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Original Research Article

Evaluation of Electrocardiographic and Echocardiographic Profile of Left Ventricular Hypertrophy in Systemic Hypertension

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Abstract

Aim: The aim of the present study was to detect left ventricular hypertrophy in hypertensive patients using Electrocardiography and echocardiography.

Methods: The study was conducted in the Department of Medicine of Ford hospital and research centre Pvt. Ltd, Patna, Bihar, India . Sample size calculated by purposive sampling method was one hundred.

Results: The mean age of the study population was 59.65 ± 12.34 years. Mean duration of hypertension in the study population was 4.72 ± 3.2 years. Mean pulse rate was 77±9.54 beat per minute. Similarly mean systolic and diastolic blood pressure of the study population was 137± 15.42 mmHg and 84±10.5 mmHg respectively. Around 46% of the study population had family history of hypertension and 4% of them were found to have hypertension for the first time. Out of 100 study population, 20 of them had left ventricular hypertrophy on ECG as defined by Sokolow-Lyon criteria, and 15 had left ventricular hypertrophy on ECG as per Cornell Voltage criteria. On combining both Sokolow-Lyon and Cornell Voltage criteria, 10 were found to have left ventricular hypertrophy on ECG (either by Sokolow-Lyon or Cornell Voltage criteria). On echocardiography 22 of study population were found to have left ventricular hypertrophy. The sensitivity of ECG to detect LVH by Sokolow-Lyon criteria was 47% and specificity was 98.8%. Similarly Positive Predictive Value (PPV) and Negative predictive Value (NPV) for the same criteria was 96.6% and 70.8% respectively.

Conclusion: Electrocardiography is less sensitive tool to diagnose left ventricular hypertrophy in hypertensive people. The sensitivity of ECG to find left ventricular hypertrophy by Cornell Voltage criteria is 40.5% and by Sokolow-Lyon criteria is 47%. On combining both criteria sensitivity of ECG increased to 53.2%. Specificity of both criteria is high (>95%). Due to its low sensitivity, ECG can't be considered as screening method to detect LVH in hypertensive people. Investigation of choice to detect LVH in hypertensive population is still the echocardiography.

Keywords: left ventricular hypertrophy, hypertensive patients, Electrocardiography, echocardiography

Introduction

Left ventricular hypertrophy is the thickening of the wall of left ventricle resulting in an increase in left ventricular mass. Left ventricular hypertrophy is a powerful independent risk factor for cardiovascular morbidity and mortality. [1] The increase in left ventricular mass represents a common final pathway toward the adverse effects on the cardiovascular system and higher vulnerability to complications. [2]

Left ventricular hypertrophy may occur as a result of two basic hemodynamic abnormalities: Systolic overload and diastolic overload. Systolic overload is also known as pressure overload and occurs with conditions like aortic stenosis, systemic hypertension, hypertrophic cardiomyopathy, and coarctation of aorta. Diastolic overload is due to overfilling of left ventricle in diastole so that the left ventricle compromise occurs during diastole. Left ventricular diastolic overload is also known as volume overload, and occurs with mitral incompetence, aortic incompetence, and also with moderate left to right shunt. Echocardiography is considered as gold standard for LVH detection in clinical practice, but ECG remains widely used due to its simplicity, low cost, and easy accessibility. However, ECG criteria for LVH detection exhibit only limited accuracy (generally due to poor sensitivity). [3]

Left ventricular hypertrophic heart disease is one of the most commonly encountered problems in a few systemic diseases and cardiac patients. This can lead to diastolic dysfunction and progressive heart

failure, initially with preserved ejection fraction and later to heart failure with reduced ejection fraction. Also, left ventricular hypertrophy (LVH) per se can lead to increased acute coronary vascular events. There is a huge number of undiagnosed hypertensive patients worldwide, one of the most common causes of LVH, among which are many undiagnosed patients with LVH. Hence, this leads to a gap in the bridge which needs to be addressed to increase the survival of these patients. Hence, its detection and intervention can help to increase the survival of those patients, thereby decreasing mortality due to LVH. [4,5]

Antihypertensive treatments which are aimed at reducing blood pressure (BP) can also produce regression of LVH, and prevention of progression to LVH. But the lower sensitivity of ECG as compared to other imaging modalities has been put as a limitation of ECG to diagnose LVH. [6]

The aim of the present study was to detect left ventricular hypertrophy in hypertensive patients using Electrocardiography and echocardiography.

Materials and Methods

The study was conducted in the Department of Medicine of Ford hospital and research centre Pvt. Ltd, Patna, Bihar, India for one year Sample size calculated by purposive sampling method was one hundred. Written informed consent was taken from subjects before participating them on the study. Subjects were studied for presence or absence of LVH by doing ECG and ECHO.

Subjects meeting the case definition of systemic hypertension, who were 18 years of age or above and who gave written informed consent were included in the study. Known cases of Hypertension who were already taking antihypertensive treatment were also included. Subjects having conditions other than systemic hypertension that can cause LVH such as Aortic Stenosis, Hypertrophic Obstructive Cardiomyopathy, and Myocardial infarction were excluded from the study. Similarly, those with congenital heart diseases – Ventricular Septal Defect, Patent Ductus Arteriosus, Co-arctation of Aorta were excluded. Those having Left bundle branch block (LBBB) on ECG were also excluded

Systemic Hypertension was defined as the Systolic Blood pressure of ≥140 mmHg and diastolic Blood Pressure of ≥90 mmHg as per Joint National Committee (JNC) 7 definition. [7] Twelve lead ECG was done to the subjects at the paper speed of 25 mm/sec and at the calibration of 10mm. ECG criteria used to diagnose LVH were either Sokolow-Lyon Index or Cornell Voltage Criteria. LVH was defined as follows.

1. Sokolow-Lyon Index8

Sum of S wave in V1 and R wave in V5 or V6 ≥ 3.5 mV (35 mm) And / or

R wave in aVL ≥1.1 mV (11mm)

2. Cornell Voltage Criteria [9]

For Male: Sum of S wave in V3 plus R wave in aVL > 2.8 mV (28mm)

For Female: Sum of S wave in V3 plus R wave in aVL> 2.0 mV (20mm)

After obtaining ECG subjects meeting the inclusion criteria underwent M-Mode, 2-Dimensional (2D), colour flow and Pulsed Wave Doppler transthoracic Echocardiography by Phillips IE 33 echocardiography machine. Echocardiogram was obtained at rest in the lateral decubitus or supine position using parasternal and apical views. Left Ventricular septal wall thickness or Posterior wall thickness was measured at the end diastole immediately below mitral valve leaflets tip along parasternal long or short axis. Septal wall thickness or Posterior wall thickness > 10 mm in Male and > 9 mm in female was considered as LVH on Echocardiography.[10]

Data collection was done by using predesigned questionnaire in the medicine wards and OPD of BPHIKS. Demographic profile of study subjects - age, sex, address, family history of Hypertension, duration of Hypertension (for known case of Hypertension) was noted. ECG findings of LVH using Sokolow-Lyon Index and Cornell Voltage Criteria was recorded. Then these patients underwent Echocardiography where Echocardiographic evidence of presence or absence of LVH was noted.

Data were entered into Microsoft Excel 2010 & Statistical analysis was performed by using SPSS Programme 11.5 version. Quantitative data regarding the baseline characteristics were described with frequency, percentage, proportions, mean, standard deviation etc. Sensitivity, specificity, positive predictive value and negative predictive values to diagnose LVH using ECG and Echo were calculated. Receiver Operating Characteristic curve of different ECG criteria was plotted for sensitivity analysis.

Results

Table 1: Baseline Characteristics of the study Population

Characteristic		n (%)
Age in years (mean ± SD)		59.65 ± 12.34
Gender	Male	52 (52)
	Female	48 (48)
Age of male Population in years (mean ±SD)		58.22 ± 11.27
Age of female population in years(mean ±SD)		59.19 ± 11.46
Duration of Hypertension in years(mean ±SD)		4.72 ± 3.2
Family history of hypertension		46 (46)
Newly Diagnosed Hypertension		4 (4)
Pulse in rate per minute(mean ± SD)		77 ± 9.54
Systolic BP in mmHg (mean ± SD)		137 ± 15.42
Diastolic BP in mmHg (mean ± SD)		84 ± 10.5
Duration of Hypertension in years	< 5	58 (58)
	5-10	32 (32)
	10-15	8 (8)
	>15	2 (2)

The mean age of the study population was 59.65 ± 12.34 years. Mean duration of hypertension in the study population was 4.72 ± 3.2 years. Mean pulse rate was 77±9.54 beat per minute. Similarly mean systolic and diastolic blood pressure of the study population was 137± 15.42 mmHg and 84±10.5 mmHg respectively. Around 46% of the study population had family history of hypertension and 4% of them were found to have hypertension for the first time.

Table 2: Left Ventricular hypertrophy detected by Electrocardiography and Echocardiography

	Left Ventricular Hypertrophy	
Diagnostic criteria	**Yes, n**	**No, n**
LVH on ECG by Sokolow-Lyon criteria	20	22
LVH on ECG by Cornell Voltage Criteria	15	20
ECG LVH on combining both Sokolow-Lyon and Cornell Voltage Criteria	10	13
Echocardiographic LVH	45	55

Out of 100 study population, 20 of them had left ventricular hypertrophy on ECG as defined by Sokolow-Lyon criteria, and 15 had left ventricular hypertrophy on ECG as per Cornell Voltage criteria. On combining both Sokolow-Lyon and Cornell Voltage criteria, 10 were found to have left ventricular hypertrophy on ECG (either by Sokolow-Lyon or Cornell Voltage criteria). On echocardiography 22 of study population were found to have left ventricular hypertrophy.

Table 3: Sensitivity, Specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV) of Diagnostic Criteria to diagnose LVH

Diagnostic Criteria	Sensitivity	Specificity	PPV	NPV
Sokolow-Lyon Criteria	47%	98.8%	96.6%	70.8%
Cornell Voltage Criteria	40.5%	95.2%	86.2%	67.5%
Combining Sokolow-Lyon and Cornell Voltage Criteria	53.2%	95.1%	88.1%	72.6%

The sensitivity of ECG to detect LVH by Sokolow-Lyon criteria was 47% and specificity was 98.8%. Similarly Positive Predictive Value (PPV) and Negative predictive Value (NPV) for the same criteria was 96.6% and 70.8% respectively. Likewise sensitivity and specificity of ECG by Cornell Voltage to detect LVH was 40.3% and 95.1% respectively, and PPV and NPV for the same criteria was found to be 86.2% and 67.5% respectively. On combining both ECG criteria the sensitivity of ECG increased to 53.2% with specificity of 95.1%. PPV and NPV of the combined ECG criteria were 88.1% and 72.6% respectively.

Discussion

Hypertension is a disease affecting about 65.4% of people aged over 60 years and is responsible for

6% of all deaths worldwide. Left ventricular hypertrophy (LVH) in hypertensive patients is common, readily detectable, and easily treatable condition. Left ventricular hypertrophy is considered as an important risk factor for adverse cardiovascular morbidity and fatal outcomes that can be detected by electrocardiography (ECG) and echocardiography (ECHO). [11] The electrocardiogram is an easily available and cost effective tool to evaluate LVH. As compared to more specific tools like echocardiography, magnetic resonance imaging, and autopsy studies, efficacy of ECG is often questionable. Still, the two- dimensional echocardiography is referred to as the gold standard tool to evaluate for LVH. [12] If LVH is detected early, it helps in guiding therapeutic options to change the course of events to a significant measure. [13] Though the specificities of ECG criteria to find LVH are high (>90%), its sensitivities are in the lower range 20-60%. [14]

The mean age of the study population was 59.65 ± 12.34 years. Mean duration of hypertension in the study population was 4.72 ± 3.2 years. Mean pulse rate was 77±9.54 beat per minute. Similarly mean systolic and diastolic blood pressure of the study population was 137± 15.42 mmHg and 84±10.5 mmHg respectively. Around 46% of the study population had family history of hypertension and 4% of them were found to have hypertension for the first time. Out of 100 study population, 20 of them had left ventricular hypertrophy on ECG as defined by Sokolow-Lyon criteria, and 15 had left ventricular hypertrophy on ECG as per Cornell Voltage criteria. On combining both Sokolow-Lyon and Cornell Voltage criteria, 10 were found to have left ventricular hypertrophy on ECG (either by Sokolow-Lyon or Cornell Voltage criteria). On echocardiography 22 of study population were found to have left ventricular hypertrophy. This result was similar to a study done in India by G. Singh et al [14] in which they found sensitivity of Sokolow Lyon criteria to be 37%. Another study done in Taiwan by Su et al [15] found the sensitivity of Sokolow-Lyon to detect LVH to be 8.3%. The difference in result from our study was probably because they included only male population of 18 to 50 years of age who were free of hypertension.

The sensitivity of ECG to detect LVH by Sokolow-Lyon criteria was 47% and specificity was 98.8%. Similarly Positive Predictive Value (PPV) and Negative predictive Value (NPV) for the same criteria was 96.6% and 70.8% respectively. Likewise sensitivity and specificity of ECG by Cornell Voltage to detect LVH was 40.3% and 95.1% respectively, and PPV and NPV for the same criteria was found to be 86.2% and 67.5% respectively. On combining both ECG criteria the sensitivity of ECG increased to 53.2% with specificity of 95.1%. PPV and NPV of the combined ECG criteria were 88.1% and 72.6% respectively which was similar to study done by R.B. Devereux et al [16] which had sensitivity of 42% and specificity of 96%. In another study conducted by Molloy TJ [17], its sensitivity to detect LVH was 36%. Hanna EB et al studied sensitivity and specificity of ECG criteria for detection of LVH in patients with anterior wall myocardial infarction, and found that sensitivity of Cornell voltage criteria was 21% with 84 % of specificity [18] which was less than what we found in our results.

Conclusion

Electrocardiography is less sensitive tool to diagnose left ventricular hypertrophy in hypertensive people. The sensitivity of ECG to find left ventricular hypertrophy by Cornell Voltage criteria is 40.5% and by Sokolow-Lyon criteria is 47%. On combining both criteria sensitivity of ECG increased to 53.2%. Specificity of both criteria is high (>95%). Due to its low sensitivity, ECG can't be considered as screening method to detect LVH in hypertensive people. Investigation of choice to detect LVH in hypertensive population is still the echocardiography.

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