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Full Length Research Paper

Prevalence, variants and determinants of electrocardiographic abnormalities amongst elderly Nigerians with type 2 diabetes

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Abstract

Type 2 diabetes is associated with increased risk of cardiovascular (CV) events, especially in the elderly. The electrocardiography (ECG) remains the most widely used non-invasive method for cardiovascular (CV) risk assessment. Hence, the study aimed to evaluate the prevalence, variants and determinants of ECG abnormalities among older patients with type 2 diabetes. A total of 200 participants with type 2 diabetes (46% men) attending diabetes clinics at two referral centres were included. Resting ECG was recorded and the various abnormalities identified; left ventricular hypertrophy (LVH), prolonged QTc, ischaemc heart disease (IHD), conduction defects, ectopic beats among other aberrations. The abnormalities were related to history, clinical, and biochemical parameters.The mean age and median duration of diabetes were 66.8 years and 20 years respectively. The variants and prevalence of ECG abnormalities detected were as follows: prolonged QTc (25.5%), T-wave changes (22%), LVH (18.5%), sinus tachycardia (15.5%), IHD (9%), conduction defects (7%) and ectopic beats (4%).ECG abnormalities among older diabetics were high and included prolonged QTc, LVH, IHD and conduction defects, and were more related to blood pressure levels, waist circumference, LDL-cholesterol, than glycaemic control

Keywords: ECG, Type 2 diabetes, LVH, QT Interval, IHD

INTRODUCTION

The global number of people with diabetes was 151 million in 2000, 366 million in 2011 and projected to increase to 551 million in 2025 (IDF Diabetes Atlas- 5th edition. Brussels: IDF, 2011). Changes in the human environment, behaviour, and lifestyle have resulted in dramatic increase in the incidence and prevalence of diabetes in people with genetic susceptibility to diabetes. Diabetes is associated with many long-term complications including retinopathy, nephropathy and neuropathy. They are also prone to macrovascular complications, coronary artery disease (CHD), stroke and peripheral vascular disease. More than 70% of patients with type 2 diabetes die of cardiovascular disease (International Task Force for Prevention of Coronary Heart Disease, International Atherosclerosis Society, 2003). Ischaemic heart disease (IHD) is a common complication of diabetes mellitus because it is the most prevalent among cardiovascular disease (CVD) and a major cause of morbidity and mortality (Barthelemey et al., 2007). Hence, the increasing prevalence of type 2 diabetes will be followed by an epidemic of diabetes-related cardiovascular disease (CVD), except pre-emptive measures are undertaking to reduce the possibility. Various methods needed to reduce cardiovascular events in this group of patients include; institution of proven treatment modalities including good glycaemic control, reduction in the blood pressure, control of dyslipidaemia and modification of abnormal risk factors among others. Regular assessment for indicators of future cardiovascular risk events in high risk group is also important.

The electrocardiogram (ECG) is widely used for monitoring (IDF Global Guidelines for type 2 Diabetes. Brussels: International Diabetes Federation, 2005)

because it is non- invasive, relatively cheap and available. ECG changes that may be present in the course of diabetes usually include sinus tachycardia, QTc prolongation, QT dispersion, changes in heart variability, ST-T changes, and left ventricular hypertrophy. ECG alterations help detect changes that may predispose to cardiac autonomic neuropathy and also detect signs of myocardial ischaemia even in asymptomatic patients. The resting ECG, frequently complemented by exercise ECG, assists in cardiac screening of diabetic individuals and helps detect silent ischaemia, assess prognosis, and predicts mortality.

In Nigeria, the prevalence of diabetes is between 0.6-7.2% (The National Expert Committee on non-Communicable Diseases in Nigeria. Report of a National survey, Lagos, 1997); majority of patients with diabetes do not have routine ECG screening. This is partly due to inadequate knowledge of its importance and relevance to patients' management by physicians. It might also be due to its non- availability in many secondary health institutions or due to poverty among patients (ECG cost USD 20- 35). Hence, failures to perform regular ECGs means opportunities to improve cardiovascular health in this group of patients are being missed.

This study therefore assessed the prevalence of ECG abnormalities, the various types and clinical determinants of these abnormalities in type 2 diabetics in the South Western part of Nigeria.

METHODS

This study is a cross- sectional carried out in two centres of LAUTECH Teaching Hospital, Ogbomoso and Federal Medical Centre, Ido- Ekiti. Both centres are referral centres, located in the South Western part of Nigeria. The diabetic clinics of the two centres served as settings for recruitment of participants for the study.

LAUTECH Teaching Hospital, Ogbomoso was recently established as a training centre for both undergraduates and resident doctors. The hospital has an Endocrinology unit, which is the main referral centre for endocrine diseases and diabetes in Oyo State, the second largest city in the State (after Ibadan). It receives patients from the city and the surrounding towns, villages and other States. The Federal Medical Centre, Ido- Ekiti, on the other hand, is located in a semi- rural town in Ekiti-State. It is a major referral centre in the State and receives patients from the surrounding villages, and towns. Both centres conducts diabetes clinics once per week and serve as referral hospitals from primary- and secondary- level health facilities, for routine consultations and follow up. Both clinics are manned by endocrinologists.

The study was conducted from May 2012 and January 2013. Patients with diabetes who receives chronic care in the two study clinics were required to have the following evaluations (both at initial presentation and regularly as the clinical presentation demand and also routinely), as part of their management.

Two hundred individuals diagnosed of type 2 diabetes mellitus (T2DM), (based on diagnosis of attending physician) were consecutively enrolled over a period of 8-month, from May 2012 and January 2013. Participants must be at least 50 years and above. Subjects who are on medications that can prolong QTc and those with heart failure, end- stage renal disease or those with previous history of chronic atrial fibrillation on ECG were excluded.

The body mass index (BMI) for each participant was calculated as weight/height2 (kg/m2). The weight (kg) was taken using a HARSON^{R} scale, with only light clothing to the nearest 0.5kg.Heights (m) were taken to the nearest 0.5cm with subjects standing erect without shoes or headgear. The waist circumference (cm) was measured with a tape measure on the horizontal plane midway between the lowest rib margin and upper edge of the iliac crest.

Blood pressure (mmHg) was measured on the right arm with patient on a seated position, after at least 10 minutes' rest, with an OMRON^{R} MX2 basic electronic device (Omron Healthcare Co, Ltd, Kyoto, Japan) with the appropriate cuff size. The average of two measurements recorded five minutes apart was used in this study. Social history such as cigarette smoking, alcohol use was obtained. Also history of complications such as previous stroke, sudden cardiac death and ischaemic heart disease were obtained.

A 12- lead resting ECG was done on all subjects using the Cardi Max Fx- 7303$^{R.}$ All tracings were interpreted by the same individual, who is a cardiologist who was not aware of the subjects' background. The following ECG abnormalities were specifically looked for: ST-segment elevation or depression, T- wave aberrations (inversion or tall T-wave), bundle branch block, left ventricular hypertrophy (LVH), arrhythmias, prolonged QT wave and other changes.

LVH was defined according to three different criteria:

1. Cornell voltage (SV3 + RaVL > 24mm in women and 28mm in men)
2. Cornell voltage-duration product {(RaVL + SV3) x QRS complex duration} > 2.623mm x ms in men and > 1.558mm x ms in women.
3. Sokolow- Lyon index (SV1 + RV5/6 > 35mm).

Compared with echocardiography, the cut- off values for the Cornell voltage duration product gave the best sensitivity with a specificity of 95%.

ECG measurements were done with a ruler on the resting ECG tracings, and were expressed as the average of three determinations on consecutive QRS complexes. R-wave amplitude in aVL and S-wave depth in V3 were measured as the distance (mm) from the

isoelectric line of their zenith and nadir, respectively. QRS duration was measured from the beginning to the

Table 1. Profile of the 200 men and women with type 2 diabetes

Variables	Men n (%)	Women n (%)	P	Total n (%)
Number (%)	87 (43.5)	113 (56.5)		200
Age (years)	66.5 (8.4)	66.4 (7.7)	0.986	66.8 (8.0)
Median (range) duration of diabetes (years)	20 (1 - 25)	18 (1- 26)		20.6 (1- 25)
Body mass index (kg/m^2)	25.5 (4.1)	29.3 (3.8)	0.001	27.5 (3.9)
Waist circumference (cm)	91.5 (9.3)	95.8 (8.7)	0.001	93.4 (7.8)
Smoking history	6	0		
Systolic blood pressure (mmHg)	141.6 (18.1)	142.7 (20.7)	0.785	141.8 (19.2)
Diastolic blood pressure (mmHg)	78.3 (12.9)	82.8 (14.0)	0.420	80.6 (13.2)
Fasting blood sugar (mmol/L)	8.6 (5.6)	10.4 (5.0)	0.030	9.4 (4.8)
2 hr PP (mmol/L)	10.3 (4.6)	12.1 (5.1)	0.002	11.4 (4.8)
Total cholesterol (mmol/L)	3.7 (1.1)	4.0 (1.3)	0.420	3.8 (1.2)
TG (mmol/l)	0.94 (0.4)	0.96 (0.6)	> 0.005	0.95 (0.5)
LDL-C (mmol/l)	2.5 (1.0)	2.8 (1.1)	0.380	2.7 (1.1)
HDL-C (mmol/l)	0.96 (0.3)	1.0 (0.3)	0.760	0.98 (0.4)

end of the QRS complex. QTc prolongation was defined as a QTc > 460ms in both men and women.

A diagnosis of ischaemic heart disease was made based on the American Heart Association criteria. These criteria include ECG features of significant ST- segment depression, defined as an ST- segment depression > 1mm in more than one lead, and T- wave inversion. Myocardial infarction was defined as an ST- segment elevation (convex upwards)> 0.08s, associated with T-wave inversion in multiple leads, and reciprocal ST-segment depression in opposite leads.

Statistical analysis

Data were analysed using SPSS version 17 (Chicago, IL). Differences in means and proportions for participants' characteristics were assessed using analysis of variance and Chi-square tests as applicable. Correlation analysis was used to assess the relation between clinical and biochemical parameters on ECG findings. A p value < 0.05 was set as threshold of statistical significance.

RESULTS

Two hundred participants with type 2 diabetes mellitus (T2DM) were included in this study. They were aged between 50-80 years, with a mean age of 66.0±8.0 years. The mean age of male to female is 66.5±8.4 and 66.5±7.7years, respectively (p>0.05). 56% of participants were females, given a ratio of male to female, 1: 1.3. The mean body mass index (BMI) was 25.5±4.1kg/m2 for males and 29.3±3.8kg/m2 for females. There is significant difference between BMI of males and females (p=0.000). The median time since diagnosis of type 2 diabetes was 20±6.4 years (ranges 1-25 years). The mean fasting blood sugar (FBS), was 8.6±5.6mmol/l and 2hours postprandial (2hrPP), 10.3mmol/l. The females had higher level of FBS compared to males, but this is not statistically significant Table 1.

A significant number of participants had a history of other cardiovascular risk factors such as hypertension (77%), obesity (56%). No participants admitted to currently smoking cigarette and only eight (all males), takes alcohol occasionally. Also, the distribution of microvascular complications as noted were retinopathy (38%), nephropathy (27%), and neuropathy (30%). (These complications were assessed with fundoscopy, microalbuminuria, and neuropathy examination scores, respectively). Majority of participants were on pharmacological therapy for type 2 diabetes; 84% on oral hypoglycaemic agents (OHA), 12% on combination of insulin and OHA and 4% on insulin alone. Of the 168 participants on OHA, 78% were on Metformin, 62% on Sulphonylureas, and 6% on Vidagliptin. None on the participants was on Glitazones or Alpha Glucosidase inhibitors (AGI). Aspirin and/or Clopidogrel used by 64%.

The pattern of electrocardiographic (ECG) abnormalities are as follows; left ventricular hypertrophy (LVH), according to Sokolow Lyon (18.5%), ischaemic heart disease (IHD),9%, sinus tachycardia, 15.5%, conduction defects 7%, T- wave changes,22%,, prolongation of QTc ,25.5%, and ectopic beats, 2.0%. other findings included, sinus bradycardia (7%), atrial premature complexes (APCs), 2.5%, and ventricular premature complexes (VPCs),1.5% Table 2.

Age, duration of diabetes, both systolic and diastolic blood pressure, various lipid subtypes were the common significant determinants of ECG abnormalities.

DISCUSSION

Table 2. ECG Changes in 200 males and Females

LVH	Male	Female	P-value
• Cornell Product			
• Sokolow Index	3	20	< 0.05
• Overall	9	11	>0.05
	9	28	<0.05
Conduction			
• LBBB	2	1	>0.05
• RBBB	6	4	>0.05
• LAFB	4	3	>0.05
• Bifascular block	2	1	>0.05
IHD	18	4	<0.05
Sinus tachycardia	31	22	>0.05
Sinus Bradycardia	5	9	>0.05
APCs	3	2	>0.05
VPC	1	2	>0.05
Prolonged QTc	51	4	<0.05

Table 3. Correlations between clinical determinants and ECG changes

Variables	LVH	Prolonged QT	IHD	T-Wave changes	Conduction abnormalities
Age	0.426	0.101	0.872	0.652	0.304
Gender	*0.009	*0.000	0.297	0.256	*0.039
Duration of diabetes (years)	*0.011	0.648	0.105	0.411	0.345
Systolic BP (mmHg)	0.742	*0.003	*0.000	0.765	0.643
Diastolic BP (mmHg)	*0.000	0.732	*0.008	0.823	0.532
Pulse Pressure(mmHg)	0.033	*0.002	0.573	*0.043	0.132
Total cholesterol	0.097	0.147	*0.006	0.653	0.432
HDL-Cholesterol	*0.006	0.026	0.130	0.102	*0.034
LDL-Cholesterol	0.971	0.654	0.575	0.786	0.651
TG	0.174	0.290	0.573	0.600	0.302

malities which included repolarisation changes, conduction defects, LVH and prolongation of QTc. 77% of participants and 56% had hypertension and obesity respectively. This percentage is higher than similar studies by (Fasanmade et al., 2003 and Fatima et al., 2008), in Nigeria. This may be related to relatively older participants with longer mean duration of diabetes present in this study. It has been found that prevalence of both obesity and hypertension increases with age (Fotoula et al., 2010 and Hammami et al., 2012). A strong relationship exists between hypertension and T2DM, and both diseases play a significant role in the development of LVH, and IHD. Hypertension, obesity and dyslipidaemia are reported to worsen the progression of individuals with type 2 diabetes mellitus (Hense et al., 1998 and Himero et al., 1999). Almost 25% of the participants studied had good glycaemic control of diabetes mellitus according to American Diabetes Association (ADA) criteria (ADA. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care. 1997).* It has been shown that poor glycaemic control of glycaemia is associated with diabetes complications especially microvascular (Ronald et al., 1995). The levels of blood sugar, fasting and two- hour postprandial, did not show any significant correlation with ECG abnormalities. The use of glycosylated haemoglobin (HbA1c), which better assesses glycaemic control than either FBS or 2hrPP would have been preferred but this could not be done. This is due to its not being readily available in developing countries, and where present, most patients are not able to afford the cost.

This study demonstrated high proportion of ECG abnormalities than previously reported in this part of the world (Fatima et al., 2008; Lutale et al., 2008; Anastase et al; 2012). The frequencies of occurrence of abnormalities are as follows: prolonged QTc (25.5%), LVH (18.5%), sinus tachycardia (15.5%), IHD (9%), and conduction defects (7%). Our study revealed that most ECG abnormal findings were related to systolic and diastolic blood pressure, waist circumference, age of the participants and levels of low density lipoprotein cholesterol (LDL-C). The high prevalence of these may be related to higher mean age of our participants (66.8 years), compared to those reported above. These factors could therefore be used as guideline for clinicians to

decide which patients they should request routine ECG. Some authorities(IDF Africa Region Task Force on type 2 Diabetes Clinical Practice Guidelines- Type 2 clinical practice guidelines for sub-Saharan Africa-IDF Afro Region, 2006 and American Diabetes Association. Standards of medical care for patients with diabetes mellitus. Diabetes Care, 2012) recommend performing ECG at initial visit of diabetic patients to clinic especially at secondary or tertiary healthcare centres where facilities for performing an ECG are more readily available. The high proportion of abnormal ECG (25.5%), in our study indicates the need for screening all type 2 diabetics especially the older patients at first clinic visit and possibly annually. The findings of ECG- diagnosis suggestive of IHD of 9.0% shows higher prevalence than values reported in this part of the world which suggests rarity of IHD (Onyemelukwu et al., 1981 and Danbanchi et al., 2001).

The basic reason of the present study was to determine and promote the use of risk approach, by looking at the prevalence of abnormal ECG results among elderly diabetic patients in this environment. Including ECG abnormalities to traditional risk factors among diabetics in a risk model, may probably improve the prediction of cardiovascular events. This may particularly important among high risk groups like elderly diabetics. This is because both major and minor abnormalities on ECG may herald an imminent or future occurrence of coronary artery disease (CAD), even in the absence of classical symptoms, which needs to be addressed.

This study is limited by the number of participants which was moderate. Also, we did not subject our participants to echocardiography or stress ECG in the absence of classical symptoms suggestive of IHD. This may have led to underreporting of ECG diagnosed CAD. ECG abnormal features were classified as abnormal regardless of their prognostic or clinical value. However, it could be argued that including all the ECG abnormalities is useful to avoid misclassification and also reduce inaccuracy.

REFERENCES

ADA (1997). Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care. 2: 1183-1197*

Abdoul Kadir A, Andre PK, Partricia G, Mesmin D(*2012)*. Prevalence and determinants of electrocardiographic in sub-Sahara African individuals with type 2 Diabetes. *Cardiovasc J Afric . 23*

American Diabetes Association Conference

American Diabetes Association. Standards of medical care for patients with diabetes mellitus. *Diabetes Care 2012, 12:365-8.*

Barthelemey O, Le Feuvre G, Timsit J (2007). Silent myocardial ischaemia screening in patients with diabetes mellitus. *Arg Bras. Endo*

Danbanchi SS, Onyemelukwu GC(*2001).* Ischemic heart disease in Nigerians. Report of three cases. *Diabetes Int. 59-60*

Fasanmade OA, Okubadejo NU(*2003)* Clinical profile of Nigerians with diabetes mellitus. Afr. *J Endocrinol Metab; 4:1: 95*

Fatima BS, Anuman FEO(*2008)*Electrocardiographic abnormalities in persons with type 2 diabetes in Kaduna Northern Nigeria. *Int. J Diabetes and Metabolism. 17:99-103*

Fotoula B, Assimina Z(*2010).* Epidemiology of hypertension in the elderly. *Health Science j. Vol 4(1): 24-30*

Hammami S, Mehrl S, Hajem S, Koubaa N, Souid H, Hammami M(*2012)* Prevalence of diabetes among non- institutionalised elderly in Monastir City. *BMC Endocrine disorders. 12; 15, 147.*

Hense WH, Gneiting B, Muscholl M(*1998).* The association between body size, and body composition with left ventricular mass; impact for indexation in adults. *J Am. Coll Cardiol. 32: 451-457*

Himero E, Nishino k, Okazati T(*1999).*A weight reduction and weight maintenance program with longitudinal improvement in left ventricular mass and blood pressure. *J Am Hyper tens.12:682-690*

IDF Africa Region Task Force on type 2 Diabetes Clinical Practice Guidelines- Type 2 clinical practice guidelines for sub-Saharan Africa-*IDF Afro Region 2006.*

IDF Diabetes Atlas- 5th edition. Brussels: IDF, 2011.

IDF Global Guidelines for type 2 Diabetes. Brussels: International Diabetes Federation, 2005.

International Task Force for Prevention of Coronary Heart Disease, International Atherosclerosis Society. Pocket Guide to prevention of coronary Heart Disease. *Munster: Born Bruckheimer Vertag GmbH, 2003*.

Lutale JJ, Thordarson H, Gulam-Abbas Z, Vetrik K, Gerdits E(*2008).* Prevalence and Covariates of electrocardiographic left ventricular hypertrophy in diabetic patients in Tanzania. *Cardiovascular J Afr . 19:8-14* Anastase D, Simeon-Pierre C, Onyemelukwu GC, Stafford WL(*1981*) Serum Lipids in Nigerians; the effect of diabetes Mellitus. *Trop Geogr Med . 33:323-328*

Ronald Klein(*1995).*Hyperglycaemia and microvascular and macrovascular disease in diabetes. *Diabetes care .18:258-268*

The National Expert Committee on non-Communicable Diseases in Nigeria. Report of a National survey, Lagos. *Federal Ministry of Health 1997*.

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