JAMP

# A COMPARATIVE STUDY OF ELECTROCARDIOGRAPHIC AND ECHOCARDIOGRAPHIC EVIDENCE OF LEFT VENTRICULAR HYPERTROPHY IN TIRUNELVELI MEDICAL COLLEGE HOSPITAL

**M. Mathan[1], G. Bharathi[2]**

[1]Senior Assistant Professor, Department of General Medicine, Thoothukudi Medical College & Hospital, Tamilnadu, India.
[2]Assistant Professor, Department of General Medicine, Thoothukudi Medical College & Hospital, Tamilnadu, India.

## Abstract

**Background:** One of the most prominent issues in several systemic diseases and cardiac patients is left ventricular hypertrophy (LVH) heart disease, which can lead to diastolic dysfunction and progressive heart failure. Objective: We evaluated the use of ECG and Echocardiography in the early detection of LVH in various disease entities and their sensitivity and specificity in picking up patients with LVH. **Materials and Methods:** It was a hospital-based cross-sectional study conducted on 50 patients coming to General Medicine OPD and Cardiology OPD in Tirunelveli Medical College Hospital who were clinically suspected of having LVH. Patients were selected after detailed history taking, general examination, and fundoscopic evaluation as listed in the inclusion and exclusion criteria. **Result:** It was seen that 42% of patients had showed LVH in ECG with Sokolow criteria, 22% of patients had showed LVH in ECG with ROMHILT-ESTES criteria, and 14% of patients had showed LVH in ECG with Cornell criteria. Additionally, 78% of patients showed LVH in Echocardiography. The sensitivity & specificity of the Sokolow criterion, ROMHILT-ESTES criterion, and Cornell criterion for echocardiography demonstrated 53.85% sensitivity and 100% specificity of the Sokolow criterion, 28.21% sensitivity, and 100% specificity of ROMHILT-ESTES criterion, while 17.95% sensitivity and 100% specificity of Cornell criterion for echocardiography. Additionally, combined ECG criteria showed 56.41% sensitivity and 100% specificity for echocardiography. **Conclusion:** We have found that all these ECG criteria were noticeably less sensitive than echocardiography at spotting LVH. However, when compared to echocardiography, all three criteria are noteworthy.

## INTRODUCTION

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.[1,5] This early detection can be done by screening with many broadly available tools like electrocardiogram (ECG), non-invasive echocardiography, and cardiac MRI, though costly, the most specific investigation.[2,4,5] In this study, we evaluated the use of ECG and Echocardiography, the two most widely available tools in the early detection of LVH in various disease entities, and their sensitivity and specificity in picking up patients with LVH, thereby starting intervention to decrease the ongoing cardiac remodelling.

## MATERIALS AND METHODS

It was a hospital-based cross-sectional study conducted on 50 patients from January 2019 to June

939

**International Journal of Academic Medicine and Pharmacy (www.academicmed.org)**
ISSN (O): 2687-5365; ISSN (P): 2753-6556

2019. Patients coming to General Medicine OPD and Cardiology OPD in Tirunelveli Medical College Hospital who were clinically suspected of having LVH as per inclusion criteria were included in the current study. This study started with approval from the hospital's ethical committee and informed consent from patients and relatives. Patients were selected after detailed history taking, general examination, and fundoscopic evaluation as listed in the inclusion and exclusion criteria.

**Inclusion Criteria**

- Known case of hypertension along with a minimum of grade 1 hypertensive retinopathy changes (with or without anti-hypertensive treatment)
- Atherosclerotic aortic sclerosis
- Rheumatic heart disease with mitral incompetence
- Ischemic cardiomyopathy with mitral incompetence
- Coronary artery disease
- Hypertrophic Cardiomyopathy (HCM)
- Age more than or equal to 13 years.

**Exclusion Criteria**

- Obese (BMI > 30 kg/m2) with no comorbidities as in inclusion criteria.
- Patients with chest wall deformities like kyphosis or scoliosis.
- Age <13 years.
- Patients with ECG findings of bundle branch block, atrial tachyarrhythmia, and WPW syndromes.
- Patients on digitalis, class IA & IC Antiarrhythmics

**Investigations Used**

- Electrocardiography (ECG)
- Echocardiography

- Direct ophthalmoscopy for fundus picture

LV mass was calculated using Devereux's anatomical formula as follows:6.

LV Mass (LVM) gm = $0.8\{1.04([LVID+PWT+IVST]-[LVID]3)\} + 0.6$ gm

LVID = Left Ventricular Internal Dimension
PWT = Posterior Wall Thickness
IVST = Inter Ventricular Septal Thickness
LV Mass Index (LVMI)7 = LVM / BSA
BSA (Body Surface Area) calculated by Mosteller formula:8

**Mosteller Formula:**

$$BSA\ (m^2) = \sqrt{\frac{Ht\ (Cm)\ x\ Wt\ (kg)}{3600}}$$

Statistical significance analysis of individual ECG criteria against echocardiography was done using the Pearson Chi-square test. The analysis showed the p-value to be < 0.0001 for all three criteria and hence showed the significance of all three criteria as they are <0.05.

## RESULTS

In the present study, 54% were male, and 46% were female. Fifty patients suspected of having LVH were taken and distributed according to age group. It was observed that 12%, 18%, 14%, 24%, and 32% of patients belonged to the age group <30, 31-40, 41-50, 51-60, and >61, respectively. This indicates that the highest number of patients were from the age group >61 years, and the least were from the age group <30. Moreover, we have seen that 52% of participants were hypertensive, 42% of participants had diabetes, 36% of patients had an abnormal total cholesterol level, and 36% were smokers [Table 1].

**Table 1: Distribution of hypertension and diabetes with grade I retinopathy or above in the study population**

| Variables | | Frequency | Percentage |
|---|---|---|---|
| Hypertension | | 26 | 52 |
| Diabetes | | 21 | 42 |
| Total cholesterol | Abnormal | 18 | 36 |
| | Normal | 32 | 64 |
| Smokers | | 18 | 36 |

[Table 2] shows the distribution of predisposing factors of LVH in the study population. It indicates that the most predisposing factors were CAD (18%), HTN (14%), and RHD with MR (20%).

**Table 2: Distribution of predisposing factors of LVH in the study population**

| Etiology | Frequency | Percentage |
|---|---|---|
| AS | 2 | 4.0 |
| CAD | 9 | 18.0 |
| CKD > S III +HTN | 1 | 2.0 |
| DCM with MR | 2 | 4.0 |
| HOCM | 4 | 8.0 |
| HTN | 7 | 14.0 |
| HTN + AS | 3 | 6.0 |
| HTN + AS + CAD | 1 | 2.0 |
| HTN + CAD | 2 | 4.0 |
| HTN + CAD + CKD>SIII | 1 | 2.0 |
| HTN +CAD | 1 | 2.0 |
| HTN+ AS | 1 | 2.0 |

| | | |
|---|---|---|
| HTN+AS | 1 | 2.0 |
| HTN+AS + CAD | 1 | 2.0 |
| HTN+AS+CAD | 1 | 2.0 |
| HTN+CAD | 1 | 2.0 |
| HTN+CKD > S III | 2 | 4.0 |
| RHD with MR | 10 | 20.0 |

[Figures 3, 4, 5, and 6] show the distribution of patients showing LVH in ECG with Sokolow and ROMHILT-ESTES criteria, respectively. This indicated that 42% of patients had showed LVH in ECG with Sokolow criteria, 22% of patients had showed LVH in ECG with ROMHILT-ESTES criteria, and 14% of patients had showed LVH in ECG with Cornell criteria. Additionally, 78% of patients showed LVH in Echocardiography.
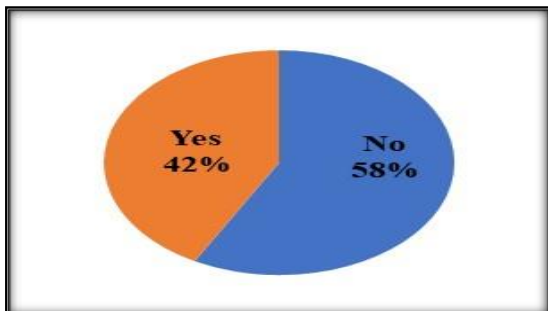


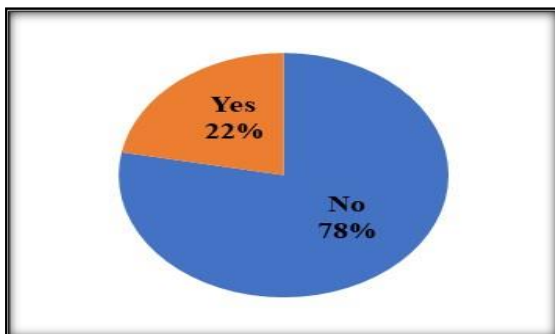**Figure 1: Distribution of patients showing LVH in ECG with Sokolow criteria**



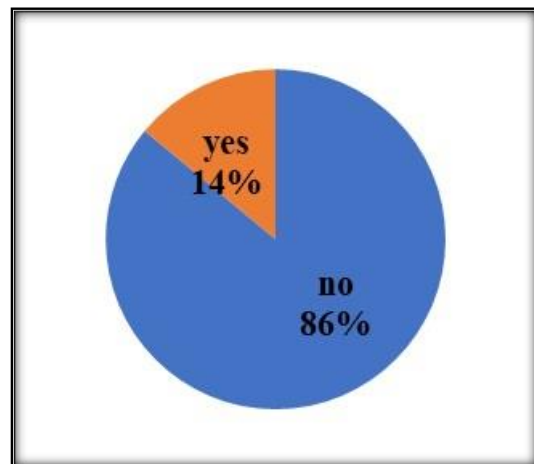**Figure 2: Distribution of patients showing LVH in ECG with ROMHILT-ESTES criteria**



**Figure 3: Distribution of patients showing LVH in ECG with Cornell criteria**
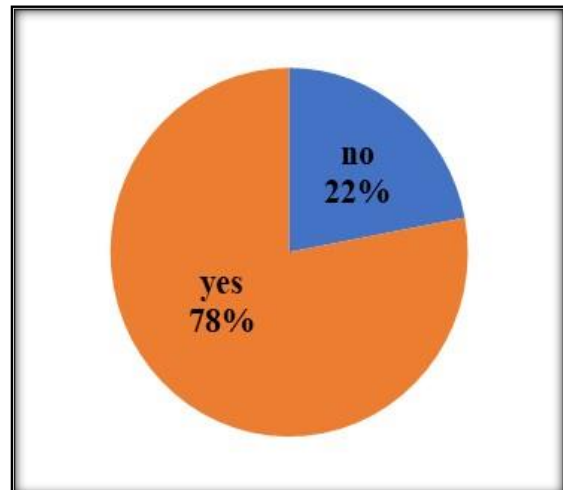


**Figure 4: Distribution of patients showing LVH in Echocardiography**

[Table 3] shows shown sensitivity & specificity of the Sokolow criterion, ROMHILT-ESTES criterion, and Cornell criterion for echocardiography. It indicated 53.85% sensitivity and 100% specificity of Sokolow criterion for echocardiography, 28.21% sensitivity and 100% specificity of ROMHILT-ESTES criterion for echocardiography, while 17.95% sensitivity and 100% specificity of Cornell criterion for echocardiography. Additionally, combined ECG criteria showed 56.41% sensitivity and 100% specificity for echocardiography.

**Table 3: Comparing sensitivity and specificity of different ECG criteria**

| | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|
| SOKOLOW | 53.85% | 100% | 100% | 37.93% | 64% |
| ROMHILT-ESTES | 28.21% | 100% | 100% | 28.21% | 44.00% |
| CORNELL | 17.95% | 100% | 100% | 25.58% | 36.00% |
| COMBINED ECG CRITERIA | 56.41% | 100% | 100% | 39.28% | 66.00% |

### DISCUSSION

In this study, 50 patients were taken as a sample as suspects to have LVH, of which 23 were female, 27 were male, and the majority were above 50 years of age. Among them, 26 were hypertensive, 24 were non-hypertensives, 21 were diabetic, and 29 were non-diabetic. Eighteen had abnormal cholesterol, and 31 had normal cholesterol levels. In addition, 18 were smokers, 32 were non-smokers, and most had multiple comorbidities. Of 50 patients, 39 were diagnosed with LVH by calculating LV Mass by

941

Devereux's formula with echocardiography. On applying ECG criteria, 21 satisfied LVH criteria per the Sokolow criterion, 11 satisfied the ROMHILT-ESTES criterion, and 7 satisfied the Cornell criterion. Taking echocardiography as the most sensitive and specific ECG criteria were compared and correlated with echocardiography, and sensitivity, specificity, and accuracy were calculated. Sokolow criterion was found to have a sensitivity of 28.21%, specificity of 100%, PPV of 100%, NPV of 28.21%, and accuracy of 44%. ROMHILT-ESTES criterion was found to have a sensitivity of 53.85%, specificity of 100%, PPV of 100%, NPV of 37.93%, and accuracy of 64%. Finally, the Cornell criterion was found to have a sensitivity of 17.95%, specificity of 100%, PPV of 100%, NPV of 25.58%, and accuracy of 36%. Combining overall all of the 3 criteria together increased sensitivity to 56.41%, specificity to 100%, PPV to 100%, NPV to 39.28%, and accuracy to 66%. Hence sensitivity, NPV, and accuracy increase by combining all 3 ECG criteria. Statistical significance by Pearson chi-square test showed the p-value to be <0.0001 for all three ECG criteria against echocardiography. So, after comparing all these ECG criteria, our study shows that all criteria are less sensitive in diagnosing LVH than Echocardiography. However, the Sokolow criterion shows maximum sensitivity (53.85%) and Cornell's criteria the least (17.95%), but the sensitivity can be increased to 56.41% by combining all three criteria. Specificity is 100% for all 3 criteria. Also, accuracy is maximum for the Sokolow criterion (64%), next being the ROMHILT-ESTES criterion (44%) and last being Cornell's criterion (36%). However, all three criteria are significant against echocardiography in our study while comparing using the Pearson Chi-square test as the p-value is <0.0001 for all three criteria. Hence use of the Sokolow criterion is much preferred when compared to others. Also, sensitivity can be further improved with the use of Cardiac MR imaging, and this observation is similar to that conducted by Dada et al.[9] According to Mohan et al.[10] females scored differently on the Sokolow, Cornell, and Romhilt-Estes criteria with sensitivities of 31.88%, 11.36%, and 20.45%. However, In the same study, sensitivities of different criteria, i.e., Sokolow, Cornell, and Romhilt–Estes, in diagnosing LVH in males were 41.68%, 17.02%, and 19.94%. In a study conducted by Casiglia et al.[11] the sensitivity of these criteria for females was 12.7, 14.6, and 10.1%, respectively. Therefore, the Sokolow criterion is better in evaluating LVH in females because it has the highest level of sensitivity, which is consistent with findings from Alfakih et al.[12] that the Sokolow criterion is better in diagnosing LVH in females. In a study conducted by Casiglia et al.[11] the male participants' sensitivities to these criteria were 16.7, 3.8, and 25.5%.

## CONCLUSION

Our study assessed these ECG criteria and found they were all significantly less sensitive than echocardiography in detecting LVH. In our study, however, all three criteria are significant when compared to echocardiography using the Pearson Chi-square test because the p-value for each of the three criteria is 0.0001. Sokolow's criterion should therefore be used far more often than not. Additionally, cardiac MR imaging can be used to increase sensitivity further.

## REFERENCES

1. Chambers J. Left ventricular hypertrophy. BMJ 1995;311:273–4.
2. Aronow WS. Hypertension and left ventricular hypertrophy. Ann Transl Med 2017;5:310.
3. Pierdomenico SD, Cuccurullo F. Risk reduction after regression of echocardiographic left ventricular hypertrophy in hypertension: a meta-analysis. Am J Hypertens 2010;23:876–81.
4. Katholi RE, Couri DM. Left ventricular hypertrophy: a major risk factor in patients with hypertension: update and practical clinical applications. Int J Hypertens. 2011; 2011:495349.
5. Marwick TH, Gillebert TC, Aurigemma G, Chirinos J, Derumeaux G, Galderisi M, et al. Recommendations on using echocardiography in adult hypertension: a report from the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE). Eur Heart J Cardiovasc Imaging 2015;16:577–605.
6. Devereux RB, Reichek N. Echocardiographic determination of left ventricular mass in man. Anatomic validation of the method. Circulation 1977;55:613–8.
7. Poppe KK, Bachmann ME, Triggs CM, Doughty RN, Whalley GA. Geographic variation in left ventricular mass and mass index: a systematic review. J Hum Hypertens 2012;26:420–9.
8. Mosteller RD. Simplified calculation of body-surface area. N Engl J Med 1987;317:1098.
9. Dada A, Adebiyi AA, Aje A, Oladapo OO, Falase AO. Standard electrocardiographic criteria for left ventricular hypertrophy in Nigerian hypertensives. Ethn Dis 2005;15:578–84.
10. Mohan G, Kaur R, Kamra A, Aggarwal A. A Comparative Study of Electrocardiographic and Echocardiographic Evidence of Left Ventricular Hypertrophy. Curr Trends Diagn Treat 2017; 1:59-63.
11. Casiglia E, Schiavon L, Tikhonoff V, Bascelli A, Martini B, Mazza A, et al. Electrocardiographic criteria of left ventricular hypertrophy in the general population. Eur J Epidemiol 2008; 23:262-271.
12. Alfakih K1, Walters K, Jones T, Ridgway J, Hall AS, Sivananthan M. New gender-specific partition values for ECG criteria of left ventricular hypertrophy: recalibration against cardiac MRI. Hypertension 2004; 44:175-179.