HOSPITAL FREQUENCY OF ELECTROCARDIOGRAPHIC LEFT VENTRICULAR HYPERTROPHY IN UNIVERSITY COLLEGE HOSPITAL, IBADAN, NIGERIA

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ABSTRACT

Background and Objective: **Left ventricular hypertrophy (LVH) is an increase in left ventricular mass due to an increase in cardiomyocyte size. It is said to be a strong predictor of cardiovascular diseases. Detection of LVH is important as early diagnosis and initiation of measures can reduce/halt progression or even cause regression, resulting in prevention or delay of unfavourable cardiovascular outcomes. There is limited data on the frequency of electrocardiographic LVH in hospital population (in-patient and out-patient) in Nigeria. Therefore, the study aimed to estimate the frequency of ECG-diagnosed LVH in hospital patients in Ibadan.**

Method: **The study was conducted at the cardiology unit of UCH, Ibadan. 12-Lead ECGs done between 01/01/2023 to 30/06/2023 for adult men and women 18 years and above were studied. Diagnosis of LVH was based on either Sokolow-Lyon or Cornell voltage criteria.**

Result: **A total of 1678 tracings were analyzed (male – 701, female - 977). LVH was present in 399 tracings (23.8%, 238 cases per thousand), and was significantly more frequent in males than females (28.8% vs. 20.16%). Frequency increased with increasing age. LVH was noted to be significantly associated with incident atrial fibrillation (AF), other arrhythmias, and left atrial enlargement with odds ratios of 3.29 (95% CI: 1.60–6.80), 1.74 (95% CI: 1.17–2.58) and 3.35 (95% CI: 2.52–4.46) respectively.**

Conclusion: **The frequency of ECG-detected LVH was 23.8% in UCH. It was predominantly seen in males and significantly associated with AF, other arrhythmias and left atrial enlargement.**

Keywords: Left ventricular hypertrophy, Frequency, Electrocardiography, Ibadan, Nigeria.

INTRODUCTION

Left ventricular hypertrophy (LVH) is a response of the heart to increased haemodynamic load that involves the increase in muscle mass of the heart through hypertrophy of cardiac myocytes.[1] It can be a physiological process as seen in athletes or a pathological condition as seen in hypertension and aortic stenosis.[2] Hypertension is generally the most common aetiological risk factor for LVH.[3] The incidence of LVH has been shown to be ten times higher in patients with a blood pressure of ≥160/95.[4]

An increase in left ventricular mass (LVM) in LVH is associated with changes in QRS and T patterns on the traditional 12-lead ECG[5] and is therefore, one of the methods of diagnosing LVH. It is fundamental in the initial assessment of patients due to its simplicity, accessibility and affordability.[6] Although it has been shown that ECG-predicted LVH (ECG-LVH) is not an objective assessment of anatomical LVH, it still serves as an important predictor of cardiovascular disease-related morbidity and mortality.[5] ECG-LVH has also been documented as an independent cardiovascular risk factor.[7] Detection of ECG-LVH is, therefore, of utmost importance for early diagnosis and initiation of therapeutic measures to reduce or halt progression or even cause regression, resulting in prevention or delay of unfavourable cardiovascular outcomes.

In high-income countries, the epidemiology of ECG-LVH is well documented, with the mean prevalence ranging between 12% and 19% among 50-59-year-olds in Finnish and Moscow cohorts[8,9,10], and as low as 0.63% in British civil servants.[11] However, in a predominantly black population from Jamaica, the mean prevalence was documented as 29% among 40-49-year-olds.

There is a paucity of data describing ECG-diagnosed LVH in the hospital population in Nigeria and Africa. In a community-based study in Niger State, a prevalence of 16.8% was documented.[12] One study estimated a mean prevalence of 48.8% among hypertensive patients in Benin City.[13] Another study found a prevalence of about 64.4% and 51.4% in ischemic and haemorrhagic stroke patients respectively.[14]

The objective of this study was, therefore to estimate the frequency of ECG-diagnosed -LVH in inpatient and outpatient population at Ibadan at the University College Hospital, Ibadan, Nigeria.

MATERIAL AND METHODS

Study design, population and setting

This is a hospital-based retrospective observational study, conducted at the cardiology unit of the Department of Medicine. All the 12 lead ECGs conducted in adult patients from January 1, 2023, to June 30, 2023, were collected and analysed. This includes 12 lead ECGs done on routine checkup, as part of evaluation for non-communicable diseases such as hypertension, heart diseases, diabetes mellitus, stroke etc. There are six ECG stations for adult patients in the hospital; the ECG unit, medical outpatient, general outpatient, geriatric centre, emergency department and the private wing of the hospital. 12-lead ECGs conducted in individuals less than 18 years, repeated measurements and poor-quality ECGs were excluded.

12-lead Electrocardiography

All the 12-lead ECGs were performed by trained ECG technicians using standard methods. CONTEC™ ECG Workstation, Model: CONTEC-8000G (Contec Medical Systems Co., Ltd, Qinhuangdao, Hebel Province, CHINA.) Electrocardiograph was used in obtaining the resting ECGs. All the ECG machines were set at standard calibration (a speed of 25mm/sec and sensitivity of 10mm/mV)

Diagnosis of LVH

LVH was diagnosed using either Sokolow-Lyon or Cornell voltage criteria as follows: sum of the amplitudes of S wave in V1 and R wave in V5 or V6 > 3.5 mV for Sokolow-Lyon Voltage criteria,[15] and sum of the amplitudes of S wave in lead V3 and R-wave in aVL >2.0mV in women or >2.8mV in men for the Cornell voltage.[16]

Ethical consideration

Ethics approval was obtained from the Joint University of Ibadan/University College Hospital ethics review committee as part of the Nigerian atrial fibrillation registry study (UI/EC/23/0193). Consent was not obtained from the patient since it was a retrospective study. The study conformed to ethical standards as enshrined in the Declaration of Helsinki on research on human subjects.[17]

Statistical analysis

All data collected were entered into IBM SPSS statistical software (IBM Corporation, 2011). Continuous variables were summarised as mean ± SD while frequencies were expressed as proportions. The correlation or relationship between presence of LVH and other ECG abnormalities was performed using the Spearman correlation coefficient. The relation between LVH and presence of other 12 lead ECG abnormalities such as atrial fibrillations, other rhythm abnormalities, atrial enlargement, conduction abnormalities, presence of poor R-wave progression, presence of Q-waves, ST-segment abnormalities and T-wave abnormalities were assessed using chi-square statistics. A p-value of <0.05 was considered significant.

RESULTS

A total of 1678 12- lead ECGs were conducted in adult subjects during the period. There were 977 females (58.2%) and 701 males (41.8%). The age distribution of the subjects is as shown in table 1. About 50% were in the 40-59-year age group. The mean age

Table 1: Age distribution according to gender

Age group	All(n=1678)	Males (n=701)	Females(n=977)
<20	17(1.0)	7(1.0)	10(1.0)
20-29	126(7.5)	55(7.8)	71(7.3)
30-39	228(13.6)	74(10.6)	154(15.8)
40-49	398(23.7)	128(18.3)	270(27.6)
50-59	391(23.3)	169(24.1)	222(22.7)
60-69	300(17.9)	146(20.8)	154(15.8)
70-79	218(13.0)	122(17.4)	96(9.8)

of all the subjects was 51.46 ± 15.15 years (53.83 ± 15.90 for males and 49.77 ± 14.35 years for females, $p < 0.001$)

Table 2 shows the main indications for the procedure. Three hundred and ninety-nine subjects (23.8%) fulfilled the criteria for LVH either by the Sokolow-Lyon criteria and/or the Cornell voltage criteria. The mean age of those with LVH was 52.61 ± 14.67 years compared to 51.11 ± 15.28 years for the 1279 subjects without LVH (p= 0.840).

Table 3 shows the prevalence of LVH according to gender. LVH was commoner in males 202 (28.8%)

Table 2: Indications for 12-lead ECG

Variables	Frequency (1678)	Percentage
No indication supplied	723	43.1
Hypertension	380	22.6
Chest pain	130	7.7
Pre-Surgery	110	6.6
Routine Checkup/Pre-employment/Pre-School	74	4.4
Palpitation	56	3.3
Dyspnoea/Easy Fatigability/Breathlessness	28	1.7
Heart Failure	24	1.4
Stroke	18	1.1
Myocardial Infarction/ACS/IHD	16	1.0
Pre-Chemotherapy	15	0.9
Syncopal Attack	15	0.9
Hypertension And DM	11	0.7
Arrhythmia	10	0.6
Bradycardia	10	0.6
DM	7	0.4
Leg Swelling	6	0.4
SCD	6	0.4
Tachycardia	6	0.4
Others	32	1.9

ACS= Acute coronary syndrome, IHD= Ischaemic heart disease, DM= Diabetes Mellitus, SCD= Sickle cell disease

Table 3: Prevalence of LVH according to gender

Age group	Male (n=701)	Female (977)	Total (n=1678)
LVH	202(28.8)	197(20.2)	399(23.8)
No LVH	499 (71.2)	780(79.8)	1279(76.2)

P<0.001, LVH= Left ventricular hypertrophy

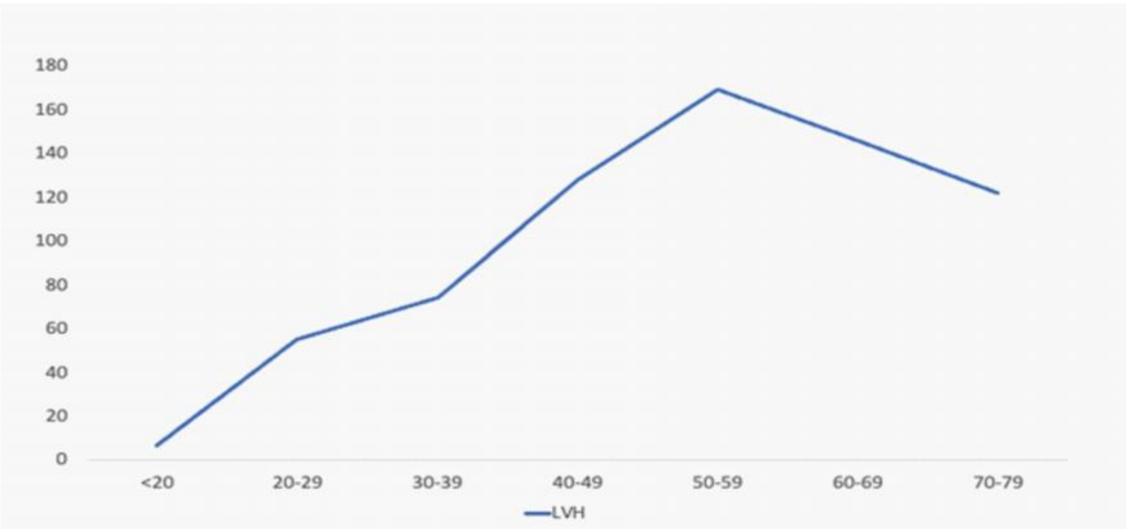

Figure 1: Frequency of LVH in the participants according to age group

vs. 197 (20.2%) in females and this was statistically significant (P < 0.001).

Figure 1 shows the frequency of LVH according to age group. This increased with age up to the age group 50 – 59 years.

Table 4 shows the baseline ECG parameters according to LVH status. The majority of the variables were not normally distributed hence; non-parametric testing was applied. The heart rate, QRS duration and corrected QT interval (QTc) were significantly higher in subjects with LVH (p=0.023, < 0.001 and 0.004 respectively).

Table 4: Baseline ECG parameters in the study participants

Variables	LVH	No LVH	P-value
Heart rate			
Mean (SD)	85.68±18.52	83.38±18.26	0.030
Median (IQR)	83(23)	81(22)	0.023
QRS axis (degree)			
Mean (SD)	22.55±37.10	22.46±43.89	0.971
Median (IQR)	27.8(41.0)	27.4(45.2)	0.052
P interval (msec)			
Mean (SD)	106.36±24.81	105.28±26.33	0.475
Median (IQR)	101(25)	100(24)	0.143
PR interval (msec)			
Mean (SD)	159.03±42.00	157.39±30.43	0.404
Median (IQR)	153(35)	155(35)	0.671
QRS interval (msec)			
Mean (SD)	97.42±15.08	92.07±18.14	<0.001
Median (IQR)	94(14)	89(13)	<0.001
QT interval (msec)			
Mean (SD)	376.32±64.74	377.16±55.70	0.801
Median (IQR)	378(62)	379(52)	0.895
QTc (msec)			
Mean (SD)	440.50±51.23	439.34±162.55	0.889
Median (IQR)	441(49)	436(41)	0.004

LVH= Left ventricular hypertrophy, SD= standard deviation, IQR= Interquartile range

Table 5: Relationship of LVH to ECG variables

Variables	LVH	No LVH	χ^2	P-value
Rhythm abnormalities				
Yes	79(19.8)	241(18.8)	0.180	0.671
No	320(80.2)	1038(81.2)		
Atrial Fibrillation				
Yes	15(3.8)	15(1.2)	11.588	0.001
No	384(96.2)	1264(98.8)		
Atrial enlargement				
None	255(63.9)	1127(88.1)	129.266	<0.001
RAE	11(2.8)	11(0.9)		
LAE	110(27.6)	129(10.1)		
BAE	18(4.5)	9(0.7)		
Indeterminate	5(1.3)	3(0.2)		
Conduction abnormalities				
Yes	42(10.5)	133(10.4)	0.005	0.942
No	357(89.5)	1146(89.6)		
Poor R-wave progression				
Yes	12(3.0)	21(1.6)	2.942	0.086
No	387(97.0)	1258(98.4)		
Presence of Q-waves				
Yes	14(3.6)	46(3.6)	0.004	0.949
No	380(96.4)	1224(96.4)		
ST segment abnormalities				
None	360(91.8)	1230(96.9)	25.199	<0.001
ST elevation	7(1.8)	18(1.4)		
ST depression	25(6.4)	21(1.7)		
T wave abnormalities				
None	289(73.7)	1083(85.3)	37.108	<0.001
Tall and peaked T waves	5(1.3)	4(0.3)		
Low amplitude isoelectric T waves	3(0.8)	11(0.9)		
Biphasic T waves	10(2.6)	7(0.6)		
Biphasic T waves with terminal negativity	3(0.8)	5(0.4)		
Inverted T waves	82(20.9)	159(12.5)		

LVH= Left ventricular hypertrophy, RAE= Right atrial enlargement, LAE= Left atrial enlargement, BAE= Biatrial enlargement.

Table 5 depicts the relationship of LVH to other major ECG abnormalities. The presence of ECG-LVH was strongly associated with atrial fibrillation (OR 3.29 (95% CI: 1.60–6.80), χ^2= 11.59, p=0.001). ST–segment abnormalities (χ^2 = 25.20, p < 0.001) and the presence of left atrial enlargement (OR 3.35 (95% CI: 2.52–4.46), χ^2 =129.3, p < 0.001).

DISCUSSION

This hospital-based study suggests the frequency of LVH of 23.8% or about 238 cases per 1000 hospital patients. We also noted that ECG-LVH is more common in males compared to female patients with a prevalence of 28.8% and 20.2% respectively. ECG-LVH rates also rise with age with the highest frequency among patients between 50-59 years old. In addition, we observed that ECG-LVH was significantly associated with atrial fibrillation, S-T segment abnormalities and atrial enlargement.

ECG-LVH has been documented to occur in 0.1-4% of the in-patient and outpatient hospital population in high-income countries.[18] Conversely, a prevalence similar to our finding was reported among inpatient and outpatient hospital population in a Tanzanian study (33.2%).[19] The disparity in prevalence may be due to ECGs being routine investigations in higher-income countries as compared to low income where indications are required.[18] Another Nigerian study conducted on a predominantly rural population in Rivers State found a prevalence of ECG-LVH of 16.4%.[12] The higher frequency found among inpatients and outpatient hospital population is likely due to selection as most hospital patients needing an ECG would have at least one cardiovascular risk factor. As shown in this study, the most common indication for ECG was hypertension.

Other authors have documented a preponderance of ECG-LVH in males.[12,19] This could be explained by the higher prevalence of risk factors for LVH in males such as hypertension, diabetes mellitus, and degenerative valvular heart disease.[20] Some researchers have also suggested that sex is an independent determinant of LVH.[21] However a cohort study conducted on 75,412 and 107,954 males and females respectively in North California documented higher rates in females.[18] The differences may be due to patient selection and differences in age structure and burden of cardiovascular risk factors.

We also demonstrated in this study that ECG-LVH increases with age, similar to other studies.[3,12] A plausible explanation for this is the higher prevalence of risk factors for cardiovascular disease with increasing age. A peak incidence was found among 50-59 year old in the Framingham study[3] just as in this study.

The indications for the 12-lead ECG in this study were mainly cardiovascular with hypertension (22.6%) being the commonest reason for the ECG request in this hospital population. Other notable indications include chest pain (7.7%), pre-surgery (6.6%), routine check-up (4.4%), palpitation (3.3%), dyspnoea or easy fatiguability (1.7%), heart failure (1.4%) and stroke (1.1%). This may explain in part the high frequency of ECG-LVH in this study as hypertension is an independent risk factor for LVH.[22]

We also found a strong association between ECG-LVH, atrial fibrillation and left atrial enlargement. This is not surprising as these conditions share risk factors with LVH. Other studies have reported a prevalence of LVH in patients with atrial fibrillation ranging from 23% to 68%.[23-25] LVH has also been documented as an independent predictor of left atrial enlargement in hypertensive patients.[26]

Potential strengths and limitations of the study

The study's significant strength lies in the examination of a large number of patients over a 6-month period, with all electrocardiograms (ECGs) conducted within the hospital setting and the inclusion of both Sokolow-Lyon and Cornell criteria for diagnosis of ECG-LVH. However, limitations should be noted. The study's hospital-based nature raises concerns about its generalizability to the broader community, potentially not providing an accurate representation of ECG-LVH prevalence in the general population. Additionally, the study may have primarily captured symptomatic patients, possibly overlooking asymptomatic individuals. Notably, our healthcare system relies predominantly on out-of-pocket payments, which might have led to the omission of some patients who were unable to afford the costs. Additionally, the lack of accurate clinical information for many of the ECG requests is a limitation as 43.1% had no documented indication for the request. The study also did not specifically aim to identify risk factors for ECG-LVH, and it did not assess structural heart abnormalities or biomarkers, as these aspects were not within the study's objectives.

Consequent to our findings, ECG is useful in the early detection and early initiation of therapy in LVH, especially in patients with high-risk factors such as hypertension. The persistence of voltage abnormalities may also be an indication of the presence of cardiac disease in those with LVH. The associated abnormalities detectable on ECG, such as left atrial enlargement and atrial fibrillation, may also offer added clinical information in patients with ECG-diagnosed LVH.

RECOMMENDATIONS

Left ventricular hypertrophy has been implicated as a potential cause of sudden cardiac death.[27] The goal would be to include routine ECG screening for LVH for all patients above 40 years, regardless of presenting complaint or reason of encounter. This would provide a better representation of the frequency of LVH in the patients presenting to the hospital.

In addition, to ensure that every patient above 40 years is captured, it would be beneficial to train internal medicine residents, emergency physicians and nurses to be able to perform 12-lead ECGs in the hospital.

CONCLUSION

In conclusion, ECG-LVH is common in hospital patients at the University College Hospital Ibadan, and hypertension is the commonest risk factor. Patients with this abnormality have a higher risk of left atrial abnormalities and atrial fibrillation.

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