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## A Non-Invasive Comparative Study of Left Ventricular Hypertrophy by Electrocardiography and Echocardiography.

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### ABSTRACT

Various ECG criteria's are available for the diagnosis of left ventricular hypertrophy. LVH diagnosed by Echo is much more sensitive than ECG. This is a small effort to study LVH by ECG and ECHO and compare the findings of these two tests. This is a single centre, non randomized, cross sectional study, done on 50 hypertensive patients. **ECG** criteria used in the study are Sokolow-Lyon criteria, Romhilt-Estes point score and Cornell voltage criteria. M-mode and 2D echo study were performed in all patients. LV mass index (LVMI) is taken as gold standard for LVH in this study, with two groups. Group I: Normal LV mass index (N-LVMI), Group II: Increased LV mass index (I-LVMI). Out of 50 patients 58% had Normal LV mass index and 42% patients had increased LVMI. Out of 50 patients, 21 (13+ 8) nos. of patients had LVH either by ECG or by Echocardiography. Among the 50 patients studied for LVH by ECG, 11 (22%) patients shown LVH in ECG. More specific correlation of ECG with LVH and LV mass index was present. Echocardiography is more reliable and cost effective tool for detecting LV mass and hypertrophy when compared to ECG. But specificity of ECG is also high.

**Keywords:** Left Ventricular Mass Index, Hypertension, Diastolic Dysfunction

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## INTRODUCTION

Hypertension, defined as abnormal elevation of the blood pressure is nearly always the result of increased peripheral vascular resistance. Hypertension is important risk factors for atherosclerosis, especially in the coronary cerebral and renal circulations. This is a major risk factor for coronary heart disease and predisposes to myocardial ischemia, infarction and sudden death. Other complications of hypertension are stroke, retinal damage, renal failure and peripheral vascular disease.(1,2,3) Diagnosis is by sphygmomanometer, but additional investigations are necessary to assess damage to the heart like Electrocardiography (ECG), X-ray, Echocardiograph (Echo) and kidney by urine analysis and renal function tests.(4,5) The prevalence of Left ventricular hypertrophy (LVH) increases with the severity of hypertension and presence of increased Left ventricular mass is associated with greater incidence of other target organ damage. LVH is associated with systolic and diastolic function abnormalities and ventricular arrhythmias which is one of the causes of sudden cardiac death among hypertensives. Hence LVH is an independent predictor of morbidity and mortality (6). LVH is a common finding in the patients with fixed or border line hypertension and can be diagnosed by either ECG or by Echocardiography. LVH is usually defined as two standard deviations above normal. The current echocardiographic criteria for LVH are Left Ventricular Mass Index (LVMI) Values  $\geq 134$  and  $\geq 110$  g/m<sup>2</sup> in men and women respectively, although there are a relatively wide range of published cut off values [17,18]. The Normal Indian LVMI for males is 120gm/m<sup>2</sup> and 110 gm/m<sup>2</sup> for females. ECG LVH is sensitive diagnostically and a powerful prognostic predictor [40]. ECG criteria for the diagnosis of LVH are increased QRS voltage, intra ventricular conduction delay manifested by delayed intrinsicoid deflection in the pericardial leads facing the left ventricle, widened QRS/T angle and tendency to left axis deviation. (41) Hence this is a study done to diagnose LVH by ECG and ECHO and compare the findings and diagnostic efficiency of these two tests.

## MATERIAL AND METHODS

**Study Type:** Non randomized, cross sectional study single centre study

### Material

- Patient's BP recording with sphygmomanometer
- Blood and urine investigation Reports
- Medication Chart
- ECG recordings
- Echocardiogram Report

### Methodology

The study was done on 50 hypertensive patient. The study group consisted of patient's age above 18 years and hypertensive for more than three years irrespective of type of treatment receiving were taken into the study.

History, Blood Pressure recordings, Std. 12 leads ECG recordings, Echocardiography done for all the patients.

Following clinical information were obtained for all patients

- Age and sex of the patient, Ht and Wt of the patient
- Body surface Area
- Duration of Hypertension
- Treatment receiving
- Std. cuff Blood pressure of Right and left upper limbs was taken
- Routine blood investigations
- Std. 12 leads ECG was obtained in all patients.

**ECG criteria** used in the study are Sokolow-Lyon (S-L) criteria, Romhilt-Estes point score and Cornell voltage criteria.

In S-L criteria: S in V1+R in V5 or V6  $\geq 35$ mm (3.5mV) was considered as LVH

In Romhilt-Estes, total score is 13, Score of 5 or more is considered as LVH

In Cornell voltage criteria S in V3+ R in aVL  $> 28$ mm for men and 20mm for women is considered as LVH

**Echocardiography:** Combined M-mode and 2Dimensional (2D) echo study were performed in all patients. In this study for the Indian population, normal LVMI for males is 120gm/m<sup>2</sup> and 110 gm/m<sup>2</sup> in females is taken as normal, Any value above this is suggestive of LVH.

### Study Criteria

#### Inclusion Criteria:

- Hypertension more than 3 years
- Essential and secondary hypertensive Patients
- No previous cardiovascular events

#### Exclusion Criteria:

- Patient with Congenital Heart Disease
- Age less than 18 years with hypertension
- Cardiomyopathies
- Renal Failure
- Old Myocardial Infarction
- Patient with Bundle branch blocks and Heart blocks
- Pacemaker patient
- Valvular heart diseases

## RESULTS

**LVH Vs AGE:** Among the total 50 hypertensive subjects 21 patients (42%) had LVH either by ECG or Echocardiography, and out of them 32% (n=16) patients were in the age group of between 51 & 70.

**LVH Vs Diabetic:** Among the total 50 subjects 29 (58%) were Diabetics out of which 14 (48%) subjects had increased LVMI.

**LVH Vs Smokers:** Among the 14 smokers of 50 total 5 (36%) subjects had increased LVMI

**LVH Vs Alcohol:** Among the total 14 alcoholic 6 (43%) subjects had increased LVMI

**LVH Vs ECG Criteria:** A Total of 11 (22%) were detected by ECG as LVH out of 50.

- a) **Romhilt Estes Score** criteria: 2 (4%) detected and One had increased LVMI
- b) **Sokolow-Lyon criteria** : 8 (16%) detected and 5 had increased LVMI
- c) **Cornell voltage criteria** : 6 (12%) detected and all had increased LVMI

**LVH Vs Wall thickness by Echo:** Out of 50 subjects 24 (48%) had LVH, 10 nos. normal LVMI and 14 Nos. increased LVMI.

**LVH Vs LV diastolic function:** among of 50 subjects 43 (86%) had impaired diastolic function. Out of them 24 had normal LVMI and 19 had increased LVMI.

**Distribution of Patients by LV mass index (LVMI):**

In this study, the Patients were divided into 2 groups.

**Group I:** One with Normal LV mass index (N-LVMI)

**Group II:** One with Increased LV mass index (I-LVMI) ( $\geq 120 \text{ gm/m}^2$  for Males and  $\geq 110 \text{ gm/m}^2$  for Females for Indian population)

Out of 50 patients, **58% (n=29) had Normal LV mass index (Group I)** with a mean LVMI of  $98.99 \text{ gm/m}^2$  and **42% (n=21) patients had increased LVMI (Group II)** with a mean LVMI of  $137.83 \text{ gm/m}^2$ .

Among the Male patients 19 (59.4%) had Normal LV mass and 13 (40.6%) had increased LV mass index.

Among the Female patients 10 (55.5%) had Normal LVMI and 8 (44.5%) had increased LVMI

**Investigations**

Out of 50 patients, **21 (13+ 8) nos. of patients had LVH either by ECG or by Echocardiography. (Table 1)** Among these patients, 11 (22%) patients had LVH by ECG and 39 (78%) nos. had normal ECG. 21 (42%) patients had increased Left ventricular mass index (LVMI) with a mean LVMI of  $137.83 \text{ gm/m}^2$ , and 29 patients had Normal LVMI with mean LVMI of  $98.99 \text{ gm/m}^2$ . 24 (48%) nos. of patients had LVH by LV wall thickness of 2D echo and 26 (52%) nos. had Normal LV chamber wall thickness.

**TABLE 1: comparison of LVH by ECG and ECHO**

ECHO		LVH by ECG		Total
		ABSENT	PRESENT	
LVH by ECHO-LVMI	Absent	26	3	29
	Present	13	8	21
Total		39	11	50

LVH: Left Ventricular Hypertrophy; LVMI: Left Ventricular Mass Index

**ECG**

Among the 50 patients studied for LVH by ECG, 11 (22%) patients shown LVH in ECG, 2 subjects were shown LVH by **Romhilt Estes Score** index criteria, 8 subjects shows LVH by Sokolow-Lyon criteria, 6 subjects shows LVH by Cornell voltage criteria, 4 subjects shows LVH by ECG by more than one criteria.

**Sensitivity of ECG =  $8/21 = 38\%$** , (true Positive cases)

**Specificity by ECG =  $26/29 = 89\%$** , (true negative cases)

On observation by ECG for LVH we can detect more nos. of true negative cases more accurately. i.e more specific. **(Table 2)**

**TABLE 2: Correlation of ECG with LVH and LV mass index (LVMI)**

ECG:			Echo LVMI		Total
			Absent	Present	Absent
LVH by ECG	Absent		26	13	39
		(% within LVH by ECG)	66.7%	33.3%	100.0%
	Present		3	8	11
		(% within LVH by ECG)	27.3%	72.7%	100.0%
Total			29	21	50
		% within LVH +/- by ECG	58.0%	42.0%	100.0%

LVH: Left Ventricular Hypertrophy, ECG: Electrocardiography, LVMI: Left Ventricular Mass Index

**Echocardiography**

Out of 50 patients studied 24 (48%) cases shown LVH by Echo based on LV wall thickness of 2D method (thickness > 12mm is taken as Concentric LVH). Out of 50 patients studied, 29 patients had Normal LVMI and 21 (42%) patients had Increased LVMI. Out of 50 patients 43(86%) had LV diastolic dysfunction and 7 (14%) had Normal LV diastolic function.

**Sensitivity of ECHO = 14/ 21= 67%**, (true Positive cases)

**Specificity by ECHO= 19/29 = 66%**, (true negative cases)

Hence, on observation Echocardiography method of detecting LVH and mass index appears more sensitive and specific when compare to ECG. **(Table 3)**

**TABLE 3: Correlation of LVH by wall thickness of by ECHO and LVMI:**

		LVMI (LV Mass Index)		
		Absent	Present	Absent
LVH by wall thickness	NO	19	7	26
	YES	10	14	24
Total		29	21	50

LVH: Left ventricular Hypertrophy; LVMI: Left Ventricular Mass index

**DISCUSSION**

**Prevalence**

In a previous study [40] LV mass index(LVMI) for Indian population was studied as 110 g/m<sup>2</sup> for females and 120 gm/m<sup>2</sup> for Males as normal and any values above this is considered as a LV H. These values were taken as reference values in this study and used as gold standard for Left Ventricular Hypertrophy.

The overall prevalence of LVH in hypertension as defined by Gender specific reference standard is reported to be 25% to 30% with 97 % specificity by Devereux RB et al [53]. Similarly Tingleff J et al [54] reported the prevalence of the LVH of 25 to 26 % in both gender. Similarly in present study of prevalence of LVH in hypertension, Left ventricular hypertrophy detected by Echocardiography LVMI method is 42 %, and a slight higher percentage may be attributed to the higher age group of hypertensive (> 60 years) and more ECG criteria (3criteria) are taken into consideration. Same finding’s noticed by Tingleff J et al [54] where he reported there was a significant difference in the prevalence of LVH between normotensive and hypertensive only in the age group of 65 years and above.

**Demographic Features**

**Age**

The mean age in years for LVH group in the present study (increase LV mass index) is higher than the normal LV mass (group-I). On comparing LVH with age numbers of patients are above the age of 60 years with LVH.

Hammond et al [53] also showed increased age was associated with LVH with increased LV mass. This may be due to increase in the duration of hypertension. There is no much difference in the mean body surface area of the 2 group.

**Gender**

In our study a slight higher percentage of (44.5%) of Females than Males (40.6%) had LVH. This is in contrary to the study by Cohen et al [55], where there was greater proportion of Men than Women had LVH.

However, Hammond et al [53] reported a greater proportion in Women than men is in favour of present study may be attributed to several factors like –

- The upper normal limit of these LVH criteria (LVMI) may be high for men than women,
- In the study the weight, BMI and duration of hypertension and diabetic etc are also the high risk factors may be the reason for increase in numbers of women with LVH than men.

### **Duration of Hypertension**

In the present study among the increased LV mass or LVH, more number of patients are found in duration of hypertensive group < 5 years. Many studies show the duration of hypertension has a significant factor in development of LVH. The Ross et al [56] report showed duration of hypertension added significantly in predicting on elevated LV mass and hypertrophy. In our study the finding may be contrary as the duration of hypertension increases, the effective and hypertensive medication has resulted in a reduced prevalence of high blood pressure and concomitant decline in LVH. Arends mastered et al [57] reported that mean decline in the hypertension was more in percent among both men and women with reduced LVH in hypertension patient in response to treatment in effective hypertensive drugs.

In the present study, more number of patient showed normal LV mass as compared to increased LVMI among the patient who received the regular antihypertensive drug treatment either by single or more than 2 drugs treatment, could give better BP control and hence reduced incidence of LVH. Many studies support this and show a regression of LVH with treatment and subsequently decrease in complication and cardiovascular incidence.

### **Investigations**

#### **ECG**

Present study compared the relative sensitivity and specificity of 2D Echocardiography and 12 Lead standard ECG method in detecting the left ventricular hypertrophy. They found, the Echo to be more sensitive and specific than 12 Lead ECG. The Sensitivity being 38% and 67% for ECG and Echo respectively and the Specificity being 89% and 66% for ECG and Echo respectively. Sensitivity of 12 Lead ECG showed much low, Hence, ECG correlated poorly with LVMI and has limited diagnostic accuracy when assessing LVH. Julius Nathan Woythaler et al [ 58 ] study for accuracy of Echo VS ECG in detecting LVH also showed low sensitivity. In the standard 12 Lead ECG on comparing the Sokolow-Lyon Voltage criteria and Cornel Voltage criteria with Romhilt – Estes Point Scoring system in detecting LVH the sensitivity was 24%, 29% and 5% in compared to LV mass index. Sokolow-Lyon Voltage criteria and Cornel Voltage criteria was more sensitive than that of Romhilt – Estes Point scoring system but specificity is more the cornel voltage and Romhilt – Estes Point score method. Hence these two criteria's may be the better criteria for diagnosing LVH based on standard 12 Lead ECG and has more diagnostic accuracy as well as closer correlation with LV mass index.

#### **Echocardiography**

Echocardiography is an extremely sensitive diagnostic tool for detecting LVH. It enables non-invasive direct visualization of cardiac chambers, wall thickness, cavity size and volumes and hence has more sensitivity and accuracy. In the present study LV wall thickness for detecting concentric LVH (>12mm wall thickness considered for LVH) shows more sensitivity and specificity (67% and 66%) with LV mass index of penns conventional formula and ASE method of calculating LVMI by Echo. The sensitivity and specificity was 67% and 66%. However, LV wall thickness method of 2D Echo did not take into account the weight and height of the patient.

Hence calculation of LVMI with Penns Conventional formula and ASE method provides more information regarding the LV weight corrected for BSA as well as height and weight of the patient and is a more reliable indicator of dilation of LVH.

About 90% of hypertensive patients with LVH have abnormal LV relaxation or grade I diastolic dysfunction. An abnormal LV relaxation is also relating frequent among subjects with normal LV mass in elderly

hypertensive. About 86% of patient in this study showed impaired diastolic function and above 22% of patients showed increased LA volume along with the increased LV mass index.

Julius Nathan Woythaler et al [ 58 ] for study of accuracy of Echo Vs ECG also showed Echo is more reliable for detecting LV mass by hypertrophy when compared with post mortem mass measurements.

Although Echo is the most sensitive and accurate diagnostic tool, the standard 12 Lead ECG and X-ray convey the other important information like arrhythmias, conduction block, pulmonary edema, increased cardiothoracic ratio etc. Hence Echo should be used in conjunction with other investigation tools like ECG & X-ray.

### CONCLUSION

In the study of 50 hypertensive patients, the prevalence of LVH was by ECG and Echo methods, where the LV mass index by Echo taken as standard reference.

1. Hypertensive patients with higher age (>60 years) are more associated with LVH and increased LV mass irrespective of gender classification.

2. Left Ventricular Hypertrophy detected by ECG criteria was 22%, among these

Romhilt - Estes point score index criteria was 4%

Sokolow – Lyon criteria was 16%

Cornel Voltage criteria was 12%

3. Left Ventricular Hypertrophy detected by ECHO was 67% based on LV wall thickness of 2D method.

4. Echocardiography is more reliable and cost effective tool for detecting LV mass and hypertrophy when compared to ECG. But specificity of ECG is also high.

5. Using Echo method of calculating LVMI as gold standard the Sensitivity of ECG for LVH was 38%.

Romhilt - Estes point score index criteria was 5%

Sokolow – Lyon criteria was 24%

Cornel Voltage criteria was 29%

6. Sensitivity of ECG found to be low and hence correlate poor with LV mass index.

7. The cornel voltage and Romhilt – Estes Point score methods have more diagnostic accuracy as well as closer correlation with LV mass index.

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