ELECTROCARDIOGRAPHIC AND ECHOCARDIOGRAPHIC EVALUATION OF LEFT VENTRICULAR HYPERTROPHY IN HYPERTENSIVE PATIENTS- A HOSPITAL-BASED STUDY

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ABSTRACT

BACKGROUND

Left ventricular hypertrophy is associated with increased risk of cardiovascular morbidity and mortality, so its early detection is of major importance for initiation of treatment and its reversal by certain antihypertensive drugs like ARB and ACE inhibitors. The commonly employed technique for detection of LVH are echocardiography and electrocardiography. Although, ECG is a cost-effective tool to detect LVH, but its reliability is often questioned when compared to Gold Standard Echocardiography.

The aim of the study is to determine the electrocardiographic and echocardiographic findings of LVH in hypertensive patients and to find out the sensitivity of electrocardiography in comparison to echocardiography in determining LVH in these patients.

MATERIALS AND METHODS

The study is a hospital-based observational study, conducted on 108 Hypertensive patients admitted in Medicine and Geriatrics ward and visited Outpatient Department of Medicine in Gauhati Medical College, Guwahati during the period from August 2016 to July 2017 after considering inclusion and exclusion criteria.

Inclusion Criteria- Age more than 12 years with Essential or Secondary Hypertension.

Exclusion Criteria- Myocardial ischaemia, cardiomyopathy, valvular heart disease and eccentric hypertrophy and bundle branch block, evidence of MI and arrhythmias on ECG. Clinical and laboratory findings were recorded in preformed proforma. Statistical analysis was performed using Microsoft Excel and GraphPad InStat 3.1 version software.

RESULTS

The study included a total of 108 Hypertensive patients, out of which 60 (56%) were males and 48 (44%) were females. 82 (75.92%) had LVH by echocardiography and 37 (34.26%) had LVH by electrocardiography. Sensitivity and specificity of ECG in diagnosing LVH is 40.24% and 86.66% respectively in comparison to echocardiography. Sensitivity is highest for Cornell Voltage criteria (40.24%) and lowest for Sokolow-Lyon index criteria (34.14%).

CONCLUSION

Our study shows that echocardiography is undoubtedly a better instrument for determination of Left Ventricular Hypertrophy. The study also reveals the fact that although ECG is a poor screening tool due to its low sensitivity, but because of its high specificity various factors determining LVH may independently effect determination of LVH.

KEYWORDS

Hypertension, Left Ventricular Hypertrophy, Electrocardiography, Echocardiography, Sensitivity.

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BACKGROUND

Left ventricular Hypertrophy is a compensatory adaptive mechanism against increased afterload to reduce wall stress and maintain pump function and is commonly seen in hypertensive patients.

LVH is not only an adaptation to raised haemodynamic load in hypertension, but also independently associated with an enhanced risk for myocardial infarction, sudden cardiac death, congestive heart failure and stroke in general population as well as in patients with systemic hypertension.[1,2] The Framingham heart study have shown the prevalence of LVH to be less than 3% using electrocardiography in general population.[3] Using echocardiography, Framingham investigators have shown the prevalence of LVH to be 16% among men and 19% among women.[4] As, LVH is associated with increased risk of cardiovascular morbidity and mortality, so its early detection is of major importance for initiation of treatment and its reversal by certain antihypertensive drugs like ARB and ACE inhibitors. Left ventricular hypertrophy (LVH) detected either by electrocardiography or echocardiography, has long been recognised as a powerful predictor of serious cardiovascular sequelae.[1,2] Even in group of Hypertensive patients, where ECG and chest x-ray are normal 30% - 40% patients show echocardiographic evidence of LVH.[5]

Aims and Objectives

1. To determine the electrocardiographic and echocardiographic findings of LVH in hypertensive patients.

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2. To find out the sensitivity and specificity of electrocardiography in comparison to echocardiography in determining LVH in these patients.

MATERIALS AND METHODS

The study is a hospital-based, observational study conducted in 108 Hypertensive patients, admitted in Medicine and Geriatrics Ward and visited Outpatient Department of Medicine in Gauhati Medical College, Guwahati during the period from August 2016 to July 2017 after considering inclusion and exclusion criteria.

Inclusion Criteria

Age more than 12 years with Essential or Secondary Hypertension.

Exclusion Criteria

Myocardial ischaemia, valvular heart disease, cardiomyopathy and eccentric hypertrophy and bundle branch block, evidence of MI and arrhythmias on ECG.

All the patients fulfilling above criteria were subjected to a thorough history and complete examination including general examination and systemic examination with special reference to cardiovascular system. Blood pressure was taken with the help of mercury sphygmomanometer based on the latest recommendation by the seventh report of the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure.[6] Hypertension was defined according to JNC 7 criteria as systolic BP >= 140 mmHg and diastolic BP >= 90 mmHg. Blood for CBC, ESR (mmAEFH), Liver function test, RBS, CXR (PA View), serum TSH and relevant laboratory investigations were done where indicated.

All the patients were subjected to ECG employing BPL CARDIART 108 T-DIGI and ECHO with colour Doppler employing Siemens Acuson CV70 present in the Department of Cardiology. ECG criteria used in this study were Sokolow-Lyon index, Romhilt-Estes score and Cornell voltage criteria.

Measurement	Criteria	
Sokolow-Lyon Index	S_{V1} + (R_{V5} or R_{V6}) > 3.5 Mv	
Romhilt-Estes Point Score System*	Any limb lead R-wave or S-wave ≥ 2.0 mV	3 points
	or S_{V1} or S_{V2} ≥ 3.0 Mv	3 points
	or R_{V5} to R_{V6} ≥ 3.0 Mv	3 points
	ST-T wave abnormality (No Digitalis Therapy)	3 points
	ST-T wave abnormality (Digitalis Therapy)	1 point
	Left atrial abnormality	3 points
	Left axis deviation (≥ 30 degrees)	2 points
	QRS duration ≥ 90 msec	1 point
	Intrinsicoid deflection in V_5 or V_5 ≥ 50 msec	1 point
Cornell Voltage Criteria	S_{V3} + S_{aVl} ≥ 2.8 mV (for men)	
	S_{V3} + S_{aVl} ≥ 2.0 mV (for women)	

For Romhilt-Estes point score, a score of more than equal to 5 was suggestive of LVH. The left ventricular mass index (LVMI) was calculated using Dubois Formula and expressed in gram/square meter. In females, LVMI of >= 96 g/m^2 and in males LVMI of >= 116 g/m^2 was taken as LVH.

Left ventricular mass determined by echocardiography was chosen as the Gold standard for determining LVH to be used for the comparison with electrocardiographic data, because various previous reports showed a good correlation between this method and necropsy data.[7-10]

In our study, Body mass index (BMI) >= 25 kg/m^2 is considered as obese individual and smoking was defined in case a subject was smoking 5 or more bidis, cigarette, hukka for 5 years or more.[11]

Statistical Analysis

Data obtained from these patients were systematically recorded and analysed using Microsoft Excel and GraphPad InStat 3.1 version. Fisher exact test was used to analyse statistical significance. P value of < 0.05 was considered significant. The test was run after finding sensitivity and specificity of ECG with Gold standard echocardiography.

RESULTS

This study included a total of 108 hypertensive patients. Out of 108 patients, 60 (56%) were males and 48 (44%) were females [Table 1]. In this study 47 patients (41%, 24 males and 20 females) were smokers and 44 patients (44%, 35 males and 12 females) were obese. The age of the patients varied from 23 to 90 yrs. with most of the patients falling in the age group of 51 - 70 yrs., 49 patients i.e. 45.37% [Figure2].

The mean age of the patients in our study population was 56.36 yrs. The mean age of males were 59.56 yrs. and mean age of females were 53.17 yrs. The mean BMI was 25.09 kg/sqm, which were more in females 25.64 kg/sqm than males 24.55 kg/sqm. The mean LVMI was 130.80 g/sqm, which were more for males than females 123.56g/sqm. The mean systolic BP was 158.813 mmHg and diastolic BP was 98.404 mmHg. LVH has been diagnosed in 82 (75.92%) patients by Echocardiography and 37 (34.26%) patients by electrocardiogram [Table 1]. The ECG and Echo findings of LVH with respect to gender and presence/ absence of risk factors (obesity and smoking) has been shown in Table 2, 3, 4, 5, 6, 7. Echocardiographically detected LVH has been found to be more in females than males (p= 0.5069), smokers than non-smokers (p= .0059) and obese than non-obese patients (p= 0.6475). Using electrocardiogram LVH has been diagnosed more in males than females (p= .6837), non-smokers than smokers (p= .1058) and non-obese than obese patients (p= .1034). The sensitivity of different ECG criteria in comparison to echocardiography has been mentioned in Table 8. The sensitivity of different ECG criteria with respect to gender and presence/ absence of risk factors (smoking and obesity) has been depicted in Table 9.

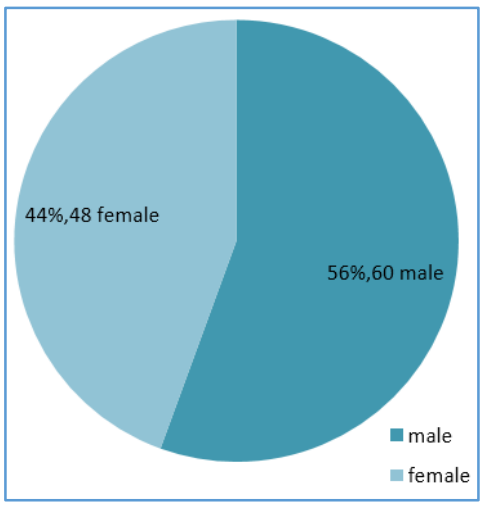

Figure 1. Pie Diagram showing Sex Distribution of the Patients

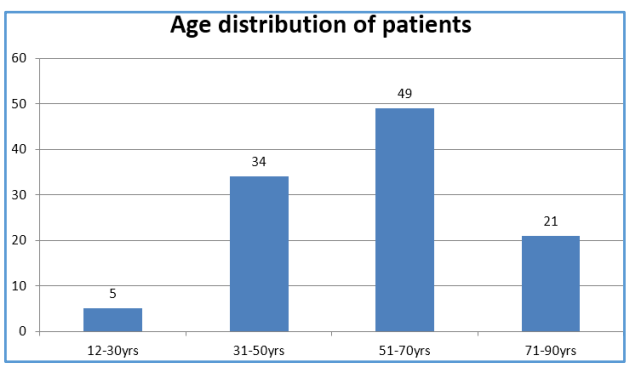

Figure 2. Bar Diagram showing Age Distribution of Patients

Parameters	Patients with LVH	Percentage
Echocardiography (LVMI)	82	75.92%
Overall ECG (any below criteria)	37	34.26%
Sokolow-Lyon	31	28.70%
Romhilt-Estes	34	31.48%
Cornell Voltage	36	33.33%

Table 1. Showing LVH in Patients according to Different ECG Criteria used and Echocardiography

Parameters	LVH in Male Patients	Percentage
Echo (LVMI)	44	73.33%
Overall ECG (any below criteria)	22	36.66%
Sokolow-Lyon	18	30%
Romhilt-Estes	19	31.66%
Cornell Voltage	21	35%

Table 2. Showing LVH in Male Patients according to different ECG Criteria used and Echocardiography

Parameters	LVH in Female Patients	Percentage
Echo (LVMI)	38	79.16%
Overall ECG (any below criteria)	15	31.25%
Sokolow-Lyon	13	27.08%
Romhilt-Estes	15	31.25%
Cornell Voltage	15	31.25%

Table 3. Showing LVH in Female Patients by Electrocardiography and Echocardiography

Parameters	LVH in Obese Patients	%
Echo (LVMI)	38	86.36%
Overall ECG (Any below criteria)	11	25%
Sokolow-Lyon	10	22.72%
Romhilt-Estes	10	22.72%
Cornell Voltage	11	25%

Table 4. Showing LVH in ECG by different Criteria and Echocardiography in BMI >= 25 (Obese Patients)

Parameters	LVH in Non-Obese Patients	%
Echo (LVMI)	44	68.75%
Overall ECG (Any below criteria)	26	40.62%
Sokolow-Lyon	21	32.81%
Romhilt-Estes	24	37.5%
Cornell Voltage	25	39.06%

Table 5. Showing LVH in Non-Obese Patients (BMI < 25) by different ECG Criteria and Echocardiography

Parameters	LVH in Smoker Patients	Percentage
Echo (LVMI)	42	89.36%
Overall ECG (Any Below Criteria)	12	25.53%
Sokolow-Lyon	10	21.27%
Romhilt-Estes	11	23.40%
Cornell Voltage	12	25.53%

Table 6. Showing LVH in Smoker by different ECG Criteria and Echocardiography

Parameters	LVH in Non-Smoker Patients	%
Echo (LVMI)	40	65.57%
Overall ECG (Any Below Criteria)	25	41%
Sokolow-Lyon	22	36.06%
Romhilt-Estes	23	37.70%
Cornell Voltage	24	39.34%

Table 7. Showing LVH in Non-Smoker by different ECG Criteria and Echocardiography

ECG Criteria	Sensitivity	Specificity
Romhilt-Estes	36.58%	86.66%
Cornell Voltage	40.24%	89.65%
Sokolow-Lyon	34.14%	89.65%
Overall ECG (Any above Criteria)	40.24%	86.66%

Table 8. Showing Sensitivity and Specificity of different ECG Criteria in Comparison to Echocardiography

Factors	Romhilt-Estes Score	Cornell Voltage	Sokolow-Lyon Index
Male	38.63%	45.45%	36.36%
Female	34.21%	34.21%	31.57%
Obese	31.25%	34.37%	31.25%
Non-Obese	40%	44%	40%
Smoker	27.5%	30%	25%
Non-Smoker	45.23%	50%	45.23%

Table 9. Showing Sensitivity of different ECG Criteria according to different Factors like Sex, Obesity and Smoking

DISCUSSION

In this study 82 (75.92%) patients have been found to have LVH by echocardiography, which is similar to study by Dubey

et al.[12] Dubey et al[12] in their study on 151 patients found LVH in 113 patients by echocardiography (74.8%).

In our study electrocardiography could diagnose LVH in 37 (34.26%) patients, which is similar to study done by Abid et al.[13] Abid et al[13] in similar study on 50 patients found left ventricular hypertrophy in 22 (44%) on electrocardiography.

In this study sensitivity and specificity of electrocardiography in diagnosing LVH has been 40.24% and 86.66% respectively, which is similar to study by Devereux et al.[15] Devereux et al[14] found a sensitivity of 34% and a specificity of 98% in the comparison with left ventricular mass shown by the echocardiogram without differences between results for either sex.

In this study, sensitivity and specificity of Sokolow-Lyon voltage criteria has been 34.14% and 89.65% respectively, which is similar to study by Casale et al (Sensitivity-33%, Specificity-94%) and Norman et al[15] (Sensitivity-30%, Specificity-86%) .

In our study sensitivity and specificity using Romhilt-Estes scoring criteria has been 36.58% and 86.66% respectively, which is similar to studies conducted by Waqas Hameed et al[16] (Sensitivity-31%, Specificity-86%) and Casale et al[17] (Sensitivity-33%, Specificity-94%).

In our study sensitivity and specificity using Cornell Voltage Criteria has been 40.24% and 89.65% respectively, which is similar to study conducted by Casale et al[17] (Sensitivity-42%, Specificity-96%).

In our study, 38 (79.16%) female patients and 44 (73.33%) male patients have been found to have LVH by echocardiography. Echocardiography could diagnose LVH more in females than males, which was statistically not significant (p= .5069) and is similar with study done by Dubey et al.[12]

In this study electrocardiography could diagnose LVH in 22 patients (36.66%), which is higher in males than females 15 patients (31.25%) that is statistically not significant (p=0.6837), which is similar to study by Okin et al.[18]

Okin et al[18] in a study on 389 patients found LVH in 116 patients suggesting that the worse performance of the ECG in women might be partially attributed to the lower voltage and duration of QRS complexes due to the differences in body surface and heart dimensions observed between the genders.

In our study in male, sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria has been 36.36%, 38.63% and 45.45% respectively. Sensitivity has been highest for Cornell voltage in male, which is similar to study by Alfakih et al.[19]

In our study in female sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria has been 31.57%, 34.21% and 34.21% respectively, which is similar to study by Venugopal et al,[20] but only varies in sensitivity which may be attributed to difference in BMI and race.

In this study echocardiography diagnosed LVH in 38 obese patients (86.36%), which is higher than non-obese 44 patients (68.75%), that is statistically not significant (p=0.6475) and is similar to study by Dubey et al.[12]

In this study electrocardiography could diagnose LVH in 26 (40.62%) non-obese patients, which is higher than obese patients 11 (25%) and is statistically not significant (p=0.1034). Obesity attenuates precordial voltage and reduce the sensitivity of electrocardiography.

In obese patients, sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria was 31.25%, 31.25% and 34.37% respectively. In non-obese patients, sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria was 40%, 40% and 44% respectively and which was similar to study done by Rodrigues et al.[21]

In this study, echocardiography diagnosed LVH in 42 smoker patients (89.36%) which is higher than non-smoker patients 40 (65.57%) patients, that is statistically significant (p=0.0059) which is similar to study done by Venugopal et al.[20]

In our study electrocardiography could diagnose LVH in 25 (41%) non-smoker patients, which is higher than smoker patients 12 (25.53%) that is statistically not significant (p=0.1058) which is similar to study by Schillaci G et al.[22]

In this study in non-smoker patients, sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria has been 45.23%, 45.23% and 50% respectively. In smoker patients, sensitivity of Sokolow-Lyon, Romhilt-Estes and Cornell voltage criteria has been 25%, 27.5% and 30%. Our study in relation to risk factor, smoking is similar to study done by Schillaci G et al.[22]

Schillaci G[22] et al also showed that Electrocardiography (ECG) has a lower sensitivity for the diagnosis of left ventricular (LV) hypertrophy in smokers than in non-smokers.

CONCLUSION

This study included a total of 108 hypertensive patients, where 82 (75.92%) patients showed LVH by echocardiography and 37 patients (34.26%) by echocardiography. Sensitivity and specificity of ECG in diagnosing LVH was 40.24% and 86.66% respectively in comparison to echocardiography. Sensitivity has been highest for Cornell Voltage criteria (40.24%) and lowest for Sokolow-Lyon voltage criteria (34.14%).

This study shows that obesity, smoking and female gender decreases the sensitivity of electrocardiography and increases the sensitivity of echocardiography.

The study shows that echocardiography is undoubtedly a better instrument for determination of Left Ventricular Hypertrophy. The study also reveals that although ECG is a poor screening tool due to its low sensitivity, but because of its high specificity various factors determining LVH may independently effect determination of LVH.

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