalities present in this group of patients will offer knowledge that will enhance physicians' patient management and provide data for future research.

I. INTRODUCTION

Stroke according to 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. 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.[1-9]

About eight hundred thousand (800,000) people in the United States, have stroke each year, one hundred and thirty thousand (130,000) of them die each year. The incidence of stroke increases exponentially from thirty years of age, and the etiology varies with age. Advanced age is one of the most significant stroke risk factors. Ninety five percent of stroke occurs in people aged forty-five and above, two-thirds of stroke occurs in those over the age of sixty-five. [3,12]

Stroke can be classified into two major categories - ischaemic stroke and haemorrhagic stroke[2]

Ischaemic stroke occurs as a result of an obstruction within a blood vessel supplying blood to the brain. It accounts for about eighty seven percent 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;

Haemorrhagic stroke arises from bleeding within the brain parenchyma or intra ventricular spaces. They constitute about fifteen percent of stroke. They result in tissue injury by causing compression of tissue from expanding haematoma 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 blood released by brain haemorrhage appears to have direct toxic effects on brain tissue and vasculature. Inflammation also contributes to the secondary brain injury after haemorrhage [13, 16, 17].

Kocan in USA found that patients at highest risk for 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].Oppenheimer 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 enzymes 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. Recent experimental evidence indicate that the insular cortex plays a principal role in stroke – related cardiac damage.[18,19]

Oppenheimer demonstrated that micro stimulation of the rat posterior insular cortex in phase with the ECG R-wave elicit pure cardiac effects unaccompanied by change in blood pressure or respiration. This successfully demonstrates cardiac chronoscopic organization and arrhythmogenesis within the insular. He 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.[18,19]

Goldstein 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%). Cerebral embolism patients had a significant increased frequency of atrial fibrillation (47%). While those with Subarachnoid heamorrhage showed an increased frequency of QT prolongation (71%) and sinus arrhythmia (18%). Familoni in Nigeria 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%. Ogun in Shagamu and Imarhiagbe in Benin both in Nigeria found that when CT scan is not available or its use is limited by distance the WHO criteria for acute stroke syndrome and the Benin Stroke Score are respectively useful.[5,6,20,21]

- AIMS AND OBJECTIVES. To determine the influence of co-morbid diabetes mellitus/hypertension on electrocardiographic abnormalities in stroke cases.

II. MATERIALS AND METHODOLOGY

Study area/design: This study was carried in 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 of electrocardiographic abnormalities between diabetic/hypertensive and non-diabetic/hypertensive cases.

Sampling method: A simple non-randomized sampling method was used in selecting patients recruited for this study. Fifty-six patients presenting 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 twenty-four hours of presentation.

Inclusion criteria:

A. Patients that have first ever occurrence of stroke.
B. Patients that are eighteen (18) years old and above.

Exclusion criteria:

Patients excluded from this study were:

A. Patients that have two or more occurrence of stroke (recurrent stroke).
B. Patients less than eighteen (18) years of age.
C. Stroke resolved within twenty-four (24) hours, as evidenced by resolution of presenting complaints.
D. Patients that are pregnant.
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 (IBM- SPSS) 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 the Pearson's Chi-square test

while means were compared using the independent t-test. Where the data was skewed, continuous data were expressed as mean (inter-quartile 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 less than 0.05 were considered significant for all statistical comparisons.

ETHICAL CLEARANCE: Ethical clearance was obtained from the Research and Ethics Committee of the University of Benin Teaching Hospital, Benin City, Edo State. Informed consent was obtained from patients before participation in the study. Autonomy: Respect for respondents and confidentiality was maintained throughout the process of extracting the data.

Table: ECG Observations in diabetic/hypertension vs. non-diabetic/hypertension CVA Cases.

	DM/HTN N (%)	NO DM/HTN N (%)	P Value
MEAN AGE (years)	58.00 ± 7.81	53.29 ± 7.11	0.477
SEX MALE	32(57.2)	32(57.2)	>0.05
FEMALE	24(42.9)	24(42.9)	>0.05
NO ABNORMALITY	8(14.3)	8(14.9)	>0.05
ABNORMALITY	48(85.7)	48(85.7)	>0.05
SINUS TACHYCARDIA	0	8(16.7)	0.037
ATRIA FIBRILLATION	8(16.7)	0	0.01*
LEFT AXIS DEVIATION	24(50.0)	24(50.0)	>0.05
RIGHT AXIS DEVIATION	0	0	0
T WAVE INVERSION	8(16.7)	2(4.2)	0.09
PROLONG QT	8(16.7)	0	0.01*
ST DEPRESSION	16(33.3)	6(12.6)	0.015*
LEFT ATRIA ENLARGEMENT	16(33.3)	0	<0.001*
BI-ATRIA ENLARGEMENT	0	8 (16.7)	0.01*
LEFT VENTRICULAR HYPERTROPHY	8 (16.7)	0	0.01*
RIGHT VENTRICULAR HYPERTROPHY	0	0	
LEFT ANTERIOR FASCICULAR BLOCK	8 (16.7)	0	0.01*
PREMATURE ATRIA COMPLEX	0	0	
PREMATURE VENTRICULAR COMPLEX	0	0	
LOW LIMB LEAD VOLTAGE	0	0	
NON-SPECIFIC INTRAVENTRICULAR BLOCK	8 (16.7)	0	0.01*
REVERSAL OF LEADS	0	0	

As in table above, fifty-six of cases in this study had diabetes mellitus/hypertension and fifty-six were non-diabetes/hypertensive cases. The mean age of the diabetes mellitus/hypertensive 58.00+/- 7.81 and non-diabetes mellitus cases 53.29 +/- 7.11 years was not statistically significant, p = 0.477. Of the diabetes mellitus/hypertensive cases, thirty-two (57.14%) were males and non-diabetes mellitus/hypertensive cases

thirty-two (57.14%) were males. Of the diabetes mellitus/hypertensive cases twenty-four (42.86%) were females and the non-diabetes mellitus/hypertensive cases twenty-four (42.86%) were females. This difference was not significant, p >0.05.

Among both case group, stroke was more in males than females. Eight (14.86%) and eight (14.86%) of diabetes mellitus/hypertensive and non-diabetes mellitus/hypertensive cases have no abnormalities on their ECG. Forty-eight (85.14%) and forty-eight (85.14%) of diabetes mellitus/hypertensive and non-diabetes mellitus/hypertensive cases had abnormalities on their ECG. This difference was not significant, p >0.05.

RATE. Sinus tachycardia in eight (16.67%) was only in non-diabetes mellitus/hypertensive cases, p =0.01.
RHYTHM: Atrial fibrillation was present in only eight (16.67%) of diabetes mellitus/hypertensive cases, this was significant with p = 0.01.

AXIS: Twenty-four (50.00%) each of diabetes mellitus/hypertensive and non-diabetes mellitus/hypertensive had left axis deviation on their ECG. This was not significant p >0.05. No right axis deviation was present in the various groups in this study.

P WAVE. One hundred and two to one hundred and thirty-four milliseconds with mean of 116.33+/- 12.23ms and seventy-eight to one hundred and thirty-four milliseconds with mean of 105.42 +/- 10.07ms for diabetic and non- diabetic patients respectively. The difference was not significant, p= 0.857.

QRS COMPLEX: Seventy-eight to one hundred and forty milliseconds with mean of 95.71 +/- 20.89ms for diabetic, seventy-eight to one hundred and eighteen milliseconds with mean of 88.96 +/- 14.02ms for non-diabetic patients. The difference is not significant, p = 0.148.

T WAVE INVERSION: Among diabetic/hypertensive cases eight (16.67%) and two (4.17%) non-diabetic/hypertensive cases. This is not significant, p = 0.09.

PR INTERVAL: One hundred and fifty to one hundred and sixty-six milliseconds with mean of 159.50 +/- 4.99ms, one hundred and fourteen to one hundred and eighty-six milliseconds with mean of 148.11 +/- 15.99ms for diabetic and non-diabetic patients respectively. The difference is not significant, p > 0.05.

QT INTERVAL: Four (16.67%) and none of diabetes mellitus/hypertensive and non-diabetes mellitus/hypertensive cases respectively have prolonged QT. This is significant with p = 0.01.

ST SEGMENT DEPRESSION: Sixteen (33.33%) and six (12.60%) of diabetic/hypertensive and non-diabetic/hypertensive respectively. This is significant, p = 0.015.

OTHER OBSERVATIONS: Sixteen (33.33%) of only diabetic/hypertensive cases had left atria enlargement, this difference was significant with p< 0.001. Eight (16.67%) of only non-diabetic/hypertensive cases had bi-atrial enlargement, this was significant p = 0.01. Left ventricular hypertrophy was present in eight (16.67%) and none of diabetes mellitus/hypertensive and non-diabetes mellitus/hypertensive cases respectively, this difference was significant, p = 0.01. No right ventricular hypertrophy was seen in this study.

Eight (16.67%) of only diabetes mellitus/hypertensive cases had left anterior fascicular block. This was significant with p = 0.01. No left bundle branch block was seen in this study. Premature atrial complex, premature ventricular complex and Low limb lead voltage were not present in either case group. Non-specific intra ventricular block was present in eight (16.67%) diabetes mellitus/hypertensive cases only, p = 0.01.

III. DISCUSSION

Stroke occurred un-expected equally in diabetic/hypertensive and non-diabetic/hypertensive cases in this study, the mean age and sex distribution of both groups was not significantly different and ECG abnormalities in this study was equally spread among both groups.

Left axis deviation, ST depression and left atrial enlargement predominates in diabetic/hypertensive cases while Left axis deviation, sinus tachycardia and bi atrial enlargement predominates in non-diabetic/hypertensive cases.On head to head assessment, co-morbid diabetes mellitus and hypertension predisposed stroke cases to more varieties of ECG abnormalities. And more of arrhythmic changes.

Sinus tachycardia and bi-atrial enlargement were only seen on the ECG of non diabetic/hypertensive cases. While atrial fibrillation, prolong QT, left atrial enlargement, left anterior fascicular block and non-specific intraventricular block were only on the ECG of diabetic/hypertensive in this study. From these, one may say that the presence of atria fibrillation,prolong QT, left atria enlargement, left anterior fascicular block and /or non-specific intraventricular block on ECG of stroke cases could indicate that co-morbid diabetes and hypertension is the risk factor for the stroke. And this becomes more solid if there is concomitant absence of of sinus tachycardia and bi-atria enlargement on the patient ECG.

Though up till this day, no specific ECG abnormality type has correlated with any area of the brain but the findings in this study indicates that ECG findings in acute stroke could be used to determine the risk factor for the stroke. This may help in management strategies employed specifically in relation to treatment of stroke patients.

CONCLUSION

Co-morbid diabetes mellitus/hypertension influences ECG abnormalities in acute stroke cases. And these ECG abnormalities in acute stroke could be used to determine with some degree of certainty the risk factor for the stroke

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

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

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