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# Resting Electrocardiographic Abnormalities in Patients at the Medical Outpatient Clinics of Komfo Anokye Teaching Hospital, Kumasi, Ghana

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## Abstract

The electrocardiogram (ECG) is an objective quantitative record of electrical action currents generated at each contraction of the heart muscle as a function of time and is used in investigating in patients with cardiac conditions and in cardiovascular surveys. The objective for this study was to determine the prevalence of ECG abnormalities in patients reporting at the medical outpatient clinics of Komfo Anokye Teaching Hospital (KATH). This was a cross-sectional study undertaken in the outpatient clinics of KATH and a total of 572 patients were recruited. These were patients aged 20 years and over who were reporting for the first time to KATH. A questionnaire was administered after obtaining informed consent, anthropometric measurements were then taken and blood investigations including fasting blood glucose were undertaken. ECG was recorded using a Fukuda Denshi FCP-4101 machine. Almost 60% had one or more ECG abnormalities while at least one patient had 6 different kinds of these abnormalities. The commonest abnormality was prolonged QT (23%) followed by left ventricular hypertrophy (16%), axis deviation (15%), left atrial enlargement (14%) and ST-T changes (13%). And all these abnormalities were significantly common in patients with hypertension and males with the exception of prolonged QT which was more common in the females. In conclusion among the medical outpatients attending clinics in the medical outpatient department at KATH, ECG abnormalities were very common and they were more prevalent in patients with hypertension and in male patients.

## Keywords

Electrocardiogram, ECG Abnormalities, Hypertension, Diabetes Mellitus

## 1. Introduction

The electrocardiogram (ECG) is an objective quantitative record of electrical action currents generated at each contraction of the heart muscle as a function of time. The electrocardiogram is the printed record of electrical activity generated during impulse propagation in the heart, while the electrocardiograph is the instrument with which it is recorded. ECG was discovered by Einthoven in 1893 and has since been a major diagnostic tool in cardiology. It is usually the first investigation in patients with cardiac conditions because it is harmless, cheap and simple. It can also be used in the course of health screening where the patient has no cardiac complaints and may be asymptomatic. The interpretation of the ECG will then depend on whether the patient is symptomatic or not since there are a number of normal variants.

In the clinical setting ECG is important in the patient with chest pain. It can help in distinguishing, myocardial ischaemia, injury and infarction from non-cardiac chest pain. It also has a role in the patient who presents with breathlessness. In this case it helps to distinguish between cardiac causes and chronic lung diseases. A finding of old myocardial infarction or left ventricular hypertrophy may point to a cardiac cause while the finding of right ventricular hypertrophy may indicate a

pulmonary disease. A cardiac cause of breathlessness is unlikely in the presence of a completely normal ECG.

ECG has characteristic appearance in a number of conditions which are not primary cardiac conditions. An example is diabetic ketoacidosis with severe electrolyte derangement and other electrolyte imbalances such as hypokalaemia, hypocalcaemia and hypomagnesaemia. Prolonged QT can be caused by certain drugs, and this may cause sudden death from ventricular tachycardia. Therefore ECG is important in the development of new drugs to detect drugs which will cause QT prolongation. ECG is of paramount importance in the investigation and management of patients with cardiac arrhythmias. Patients may complain of palpitation, dizziness, syncope, easy fatigability and chest pains. Such arrhythmias may be caused by structural heart diseases such as congenital heart disease, coronary artery disease, hypertensive heart disease, valvular heart disease or cardiomyopathies or it may occur with no underlying structural cardiac abnormality. ECG may detect tachycardia, bradycardia, conduction abnormalities and extrasystoles, some of which may be persistent or paroxysmal [1-4].

It is also of value in cardiovascular surveys, providing information on rhythm, rate, conduction, and the state of the myocardium. It thus has significance for both diagnosing diseases such as systemic hypertension and coronary artery disease, as well as establishing categories of risk for future cardiac events and mortality. ECGs are commonly used in cardiovascular studies which may be in healthy subjects or participants with particular disease condition like hypertension, heart failure, arryhythmias or cardiomyopathy. And in most instances the results may not include detailed reports of the ECG findings since the focus may be on the particular disease condition being studied. We examined the ECGs of patients attending the outpatient clinics of our medical department generally and without focusing on any definite cardiac disease condition. The aim of this study was to determine the prevalence of ECG abnormalities in patients reporting at the medical outpatient clinics of Komfo Anokye Teaching Hospital (KATH).

## 2. Materials and Methods

This cross sectional study was conducted at the Directorate of Medicine, KATH from June 2015 to August 2015. The inclusion criteria for the study were patients 20 years and above who received treatment as outpatients at the directorate. The exclusion criterion was age less than 20 years. Patients were recruited from the General Medical Outpatient clinic, the Hypertension Clinic and at the Diabetes Centre. The Directorate of Medicine has a Cardiology Clinic for patients with diagnosed cardiac conditions, including those with heart failure and patients from this clinic were not recruited for this study.

A questionnaire was administered to each participant. Blood pressure (BP) was measured with an automatic BP machine (OMRON M7 sphygmomanometer; Omron Matsusaka Co. Ltd, Matsusaka City, Mie-Ken, Japan) using the appropriate size of cuff. Three readings were taken 1 minute apart but the mean of the last two readings was used in the data analysis having discarded the first reading. Height was measured to the nearest 0.5 cm and weight was measured to the nearest 0.1 kg after participants had removed their footwear using a standardized combined manual scale and stadiometer (Asimed MB 201T Plus from Aparatos Y Sistemas De Medida, S. A.). A plastic tape measurement was used in measuring the hip and waist circumferences to the nearest 0.5 cm. Fasting plasma glucose (FPG) was determined on a fasting venous blood using a BT3000 auto analyser, manufactured by Biotechnica Instruments S.p.A. Rome, Italy.

The participants had the ECG recorded using a Fukuda Denshi FCP-4101 machine with the participants lying supine and relaxed on a low pillow. The electrodes were placed on the precordium and limbs with the use of gel to maintain proper contact between the skin and electrodes in accordance with the recommendations of American Heart Association specifications [5]. The stylus control was set at 10mm/mV and paper speed at 25mm/s.

The following definitions were adopted for this study:

(i) Systemic hypertension is systolic blood pressure (SBP) ≥ 140 and / or diastolic blood pressure (DBP) ≥ 90 [6].

(ii) Overall Obesity is Body Mass Index (BMI) ≥ 30 kg/$m^2$ [7].

(iii) Central Obesity or High Waist Hip Ratio (WHR) is WHR > 0.9 for males and > 0.8 for females [7].

(iv) High Waist Circumference (WC) is WC ≥ 94 cm in men or ≥80 cm in women [7].

(v) Diabetes mellitus. Fasting venous plasma glucose ≥ 6.1 mmol/L or being on drug or diet therapy for DM [8-9].

(vi) Abnormal ECG criteria

a. Arrhythmia is any ECG rhythm other than sinus rhythm.

b. Sinus Bradycardia is ECG heart rate < 60 beats per minute in sinus rhythm.

c. Sinus Tachycardia is ECG heart rate > 100 beats per minute in sinus rhythm.

d. Abnormal axis deviation is any QRS axis other than the normal axis. These include left, right, extreme and indeterminate axis deviations.

e. Conduction abnormalities is any abnormality in conduction such as first, second and complete atrioventricular blocks and right and left bundle branch blocks.

f. Right Atrial Enlargement is P wave amplitude ≥ 2.5 mm in Lead II and or the amplitude in $V_1$ greater than 1 mm.

g. Left Atrial Enlargement is P wave biphasic (positive then negative in $V_1$ with terminal negative part wider than 0.04 s) and nadir deeper than 1 mm.

h. Right Ventricular Hypertrophy is R > S in $V_1$, R in $V_1$ > 5mm; deep S in $V_6$.

i. Left Ventricular Hypertrophy is SV1 + RV5 or RV6 > 35 mm or RV5 or RV6 > 25 mm or SV1 or SV2 > 25mm.

j. ST-T Changes is any abnormality in the ST segment or T wave such as non-specific ST-T changes, ST elevation and depression, tall peaked T wave and inverted T wave.

k. Pathological Q wave is any Q wave ≥ 0.04 s.

l. Prolonged QT is corrected QT > 0.43 s.

Microsoft Excel 2010 and Stata version 8.0 statistical package were used in analysing the data. The Pearson Chi-square test was used in comparing discrete variables after calculating percentages while the Student t-test was used for the continuous variables using the calculated mean and standard deviation for these continuous variables. P-values of less than 0.05 were taken as statistically significant. Each participant gave formal consent by signing or thumb printing an informed consent form after the study was thoroughly explained to them. The study was approved by the Committee of Human Research, Publication and Ethics of KATH and School of Medical Sciences, Kwame Nkrumah University of Science and Technology.

## 3. Results

There were 572 participants, 210 (37%) males, 362 (63%) females and we present the results of all these participants. There were 154 (27%) participants with only DM, 108 (19%) with only hypertension, 234 (41%) with both DM and hypertension and 76 (13%) who had neither DM nor hypertension. In all 388 (68%) had DM (that is combining the only DM with DM-hypertension) and 342 (60%) had hypertension (that is considering those with only hypertension and those with DM-hypertension).

The basic characteristics of the participants are presented in Table 1. The mean (sd) age of participants was 50.3 (13.6) years and there was no significant age difference between the males and females. However the DM and hypertension participants were significantly older than those who were not. Though there were more males with DM and hypertension these differences were not statistically significant. Mean BMI was 26.3 (5.5) and this was significantly higher in the females compared to the males, in hypertension patients compared to those with normal blood pressure and in DM participants compared to those without DM. The mean WHR was 0.91 (0.09). This was similar in the males and females but was significantly higher in the DM and hypertension groups. Mean WC was significantly higher in the females, DM and hypertension participants. The males and hypertension subjects had significantly higher mean SBP and DBP and though the DM subjects had higher mean blood pressure these were not up to statistical significance when compared to the subjects with no DM. Mean FPG was significantly high in the DM group but not in the other groups. The females, the DM and hypertension participants had significantly higher prevalence of high WC and high WHR but only the females had higher prevalence of BMI≥30.

***Table 1.*** *Characteristics of participants by sex, hypertension and DM.*

| | **Male** | **Female** | **p** |
|---|---|---|---|
| | **Mean (SD)** | **Mean (SD)** | **t or χ2 test** |
| Number | 210 | 362 | |
| Age (years) | 49.1 (14.2) | 51.0 (13.2) | 0.12 |
| Age range (years) | 21 - 88 | 20 - 85 | N/A |
| Females (%) | N/A | N/A | N/A |
| Weight (kg) | 69.0 (12.7) | 68.5 (15.9) | 0.72 |
| Height (m) | 1.68 (0.06) | 1.58 (0.06) | <0.0001 |
| BMI (kg/m$^2$) | 24.4 (3.9) | 27.5 (6.0) | <0.0001 |
| WHR | 0.91 (0.07) | 0.91 (0.10) | 0.71 |
| Waist (cm) | 87.0 (11.4) | 91.7 (13.7) | <0.0001 |
| Hip (cm) | 95.6 (8.2) | 100.9 (12.1) | <0.0001 |
| SBP (mmHg) | 135.8 (25.1) | 131.7 (21.8) | 0.04 |
| DBP (mmHg) | 85.2 (12.5) | 84.3 (11.9) | 0.39 |
| BMI≥30 (%) | 12 (5.7) | 122 (33.7) | <0.001 |
| High WHR (%) | 116 (55.2) | 327 (90.3) | <0.001 |
| High Waist | 62 (29.5) | 288 (79.6) | <0.001 |
| FBG (mmol/L) | 8.48 (4.71) | 8.61 (4.49) | 0.76 |

| | **No Hypertension** | **Hypertension** | **p** |
|---|---|---|---|
| | **Mean (SD)** | **Mean (SD)** | **t or χ2 test** |
| Number | 230 | 342 | |
| Age (years) | 44.1 (12.9) | 54.4 (12.4) | <0.0001 |
| Age range (years) | 20 - 82 | 23 - 88 | N/A |
| Females (%) | 139 (60.4) | 223 (65.2) | 0.25 |
| Weight (kg) | 66.8 (14.8) | 70.0 (14.7) | 0.01 |
| Height (m) | 1.62 (0.08) | 1.61 (0.08) | 0.06 |
| BMI (kg/m$^2$) | 25.4 (5.6) | 27.0 (5.4) | <0.001 |
| WHR | 0.89 (0.07) | 0.93 (0.10) | <0.0001 |
| Waist (cm) | 86.7 (13.2) | 92.2 (12.5) | <0.0001 |
| Hip (cm) | 97.7 (11.0) | 99.8 (11.1) | 0.03 |
| SBP (mmHg) | 116.1 (12.0) | 144.7 (21.7) | <0.0001 |
| DBP (mmHg) | 76.6 (7.5) | 90.0 (11.7) | <0.0001 |
| BMI≥30 (%) | 48 (20.9) | 86 (25.2) | 0.24 |
| High WHR (%) | 157 (68.3) | 286 (83.6) | <0.001 |
| High Waist | 117 (50.9) | 233 (68.1) | <0.001 |
| FBG (mmol/L) | 8.95 (5.07) | 8.31 (4.18) | 0.10 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | t or $\chi 2$ test | Mean (SD) |
| Number | 184 | 388 | | 572 |
| Age (years) | 47.4 (13.2) | 51.7 (13.2) | <0.001 | 50.3 (13.6) |
| Age range (years) | 20 - 83 | 21 - 88 | N/A | 20 - 88 |
| Females (%) | 1 13 (61.4) | 249 (64.2) | 0.52 | 362 (63.3) |
| Weight (kg) | 67.6 (13.7) | 69.2 (15.3) | 0.23 | 68.7 (14.8) |
| Height (m) | 1.62 (0.08) | 1.61 (0.08) | 0.09 | 1.62 (0.08) |
| BMI ($kg/m^2$) | 25.6 (5.8) | 26.7 (5.8) | 0.03 | 26.3 (5.5) |
| WHR | 0.87 (0.07) | 0.93 (0.09) | <0.0001 | 0.91 (0.09) |
| Waist (cm) | 86.5 (11.8) | 91.6 (13.3) | <0.0001 | 90.0 (13.1) |
| Hip (cm) | 99.0 (10.3) | 99.0 (11.5) | 0.96 | 99.0 (11.1) |
| SBP (mmHg) | 131.1 (22.9) | 134.2 (23.2) | 0.13 | 133.2 (23.1) |
| DBP (mmHg) | 83.9 (13.1) | 85.0 (11.6) | 0.31 | 84.6 (12.1) |
| BMI≥30 (%) | 35 (19.0) | 99 (25.5) | 0.09 | 134 (23.4) |
| High WHR (%) | 116 (63.0) | 327 (84.3) | <0.001 | 443 (77.5) |
| High Waist | 91 (49.5) | 259 (66.8) | <0.001 | 350 (61.2) |
| FBG (mmol/L) | 5.17 (0.64) | 10.20 (4.74) | <0.0001 | 8.56 (4.57) |

Table 2 shows the different ECG abnormalities found in the study and their prevalence. The most common abnormality was prolonged QT (23%) while the lowest prevalence was in arrhythmias (1%). All the cases of arrhythmias were in the females and prolonged QT was significantly more common in the females. Females also had significantly more sinus tachycardia than the males. On the other hand, axis deviation, LAE, RVH and LVH were significantly more prevalent in the males. The hypertension participants had a significantly higher prevalence of axis deviation, LAE, LVH, prolonged QT and ST-T changes. Sinus bradycardia was more common in the participants with normal blood pressure. The prevalence of most of the ECG abnormalities were similar in the participants with DM and those without DM, with the exception of LVH which was significantly common in the non-DM participants.

***Table 2.*** *Prevalence of ECG abnormalities by sex, hypertension and DM.*

| | Male | Female | p |
|---|---|---|---|
| | Number (%)) | Number (%) | $\chi 2$ test |
| Number | 210 | 362 | |
| Arrhythmia | 0 (0) | 6 (1.7) | 0.06 |
| Sinus Bradycardia | 10 (4.8) | 8 (2.2) | 0.09 |
| Sinus Tachycardia | 11 (5.2) | 37 (10.2) | 0.04 |
| Axis Deviation | 43 (20.5) | 44 (12.2) | <0.01 |
| Conduction Abnormalities | 11 (5.2) | 14 (3.9) | 0.44 |
| RAE | 3 (1.4) | 8 (2.2) | 0.51 |
| LAE | 37 (17.6) | 40 (11.1) | 0.03 |
| RVH | 8 (3.8) | 1 (0.3) | <0.01 |
| LVH | 53 (25.4) | 39 (10.8) | <0.001 |
| ST-T Changes | 33 (15.7) | 39 (10.8) | 0.09 |
| Pathological Q | 10 (4.8) | 10 (2.8) | 0.21 |
| Prolonged QT | 36 (17.1) | 98 (27.1) | <0.01 |
| Abnormal ECG | 136 (64.8) | 205 (60.1) | 0.06 |

| | No Hypertension | Hypertension | p |
|---|---|---|---|
| | Number (%) | Number (%) | $\chi 2$ test |
| Number | 230 | 342 | |
| Arrhythmia | 0 (0) | 6 (1.8) | 0.40 |
| Sinus Bradycardia | 12 (5.2) | 6 (1.8) | 0.02 |
| Sinus Tachycardia | 16 (7.0) | 32 (9.4) | 0.31 |
| Axis Deviation | 26 (11.3) | 61 (17.8) | 0.03 |
| Conduction Abnormalities | 9 (3.9) | 16 (4.7) | 0.66 |
| RAE | 4 (1.7) | 7 (2.1) | 0.79 |
| LAE | 20 (8.7) | 57 (16.7) | <0.01 |
| RVH | 5 (2.2) | 4 (1.2) | 0.34 |
| LVH | 28 (12.2) | 64 (18.8) | 0.04 |
| ST-T Changes | 14 (6.1) | 58 (17.0) | <0.001 |
| Pathological Q | 4 (1.7) | 16 (4.7) | 0.06 |
| Prolonged QT | 38 (16.5) | 96 (28.1) | <0.01 |
| Abnormal ECG | 121 (52.6) | 220 (64.3) | <0.01 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Number (%) | Number (%) | χ2 test | Number (%) |
| Number | 184 | 388 | | 572 |
| Arrhythmia | 2 (1.1) | 4 (1.0) | 0.95 | 6 (1.1) |
| Sinus Bradycardia | 8 (4.4) | 10 (2.6) | 0.26 | 18 (3.2) |
| Sinus Tachycardia | 14 (7.6) | 34 (8.8) | 0.64 | 48 (8.4) |
| Axis Deviation | 27 (14.7) | 60 (15.5) | 0.81 | 87 (15.2) |
| Conduction Abnormalities | 8 (4.4) | 17 (4.4) | 0.99 | 25 (4.4) |
| RAE | 6 (3.3) | 5 (1.3) | 0.11 | 11 (1.9) |
| LAE | 31 (16.9) | 46 (11.9) | 0.10 | 77 (13.5) |
| RVH | 3 (1.6) | 6 (1.6) | 0.94 | 9 (1.6) |
| LVH | 42 (22.8) | 50 (12.9) | <0.01 | 92 (16.1) |
| ST-T Changes | 24 (13.0) | 48 (12.4) | 0.82 | 72 (12.6) |
| Pathological Q | 8 (4.4) | 12 (3.1) | 0.45 | 20 (3.5) |
| Prolonged QT | 40 (21.7) | 94 (24.2) | 0.51 | 134 (23.4) |
| Abnormal ECG | 113 (61.4) | 228 (58.8) | 0.55 | 341 (59.6) |

In the 76 participants who had neither hypertension nor DM, none had arrhythmia, 4 (5.3%) had sinus bradycardia, 4 (5.3%) sinus tachycardia, 9 (11.8%) axis deviation, 4 (5.3%) conduction abnormalities, 1 (1.3%) RAE, 6 (7.9%) LAE, 2 (2.6%) RVH, 14 (18.4%) LVH, 6 (7.9%) ST-T changes, 2 (2.6%) pathological Q and 12 (15.8%) had prolonged QT. Forty (52.6%) of these 76 participants had one or more of these ECG abnormalities. When the prevalence of ECG abnormalities in these 76 participants were compared to the rest of the participants there were no statistically significant differences.

When all these abnormalities were combined there were a total of 599 ECG abnormalities in 341 (60%) participants. Of the 341 participants, 182 (53%) had one abnormality, 94 (28%) had 2 abnormalities, 40 (12%) had 3 abnormalities, 17 (5%) had 4 abnormalities, 7 (2%) had 5 abnormalities and 1 had 6 different types of ECG abnormalities. In addition a significantly higher proportion of these 341 participants had hypertension compared to those who had normal blood pressure.

The details of conduction abnormalities, pathological Q waves and ST-T changes are shown in Tables 3-5. The commonest conduction abnormalities were first degree AV block and RBBB. Non-specific ST-T changes and changes suggestive of LVH were the predominant ST-T changes. The others included ST elevation and depression, peaked T waves and biphasic T waves. The pathological Q waves were suggestive of anterolateral, anteroseptal, inferior and septal MI.

***Table 3.*** *Prevalence of conduction abnormalities by sex, hypertension and DM.*

| | Male | Female | p |
|---|---|---|---|
| | Number (%)) | Number (%) | χ2 test |
| Number | 11 | 14 | |
| First Degree AVB | 3 (27.3) | 7 (50.0) | 0.25 |
| Complete RBBB | 7 (63.3) | 3 (21.4) | 0.03 |
| Others | 1 (9.1) | 4 (28.6) | 0.23 |

| | No Hypertension | Hypertension | p |
|---|---|---|---|
| | Number (%) | Number (%) | χ2 test |
| Number | 9 | 16 | |
| First Degree AVB | 4 (44.4) | 6 (37.5) | 0.73 |
| Complete RBBB | 3 (33.3) | 7 (43.8) | 0.61 |
| Others | 2 (22.2) | 3 (18.8) | 0.83 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Number (%) | Number (%) | χ2 test | Number (%) |
| Number | 8 | 17 | | 25 |
| First Degree AVB | 3 (37.5)) | 7 (41.2) | 0.86 | 10 (40.0) |
| Complete RBBB | 4 (50.0) | 6 (35.3) | 0.48 | 10 (40.0) |
| Others | 1 (12.5) | 4 (23.5) | 0.52 | 5 (20.0) |

***Table 4.*** *Prevalence of ST-T changes by sex, hypertension and DM.*

| | Male | Female | p |
|---|---|---|---|
| | Number (%)) | Number (%) | χ2 test |
| Number | 33 | 39 | |
| Non Specific ST-T Changes | 11 (33.3) | 21 (53.9) | 0.08 |
| Suggestive of LVH | 6 (18.2) | 6 (15.4) | 0.75 |
| Suggestive of RBBB | 3 (9.1) | 3 (7.7) | 083 |
| Others | 13 (39.4) | 9 (23.1) | 0.13 |

| | No Hypertension | Hypertension | p |
|---|---|---|---|
| | Number (%) | Number (%) | χ2 test |
| Number | 14 | 58 | |
| Non Specific ST-T Changes | 6 (42.9) | 26 (44.8) | 0.89 |
| Suggestive of LVH | 1 (7.1) | 11 (19.0) | 0.29 |
| Suggestive of RBBB | 1 (7.1) | 5 (8.6) | 0.86 |
| Others | 6 (42.9) | 16 (27.6) | 0.27 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Number (%) | Number (%) | χ2 test | Number (%) |
| Number | 24 | 48 | | 72 |
| Non Specific ST-T Changes | 7 (29.2) | 25 (52.1) | 0.07 | 32 (44.4) |
| Suggestive of LVH | 5 (20.8) | 7 (14.6) | 0.50 | 12 (16.7) |
| Suggestive of RBBB | 2 (8.3) | 4 (8.3) | 0.99 | 6 (8.3) |
| Others | 10 (41.7) | 12 (25.0) | 0.15 | 22 (30.6) |

***Table 5.*** *Prevalence of pathological Q waves by sex, hypertension and DM.*

| | Male | Female | p |
|---|---|---|---|
| | Number (%)) | Number (%) | χ2 test |
| Number | 10 | 10 | |
| Anterolateral MI | 4 (40.0) | 1 (10.0) | 0.12 |
| Anteroseptal MI | 1 (10.0) | 4 (40.0) | 0.12 |
| Inferior MI | 2 (20.0) | 4 (40.0) | 0.33 |
| Septal MI | 3 (30.0) | 1 (10.0) | 0.26 |

| | No Hypertension | Hypertension | p |
|---|---|---|---|
| | Number (%) | Number (%) | χ2 test |
| Number | 4 | 16 | |
| Anterolateral MI | 1 (25.0) | 4 (25.0) | 0.99 |
| Anteroseptal MI | 0 (0) | 5 (31.3) | 0.20 |
| Inferior MI | 1 (25.0) | 5 (31.3) | 0.81 |
| Septal MI | 2 (50.0) | 2 (12.5) | 0.09 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Number (%) | Number (%) | χ2 test | Number (%) |
| Number | 8 | 12 | | 20 |
| Anterolateral MI | 2 (25.0) | 3 (25.0) | 0.99 | 5 (25.0) |
| Anteroseptal MI | 2 (25.0) | 3 (25.0) | 0.99 | 5 (25.0) |
| Inferior MI | 1 (12.5) | 5 (41.7) | 0.16 | 6 (30.0) |
| Septal MI | 3 (37.5) | 1 (8.3) | 0.11 | 4 (20.0) |

Table 6 shows the mean values of the various standard measurements from the ECG. The mean ECG heart rate was 81.7 (15.4) per minute, and the rate was significantly higher in the females and participants who did not have DM. Mean SV1 + RV5 or RV6 was significantly higher in the males, hypertension and the non-DM participants. Mean QT duration was 0.36 (0.04), mean RR duration was 0.76 (0.14) while mean QT corrected which is derived from the preceding parameters was 0.41 (0.04).

***Table 6.*** *Prevalence of ST-T changes by sex, hypertension and DM.*

| | Male | Female | p |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | t test |
| Number | 210 | 362 | |
| Rate (per min) | 78.4 (13.6) | 83.7 (16.1) | <0.001 |
| SV1 + RV5 or RV6 (mm) | 29.4 (8.8) | 25.1 (7.8) | <0.0001 |
| QT Duration (s) | 0.36 (0.03) | 0.36 (0.04) | 0.58 |
| RR Duration (s) | 0.79 (0.14) | 0.74 (0.14) | <0.001 |
| QT Corrected (s) | 0.42 (0.05) | 0.40 (0.03) | <0.001 |

| | No Hypertension | Hypertension | p |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | t test |
| Number | 230 | 342 | |
| Rate (per min) | 80.4 (14.4) | 82.6 (16.0) | 0.10 |
| SV1 + RV5 or RV6 (mm) | 25.1 (8.2) | 27.7 (8.4) | <0.001 |
| QT Duration (s) | 0.35 (0.05) | 0.36 (0.03) | 0.42 |
| RR Duration (s) | 0.77 (0.14) | 0.75 (0.14) | 0.23 |
| QT Corrected (s) | 0.41 (0.06) | 0.41 (0.03) | 0.07 |

| | No DM | DM | p | All |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | t test | Mean (SD) |
| Number | 184 | 388 | | 572 |
| Rate (per min) | 78.8 (15.6) | 83.1 (15.2) | <0.01 | 81.7 (15.4) |
| SV1 + RV5 or RV6 (mm) | 28.3 (9.7) | 25.9 (7.7) | <0.01 | 26.7 (8.5) |
| QT Duration (s) | 0.36 (0.04) | 0.35 (0.04) | <0.01 | 0.36 (0.04) |
| RR Duration (s) | 0.79 (0.14) | 0.75 (0.15) | <0.001 | 0.76 (0.14) |
| QT Corrected (s) | 0.41 (0.03) | 0.41 (0.05) | 0.98 | 0.41 (0.04) |

## 4. Discussion

This study has shown that ECG abnormalities are very common among the patients attending clinics in the medical department at KATH. Almost 60% had one or more ECG abnormalities while at least one patient had 6 different kinds of these abnormalities. The commonest abnormality was prolonged QT (23%) followed by LVH (16%), axis deviation (15%), LAE (14%) and ST-T changes (13%). And all these abnormalities were significantly common in patients with hypertension and males with the exception of prolonged QT which was more common in the females.

ECGs are commonly used in cardiovascular studies in participants with particular disease condition like hypertension, heart failure or cardiomyopathy and in a few cases in healthy subjects. The results of these studies in most instances may not include detailed reports of the ECG findings since the focus may be on the disease condition being studied. Ogunlade et al studied the ECGs of 353 healthy young adults in South – Western Nigeria. They reported on the mean parameters of the various measurements of the ECG and found early repolarization to be the commonest abnormality and this was significantly common in the male subjects [10]. Other studies have been undertaken in heart failure patients, chronic kidney disease, sickle cell disease and normal pregnancy [11-17]. Okoye and Anyabolu have studied the ECG abnormalities in treatment-naïve HIV-positive patients in Enugu, south-east Nigeria. ECG abnormalities were significantly more common in HIV-positive patients than in the HIV-negative subjects. The prevalence of abnormal ECG was 70% in the HIV-positive patients, and commonest abnormalities were sinus bradycardia in 64%, QTC prolongation in 48%, ST depression in 30% and T-wave inversion in 22% of the HIV-positive patients [18]. In a study of 1443 acute coronary syndrome elderly patients undergoing percutaneous coronary intervention during index admission as part of Elderly-ACS 2 multicenter randomized trial Morici and others found 41% of patients as having ST Elevation Myocardial Infarction, and 59% had Non-ST Elevation ACS (48% Non-ST Elevation Myocardial Infarction and 11% unstable angina) based on their ECG [19]. Recently Baladi et al have studied the frequency of ECG changes in patients with primary hyperthyroidism in Karachi. Atrial fibrillation was observed in 12% of cases and sinus tachycardia was found in 60% of the patients [20].

Nkum et al has reported on the ECG findings of hypertensive and non-hypertensive Gambians. There were 5 participants with complete left bundle branch block but none with either complete right bundle branch block or atrial fibrillation. The prevalence of ECG LVH was 57.5% among the hypertensives which was significantly higher than 36.8% in the non-hypertensives ($p < 0.01$) [21]. In a study of 70 Nigerians with hypertensive heart disease and 68 healthy controls, Opadijo and others found a positive correlation between LVH and QTc prolongation and also between QTc prolongation and frequency of ventricular arrhythmias. The prevalence of cardiac arrhythmias was 20.0% while that of QTc prolongation was 14.3%. In addition 3 patients had premature ventricular contractions [22]. In a comparative ECG study of 340 normal Nigerians and 288 hypertension patients, Araoye and others established that the QRS voltage was high in normal Nigerian (compared to Caucasians) but was significantly higher in the Nigerian patients with hypertension. Furthermore in the hypertensives, the amplitude of the T wave diminishes resulting in the flattening of ST-T segment or down-sloping ST-segment with asymmetric T inversion, the so called "strain pattern" [23].

Another study from the Hypertension Clinics of the University of Nigeria Teaching Hospital Enugu, Nigeria has shown that a significant proportion of patients with hypertension present initially with significant rhythm disturbances. Out of 346 consecutive hypertensive subjects, 75 (27%) of them had arrhythmias, 28.2% of all the females had arrhythmias while 26.9% of all the male subjects had arrhythmias. The commonest arrhythmias were atrial fibrillation, sinus tachycardia, sinus bradycardia and multiple ventricular ectopics [24]. In another Nigerian study of 140 newly diagnosed hypertensive patients and 70 controls maximum QT and corrected maximum QT intervals were found to be significantly higher among hypertensive subjects compared to the controls. Seventy three (52.14%) of the hypertensive subjects had corrected maximum QT intervals >440ms compared to 21.43% of controls, P=0.01. The prevalence of LVH was 51.4% in the hypertensive patients compared to 11.4% in the controls ($p <0.001$) [25]. In our current study the commonest ECG abnormalities in patients with hypertension were, prolonged QT (28%) followed by LVH (19%), axis deviation (18%), LAE (17%) and ST-T changes (17%) and the prevalence of all these abnormalities were significantly higher in those with hypertension compared to participants without hypertension. However even though prevalence of prolonged QT was higher in the participants with hypertension, both mean QT duration and mean corrected QT duration were similar in those with

and without hypertension.

A 2011 study involving 200 hypertensive and normotensive type 2 diabetic females who were seen at the University of Port Harcourt Teaching Hospital, Rivers State, Nigeria revealed that 16.5% of the hypertensive and 13.0% of the normotensive diabetics had ECG LVH. The common ECG abnormalities among the normotensive diabetics were atrial flutter and other arrhythmias while in the hypertensive diabetics' right ventricular hypertrophy, left atrial block and bifascicular block were common [26]. In the Gambia, Jobe et al studied ECG LVH among 415 diabetic patients attending the teaching hospital. The prevalence of ECG LVH was 35.2% and was common in females compared to the male patients (39.5% vs 24.8%, $p < 0.01$). Hypertension was more prevalent in the diabetics with ECG LVH (66.4%) than in those without ECG LVH (56.5%) (P=0.06) [27]. From two tertiary level hospitals in Cameroon, Dzudie et al, recruited 420 type 2 DM patients and the commonest ECG aberrations were ectopic beats (4.8%), prolonged corrected QT (10.2%), conduction defects (11.9%), ischaemic heart disease (13.6%), arrhythmia (16.2%), LVH (16.4%) and T-wave abnormalities (20.9%) [28]. The commonest ECG abnormalities among the DM patients in our study were prolonged QT (24%) followed by axis deviation (16%), LVH (13%), ST-T changes (13%) and LAE (13%). The prevalence of these abnormalities were not significantly different from those without DM with the exception of the prevalence of LVH which was significantly lower than the prevalence of 23% in the participants without DM.

Atrial fibrillation is the most common cardiac arrhythmia worldwide as well as in Africa [29-30]. It is more common in men than women [31]. Anisiuba et al in Enugu, Nigeria found 3.5% of 860 ECG to have atrial fibrillation and this was more common in males. Systemic hypertension (33.3%) was the most common underlying disease among these patients with atrial fibrillation [32]. In Lagos, Nigeria, a study of 39 patients with atrial fibrillation reported the causes as hypertension (46.2%), dilated cardiomyopathy (20.8%), rheumatic heart disease (17.9%), thyrotoxic heart disease (7.7%), hypertrophic cardiomyopathy (5.1%), endomyocardial fibrosis and idiopathic causes (2.6%) [33]. In our study however even though there were 6 cases of arryhythmias there were no cases of atrial fibrillation. This is more surprising since atrial fibrillation is common in hypertension and we had studied about 342 cases of hypertension. In a retrospective, case-based analysis of patients attending the Cardiac Clinic at Groote Schuur Hospital in South Africa, 15% (n = 42) of patients were identified as having lone AF out of 289 patients with AF. Of these lone AF patients 29% had persistent AF, 15% had paroxysmal AF while 12% progressed from paroxysmal to permanent AF [34].

Two main cardiovascular studies have been conducted in KATH. The first was a 2004 – 2005 study on in patients with heart failure and the second on cardiac clinic outpatients with heart failure in 2013. In the first study, out of 167 in patients with heart failure, 111 (66.5%) had ECG LVH. Further 71 (42.5%) of these heart failure cases were as a result of hypertension. Out of these 71 with hypertensive heart failure, 65 (91.5%) had ECG LVH and other ECG findings seen included: left axis deviation 44 (17.0%), left atrial enlargement 30 (42.3%) and complete bundle branch block 11 (15.5%). In the second study, 398 outpatients with heart failure were studied and 179 (45.0%) of these patients had hypertension. The prevalence of ECG LVH was 43.7% in these heart failure patients. The other ECG abnormalities included: left axis deviation (39.6%), left bundle branch block (19.2%), and left atrial enlargement (25.6%), ventricular extrasystoles (11.2%), atrial fibrillation (8.9%), complete heart block (5.3%), and ventricular tachycardia (3.6%) [35-40]. Our study in general medical outpatients cannot be compared directly to these cardiac patients but what it shows generally is that the prevalence of the various ECG abnormalities are lower than in the heart failure patients.

Our study demonstrates the importance of conducting ECG examination in outpatients particularly in patients with hypertension and diabetes who may present with no cardiac complications warranting cardiology referral. Even in the group who had neither diabetes nor hypertension more than half of the participants had one or more ECG abnormalities. There is therefore the need for more ECG examination among patients reporting at these outpatient clinics. The presence of these abnormalities in normotensives and patients without DM suggests that they should be closely monitored for the development of these medical conditions.

## 5. Conclusion

In conclusion this study has shown that ECG abnormalities were very prevalent among the medical outpatients attending clinics in the medical department at KATH. These abnormalities were more common in the males and in the patients with hypertension. There is therefore the need for the conduction of ECG examination in outpatients who may present with no cardiac complications warranting cardiology referral especially in patients with diabetes and hypertension.

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