Original Article

Influence of Diabetes Mellitus on Electrocardiographic Abnormalities in Stroke Cases

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Abstract

Background: Stroke or cerebrovascular accident according to the World Health Organization is a focal or global neurological deficit of vascular origin lasting more than 24 h or resulting in death before 24 h. In Sub-Saharan Africa as well as around the globe, stroke is the other leading cause of death among noncommunicable diseases, 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. **Aim:** The aim of this study is to evaluate the influence of diabetes mellitus on ECG abnormalities in stroke cases at University of Benin Teaching Hospital (UBTH). **Materials and Methods**: This was a cross-sectional analytical study carried out in UBTH, Benin, between January 2010 and 2013. The study subjects consisted of consecutive 120 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. Data were analyzed using SPSS version 22 software with a $P < 0.05$ considered significant for all comparisons. **Results:** In this study, stroke was less in diabetic 28 (23.33%) than in nondiabetic 92 (76.67%). Four (14.3%) and 24 (26.1%) of diabetic and nondiabetic cases, respectively, in this study, had no ECG abnormalities. Sixty-eight (85.70%) and 24 (73.90%) of diabetic and nondiabetic, respectively, had ECG abnormalities; this was not significant $P = 0.196$. **Conclusion:** The only significant ECG abnormalities noted in diabetic and nondiabetic stroke cases were left atrial enlargement and nonspecific intraventricular block, which were seen more in diabetic stroke cases.

Keywords: Cerebrovascular accident, diabetes mellitus, electrocardiography, stroke

Introduction

Stroke according to the World Health Organization is a neurological deficit of cerebrovascular cause that persists beyond 24 h or is interrupted by death within 24 h. Stroke is currently the second leading cause of death ranking after heart disease worldwide.[1-11]

About 800,000 people in the United States have stroke each year, 100 and 130,000 of them die each year. The incidence of stroke increases exponentially from 30 years of age, and the aetiology varies with age. Advanced age is one of the most significant stroke risk factors. Ninety-five percent of stroke occur in people aged 45 and above, two-thirds of stroke occurs in those over the age of 65 years.[3,12]

Stroke can be classified into two major categories – Ischaemic stroke and hemorrhagic stroke.[2]

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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.

Hemorrhagic stroke arises from bleeding within the brain parenchyma or intraventricular spaces. They constitute about 15% of strokes. They result in tissue injury by causing compression of

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tissue from expanding haematoma (s). 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 hemorrhage appears to have direct toxic effects on brain tissue and vasculature. Inflammation also contributes to secondary brain injury after hemorrhage.[13-16]

Stroke is a well-recognized feature of some cardiac arrhythmias, especially atrial fibrillation. Atrial fibrillation and other electrocardiography (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 increase sympathoadrenal tone, resulting from damage to cortical areas involved in cardiac and autonomic control. Furthermore, 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 92%.[5]

Most of the studies on ECG abnormalities in stroke patients were carried out outside Nigeria except report by Familoni O B in shagamu, Nigeria, which found prolonged QT interval in 43.8%, ST-depression in 29.7%, T-wave inversion in 21.8%, and U-wave in 9.3%, and Adeoye A. M in the multinational epidemiologic study which found that 85.4% of cases have at least one ECG abnormality.[6,7]

There are no records available showing any evaluation of influence of diabetes mellitus on ECG abnormalities in stroke cases in Africa to date; hence, this study sought to determine whether there are influence of diabetes mellitus on electrocardiographic abnormalities in stroke cases. ECG was done on the stroke patients within the first 24 h of presentation.

Knowledge of ECG abnormalities and diabetes as a risk factor for stroke is useful in making sound clinical judgment and in assessing the risk of morbidity from post cerebrovascular accidents. This knowledge will also be essential in developing management protocols locally adapted to patients based on findings. Considering the paucity of knowledge on ECG abnormalities nor studies that compared diabetic with nondiabetic stroke cases this study is essential toward enhancing knowledge in this subject area.

Aims and objectives

This study aims to determine the influence of diabetes mellitus in electrocardiographic abnormalities between diabetic and nondiabetic stroke cases.

Materials and Methods

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 neighboring states. It was a cross-sectional analytical study that assessed the difference of electrocardiographic abnormalities between diabetic and nondiabetic stroke cases.

Sampling method

A simple nonrandomized sampling method was used in selecting patients recruited for this study. One hundred and twenty admitted patients with first-time presentation of stroke as evidenced by computed tomography findings and clinical presentations were reviewed. They had a detailed history and physical examination findings entered into the data acquisition sheet. ECG was performed on the stroke patients within the first 24 h of presentation.

Inclusion criteria

a. Patients that have first-ever occurrence of stroke
b. Patients that are 18 years old and above.

Exclusion criteria

Patients excluded from this study were:

a. Patients that have two or more occurrences of stroke (recurrent stroke)
b. Patients <18 years of age
c. Stroke resolved within 24 h, as evidenced by the resolution of presenting complaints
d. HIV-positive patient
e. Patients with malignancies
f. Patients on immunosuppressive therapy
g. Patients with electrolyte abnormalities
h. Patients with known history of any cardiac disease that comes with ECG abnormalities.

Data analysis

Anthropometric measurement and data collected using the proforma 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 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 $P < 0.05$ was considered significant for all statistical comparisons.

Ethical clearance

Ethical clearance was obtained from the Research and Ethics Committee of the UBTH, 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.

Results

As shown in Table 1, 28 (23.33%) of cases in this study had diabetes mellitus and 92 (76.67%) were nondiabetes mellitus cases. The mean age of the diabetes mellitus 58.00 ± 7.89 years and nondiabetes mellitus cases 58.61 ± 8.01 years was not statistically significant, $P = 0.897$. Of the diabetes mellitus cases, 16 (57.14%) were males, and in nondiabetes mellitus cases, 46 (43.48%) were male. Of the diabetes mellitus cases, 12 (42.86%) were female, and in nondiabetes mellitus cases, 52 (56.52%) were female. This difference was not significant, $P = 0.204$.

Among the diabetes mellitus cases, stroke was more in males than in females. Among the nondiabetes mellitus patients, stroke was more in females than in males. Four (14.29%) and 24 (26.09%) of diabetes mellitus and nondiabetes mellitus cases have no abnormalities on their ECG.

As shown in Table 2, 4 (14.29%) and 24 (26.09%) of diabetes mellitus and nondiabetes mellitus cases have no abnormalities on their ECG. 24 (85.71%) and 68 (73.91%) of diabetes mellitus and nondiabetes mellitus cases had abnormalities on their ECG. This difference was not significant, $P = 0.196$.

Table 1: Age and sex distribution among diabetic and nondiabetic cerebrovascular accident cases

	Mean age (year) ± SD	Male, *n* (%)	Female, *n* (%)
DM (28; 23.33%), *n* (%)	58.00±7.89	16 (57.2)	12 (42.9)
Non-DM (92; 76.67%), *n* (%)	58.61±8.00	40 (43.5)	52 (56.5)
P	0.897	0.204	0.204

SD: Standard deviation, DM: Diabetes mellitus

Table 2: Electrocardiography observations in diabetic versus nondiabetic cerebrovascular accident cases

ECG changes	DM, *n* (%)	Non-DM, *n* (%)	*P*
Sinus tachycardia	0	12 (17.7)	0.064
Atrial fibrillation	4 (16.7)	8 (11.8)	0.795
Left axis deviation	12 (50.0)	36 (52.9)	0.804
Right axis deviation	0	0	
T-wave inversion	0	4 (5.9)	0.721
Prolong QT	4 (16.7)	4 (5.9)	0.234
ST depression	12 (50.0)	28 (41.2)	0.833
Left atrial enlargement	8 (33.3)	8 (11.8)	0.015
Bi-atrial enlargement	0	4 (5.9)	0.721
LVH	4 (16.7)	24 (35.3)	0.088
RVH	0	0	
Left atrial hemiblock	4 (16.7)	4 (5.9)	0.234
Left bundle branch block	0	0	
Premature atrial complex	0	4 (5.9)	0.721
Premature ventricular complex	0	4 (5.9)	0.721
Low limb lead voltage	0	4 (5.9)	0.721
Nonspecific intraventricular block	4 (16.7)	0	0.004

P<0.05. DM: Diabetes mellitus, ECG: Electrocardiography, LVH: Left ventricular hypertrophy, RVH: Right ventricular hypertrophy, Bi: Bi-atrial enlargement

Rate

Sinus tachycardia in 12 (17.65%) was only in nondiabetes mellitus cases, $P = 0.064$.

Rhythm

Atrial fibrillation was present in 4 (16.67%) and 8 (11.77%) of diabetes mellitus and nondiabetes mellitus cases; this was not significant with $P = 0.795$.

Axis

Twelve (50%) and 36 (52.94%) of diabetes mellitus and nondiabetes mellitus had left axis deviation on their ECG. This was not significant, $P = 0.804$. No right axis deviation was present in the various groups in this study.

P wave

100–134 ms with mean of 116.33 ± 12.23 ms and 78–134 ms with mean of 105.42 ± 10.07 ms for diabetic and nondiabetic patients, respectively. The difference was not significant, $P = 0.857$.

QRS complex

78–140 ms with mean of 95.71 ± 20.89 ms for diabetic, 78–118 ms with mean of 88.96 ± 14.02 ms for nondiabetic patients. The difference is not significant, $P = 0.148$.

T-wave inversion

No diabetic and 4 (5.90%) nondiabetic patients. This is not significant, $P = 0.721$.

PR interval

150–166 ms with mean of 159.50 ± 4.99 ms, 114–186 ms with mean of 148.11 ± 15.99 ms for diabetic and nondiabetic patients, respectively. The difference is not significant, $P > 0.05$.

QT interval

Four (16.67%) and 4 (5.88%) of diabetes mellitus and nondiabetes mellitus patients, respectively, have prolonged QT. This is not significant with $P = 0.234$.

ST segment depression

Twelve (50.20%) and 28 (41.20%) of diabetic and nondiabetic, respectively. This is not significant, $P = 0.833$.

Other observations

Eight (33.33%) and 8 (11.82%) of diabetic and nondiabetic cases had left atria enlargement; this difference was significant with $P = 0.015$. None of the diabetic cases and 4 (5.89%) of nondiabetic cases had biatrial enlargement; this was not significant $P = 0.721$. The left ventricular hypertrophy was present in 4 (16.67%) and 24 (35.29%) of diabetes mellitus and nondiabetes mellitus cases; this difference was not significant, $P = 0.088$. No right ventricular hypertrophy was seen in this study.

Four (16.67%) and 4 (5.88%) of diabetes mellitus and nondiabetes mellitus cases, respectively, had left anterior fascicular block. This was not significant with $P = 0.234$. No left bundle branch block was seen in this study. Premature atrial complex and premature ventricular complex, respectively, in 4 (5.88%) were not present in diabetes mellitus cases but in

only nondiabetes mellitus cases, $P = 0.721$. Low limb lead voltage in 4 (5.88%) was not present in diabetes mellitus cases, but in only nondiabetes mellitus cases, $P = 0.721$. Nonspecific intraventricular block 4 (16.67%) were present in diabetes mellitus cases only, $P = 0.004$.

Discussion

Stroke occurred less in diabetic cases than in nondiabetic cases in this study; other risk factors may have been associated with the prevalence of stroke cases in nondiabetic cases. The mean age of diabetic cases was not significantly different from nondiabetic. ECG abnormalities in this study were more in diabetic cases although not significant.

Left atrial enlargement and nonspecific intraventricular block significantly predominate in diabetic cases, while sinus tachycardia and left ventricular hypertrophy nonsignificantly predominate in nondiabetic cases. Sinus tachycardia, biatrial enlargement, premature atrial complex, premature ventricular complex, and low limb lead voltage were not seen on the ECG of diabetic cases. While nonspecific intraventricular block was absent on the ECG of nondiabetic in this study. From these, one may infer that the presence of nonspecific intraventricular block on the ECG of stroke cases indicates that the patient is likely diabetic while the presence of sinus tachycardia, biatrial enlargement, premature atrial complex, premature ventricular complex, and/or low limb lead voltage in cases, may indicate nondiabetic.

Although up to this day, no specific ECG abnormality type has correlated with any area of the brain, the findings in this study may help distinguish diabetic from nondiabetic cases in relation to ECG findings in stroke which may help in management strategies employed specifically to patients, especially in relation to the treatment of stroke patients.

Conclusion

Diabetes mellitus influences ECG abnormalities in stroke cases in this study, as some ECG types are present or significantly predominate in diabetic stroke cases. This should be further studied to see if this can be used with some degree of certainty to predict diabetes mellitus as a risk factor for stroke.

Recommendation

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

Limitations of this study

This is a single-study thus the sample size although adequate can be improved on. 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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Nil.

Conflicts of interest

There are no conflicts of interest.

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