Pattern of Arrhythmia among Diabetes Mellitus Patients in South-South, Nigeria: 24-Hour Ambulatory ECG (Holter ECG) Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Background: Diabetes is known to be an independent risk factor for cardiovascular morbidity and mortality, commonly associated with rhythm disorders like atrial fibrillation (AF) and ventricular arrhythmias (VA), Diabetes Mellitus (DM) patients have silent myocardial infarctions (MI) with conduction abnormalities like ectopics and others. Regular 12 lead ECGs may not capture subtle conduction abnormalities unlike Holter ECGs which takes longer time to record heart rhythms. The study aims to determine the occurrence and pattern of cardiac arrhythmias in Diabetes Mellitus.
Methods: A total of 33 diabetic subjects with age ranged from 18 years and above presented to Goodheart Medical Consultants hospital for 24-hour ambulatory ECG (Holter ECG) using Schiller type (MT-101) Holter ECG machine.
Results: In this study, the population consisted of 54.5% men and 45.5% women with a mean age

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of 63.4 ±14.41, the most common age group was 61–80 years with 42.4%. The two most common forms of arrhythmias for Holter ECGs in this study were supraventricular ectopics 36.4% and ventricular ectopics 33.3%.

Conclusion: Supraventricular ectopics is the most common arrhythmia observed among the diabetic subjects in Southern Nigeria and was notably observed more in diabetic male subjects than females. This arrhythmia exposes them to risk of stroke and mortality. Diabetes-related arrhythmias may be a sign of other underlying illnesses.

1. INTRODUCTION

The prevalence of diabetes is rapidly increasing and closely linked with cardiovascular morbidity and mortality [1]. While coronary artery disease represents a major cardiovascular complication associated with diabetes, it is increasingly evident that diabetes impacts the heart's electrical conduction system, leading to atrial fibrillation and ventricular arrhythmias (VA) [2]. The relationship between diabetes and arrhythmias is intricate and multifaceted, involving autonomic dysfunction, atrial and ventricular remodeling, and molecular alterations [3].

Diabetes mellitus is a group of metabolic disorders characterized by prolonged high blood sugar levels [4]. Two primary forms of diabetes exist, namely type 1 and type 2. It is acknowledged as a major worldwide health concern and a risk factor for a number of consequences, including blindness, vascular brain illnesses, renal failure, and amputations of limbs. Type 2 diabetes and prediabetes are growing major problems in sub-Saharan Africa [5]. Diabetes can also occur during pregnancy and under various conditions, including drug or chemical toxicity, genetic disorders, endocrinopathies, insulin receptor disorders, and in conjunction with pancreatic exocrine disease [4]. Clinically, diabetes is defined by hyperglycemia resulting from chronic or relative insulin insufficiency. It can develop in childhood; however, it is prevalent in adults and results from a combination of genetic predisposition and lifestyle factors such as obesity, sedentary behavior, and unhealthy dietary habits.

The incidence of diabetes is increasingly rising [6,7] In 2015, it was estimated that there were approximately 415 million individuals worldwide living with diabetes [4,8]. It is becoming increasingly evident that diabetes mellitus plays a significant role in promoting cardiac arrhythmias [1]. Cardiac arrhythmia is a group of conditions in which the heart beats too rapidly (tachycardia), too slowly (bradycardia), or irregularly [8]. Although most arrhythmias are not immediately life-threatening, prolonged episodes of arrhythmia increase an individual's risk of experiencing stroke, heart failure, and cardiac arrest [9]. Arrhythmias occur as a result of abnormalities in the electrical conduction of the heart; however, the exact cause of these complications is not fully defined. Atrial fibrillation represents the most common type of arrhythmia and is linked to significant morbidity and mortality [1]. However, despite the fact that atrial fibrillation is the most common and well-studied, ventricular arrhythmias (VA) are more severe and can result in sudden death [9].

Diabetic patients have 40% likelihood of arrhythmias compared to non-diabetic patients [10]. In 2018, a 20% rise in the likelihood of arrhythmia development was observed among individuals with prediabetes, while 28% of those with diabetes exhibited greater risk of developing arrhythmia which imply that increments in glucose levels may play a significant role in the occurrence of arrhythmia [11]. Further, this meta-analysis revealed a correlation dependent on dosage between elevated blood glucose levels and arrhythmia, implying that increments in glucose levels may play a significant role in the occurrence of arrhythmia.

Diabetes likely contributes to various types of cardiac arrhythmias; hence, this link has received the most extensive attention in previous studies. However, observational studies examining the association between diabetes mellitus and arrhythmias have yielded inconclusive and inconsistent results [1]. VA are more common in diabetic patients and are typically linked to co-morbid conditions including heart failure and coronary heart disease [9]. Although the incidence of diabetes is frequently linked with coronary artery disease however, electrical conduction abnormalities also represent a significant cardiovascular problem associated with both type 1 and type 2 diabetes [10,12,13].

Electrolyte abnormalities are also common in people with diabetes mellitus, and they have been demonstrated to raise the risk of malignant ventricular tachyarrhythmias [14]. Hence, the study is aimed at determining the occurrence and pattern of cardiac arrhythmias in diabetic subjects. We assessed the prevalence of arrhythmias in the different age groups and genders of diabetic subject using 24-hour ambulatory ECG.

The study also intends assessing the prevalence of arrhythmia in the different age groups and genders of the diabetic subjects.

2. MATERIALS AND METHODS

This is a retrospective descriptive study of the occurrence and pattern of arrhythmia among diabetic patients using Schiller type (MT-101) Holter ECG machine from January 2015 – December 2016.

A blood glucose level of 126 mg/dL (7.0mmol/L) or higher after an eight-hour fast, or a non-fasting glucose level of 200 mg/dL (11.0mmol/L) or higher is within the diabetic range, IDF criteria [15].

A total of 33 subjects with age ranged from 18 years and above. The study comprised data that were collected as part of routine procedures. The machine was installed on the subject to capture ECG recordings for a 24-hour period, following which the data is extracted. In general, Holter monitoring records ECG activity continuously for 24 hours. Additionally, a supplementary switch is provided for the subject to activate whenever they experience symptoms for symptom analysis.

The device generates a summary page of the reports. Information such as the subject's name, address, and notes/indications for the test, typically provided on the summary sheet, were documented.

The data was subsequently inputted into the MS Excel and statistical analysis was done using STATA version 15 software. Descriptive statistics, including tables, and bar charts, were used to present the data. Categorical variables were depicted as proportions and percentages, whereas continuous variables were presented as mean ± standard deviations.

- Inclusion criteria: Subjects living with diabetes and having arrhythmias detected using Holter ECG machine.
- Exclusion criteria: Subjects living with diabetes and hypertension. Diabetic subjects without Holter ECG results.

3. RESULTS

A total of 33 diabetes patients who were at least 18 years old were assessed. There were 18 (54.5%) men and 15 (45.5%) women among them with a mean age of 63.4 ±14.41. Young adults made up the least amount of the age group (18–40 years) with 2 (6.1%) and the most common age group were elderly individuals (61–80 years) with 14 (42.4%).

The two most common forms of arrhythmias for Holter ECGs were supraventricular ectopics (36.4%) and ventricular ectopics (33.3%). Tachycardia was seen in six (18.2%) and bradycardia in three (9.1%) of the diabetic patients. None of the diabetic subjects experienced ventricular tachycardia nor ventricular fibrillation. Supraventricular ectopics and bradycardia were more prevalent in male than female. Tachycardia was more prevalent in female diabetic (26.7%) than the male (11.1%). There was no significant correlation between gender of diabetic patient and arrhythmia (p value > 0.05). Table 2 shows the occurrence of arrhythmia according to genders of the diabetic subjects.

Table 1. Demographic characteristics of the study population

Variables	Frequency (%)	Mean ± Standard deviation
Gender		63.4 ± 14.41
Male	18 (54.5%)	62 ± 15.5
Female	15 (45.5%)	65 ± 13.33
Age group		
18 – 40	2 (6.1%)	33 ± 0
41 – 60	13 (39.4%)	53.5 ± 5.65
61 – 80	14 (42.4%)	69.7 ± 4.84
>80	4 (12.1%)	87.5 ± 3.79

Table 2. Prevalence of arrhythmia according to gender of the study population

Arrhythmia	Male (n =18)	Female (n =15)	Total (n =33)	P-value
Supraventricular Ectopics	7 (38.9%)	5 (33.3%)	12 (36.4%)	0.741
Ventricular Ectopics	6 (33.3%)	5 (33.3%)	11 (33.3%)	1.000
Tachycardia	2 (11.1%)	4 (26.7%)	6 (18.2%)	0.249
Bradycardia	2 (11.1%)	1 (4%)	3 (9.1%)	0.658
Ventricular Tachycardia	0	0	0	0
Ventricular Fibrillation	0	0	0	0
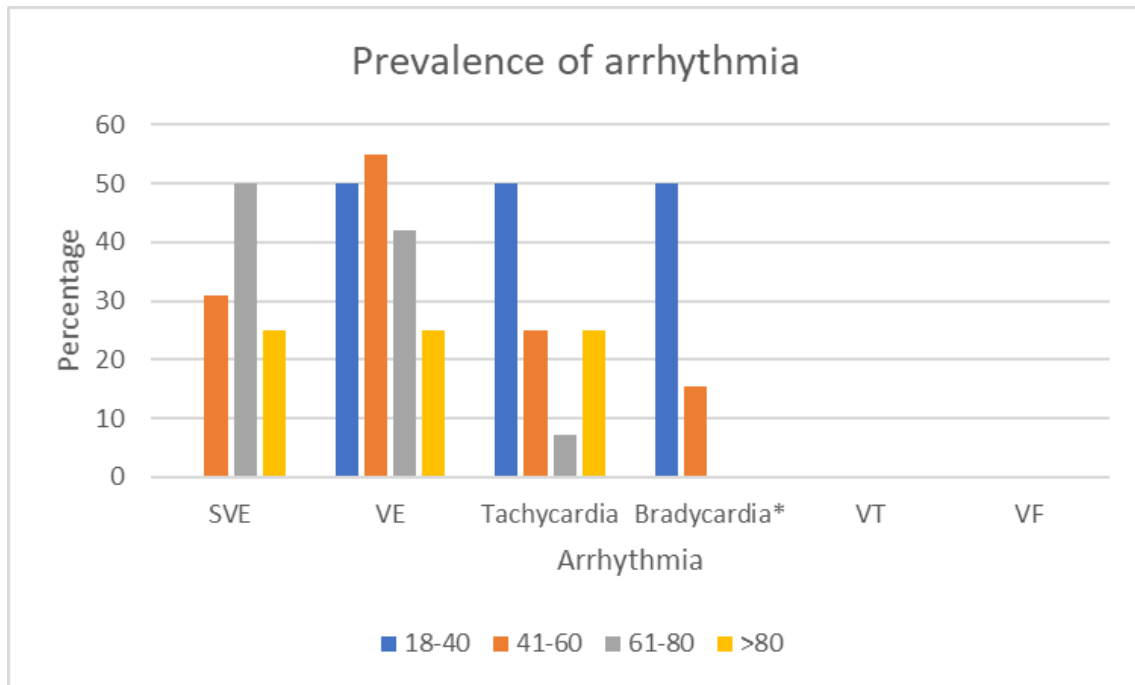
Fig. 1. Prevalence of Arrhythmia according to age group of study population
*P value = significant
SVE – Supraventricular Ectopics; VE – Ventricular Ectopics; VT – Ventricular Tachycardia; VF – Ventricular Fibrillation

Fig. 1 shows the prevalence of arrhythmia according to the age groups. None of the subjects in 18-40 age group had supraventricular ectopics. Majority (50%) of the subjects in 61-80 age group had supraventricular ectopics, followed by ventricular ectopics (42%) and tachycardia (7.14%). Majority (55%) of the subjects in 41-60 age group with ventricular ectopics, followed by those with supraventricular ectopics (30.8%), tachycardia (25%) and lastly bradycardia (15.4%).

4. DISCUSSION

This is a retrospective study which was conducted at a private medical facility in Port Harcourt. It describes the occurrence and pattern of arrhythmias observed in Holter ECGs among patients living with diabetes mellitus. To the best of our knowledge, this particular kind of study which involves the exclusion of hypertension and other comorbidities of diabetes has not been carried out previously. The mean age of the subjects was 63.4 ± 14.41 while the most prevalent age group was 61-80 years (n=14, 42.4%) with mean of 69.71 ± 4.84; this mean age is similar to 64.3 ± 13.8 reported in previous study [16]. This study found that 54.5% of patients with diabetes were males while 45.5% were females. Similar observation was made in a Swedish community where a prevalence of diabetes was noted to be more in males compared to females [17].

Our study showed that arrhythmia was more common in male than female diabetic subjects and this is comparable to another study [18]. However, this differs from another study where

arrhythmia occurred more in female than in male diabetic subjects [17]. This could be due to the inclusion of hypertension and other co-morbidities associated with diabetes in that study. Diabetes-related arrhythmias may be a sign of an underlying illness. Male gender, advanced age and African origin are recognized risk factors of arrhythmia (especially premature ventricular contraction) [19]. The existence of cardiac autonomic dysfunction, cardiac fibrosis and ventricular remodeling have been alluded to as potential causes of arrhythmias in diabetes mellitus patients [15].

We observed that cardiac arrhythmias were more prevalent in middle aged and elderly diabetic subjects. This could be due to the fact that majority of diabetic subjects were in these groups and they comprise a greater percentage of the study population. A study on the prevalence of diabetes in South-South, Nigeria also showed that diabetes is high in these age groups [5].

Supraventricular ectopics was more common, accounting for 36.4% of the sample population while bradycardia accounts for 9.1% of our study and this is in contrast to other studies done in which bradycardia was most prevalent [18,20]. Diabetes has been shown to be linked to a greater prevalence of ventricular arrhythmias [21]. Acidosis and electrolyte imbalances have been identified as the primary cause of arrhythmias in patients with diabetic ketoacidosis, impairing the pace of action potential upstroke and raise junctional resistance in the heart [22].

A study showed that even after controlling for other risk variables, having an excessive supraventricular ectopics was linked to an increase in mortality or stroke rates of more than 60% [23].

In this study, we observed no occurrence of ventricular tachycardia and ventricular fibrillation. Findings from a study in south-western part of Nigeria showed a very low occurrence of ventricular tachycardia (3.5% each for both sustained and non-sustained ventricular tachycardia) in diabetic subjects [24] Ventricular triplets and tachycardia was not observed in our study.

In as much as Framingham Study and OASIS Registry have shown association between diabetes and increased all cause death, new myocardial infarction, stroke, heart failure and arrhythmias [18,21], our study did not show gross evidence of myocardial infarction or fatal arrhythmia in diabetic subjects.

5. CONCLUSION

Supraventricular ectopics (supraventricular tachycardia and tachyarrhythmias) is the most common arrhythmia observed among the diabetic subjects in Southern Nigeria and was notably observed more in diabetic male subjects than females. This arrhythmia exposes them to risk of stroke and other cardiovascular morbidities. Diabetes-related arrhythmias may be a sign of other underlying illnesses. Every DM case presenting with arrhythmia should undergo a thorough clinical assessment as this could reduce mortality.

6. LIMITATIONS OF THE STUDY

The size of our study population would limit the generalization of our findings. Therefore, a larger population from multiple centers and/or randomized control trials will be necessary.

Duration of diabetes mellitus and other comorbidities apart from systemic hypertension could affect the generalization of our findings.

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CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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