Original Article

In hypertensive patients – measurement of left ventricular mass index by echocardiography and its correlation with current electrocardiographic criteria for the diagnosis of left ventricular hypertrophy

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Abstract

Left ventricular hypertrophy has emerged as a powerful non invasive indicator of increased vulnerability to the occurrence of major Cardiovascular disease outcomes in hypertension. Electrocardiography and Echocardiography are the two very common modalities used to detect Left Ventricular Hypertrophy. The question is which among the two is better in terms of efficacy. So the present study was undertaken, because in the Indian population, due to lack of resources, expensive investigations like Echocardiography may not be within the common man's reach. A total of 50 patients were included in this study between the age group of 31-65 years after satisfying the inclusion and the exclusion criteria. All these patients who had Echocardiographic evidence of Left Ventricular Hypertrophy were compared with the Electrocardiographic Criteria using the Romhilt-Estes scoring system and Sokolow-Lyon voltage criteria system. Our study confirms that Romhilt and Estes point score is specific but insensitive and showed that the sensitivity of both the Electrocardiographic criteria for diagnosing Left Ventricular Hypertrophy increased with increasing body mass index. Our findings suggest that Echocardiography is a better modality for the detection of Left Ventricular Hypertrophy when compared to Electrocardiography because of lack of sensitivity of the Electrocardiographic criteria, even though it is slightly more expensive. In view of its' prognostic implication, routine use of Echocardiography for" the detection of Left Ventricular Hypertrophy could be justified. However, Electrocardiography should keep its place in the detection of Left Ventricular Hypertrophy as an initial modality because of its easy availability. Hence the two procedures be regarded as complementary to each other rather than mutually exclusive.

Keywords: Left Ventricular Hypertrophy; Electrocardiography; Echocardiography; Hypertension; Left Ventricular Mass; Left Ventricular Mass Index.

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INTRODUCTION

Left Ventricular Hypertrophy has emerged as a powerful indicator of increased vulnerability to the occurrence of major cardiovascular events in hypertension. The risk of cardiovascular disease at any level of high blood pressure increases markedly for patients with damage to the heart, kidneys, brain or large arteries. Left Ventricular Hypertrophy is causally related to high blood pressure and represents hypertensive target organ damage. Electrocardiographically detected Left Ventricular Hypertrophy is associated with an increased risk of cardiovascular morbidity and mortality as proved by the well known "Framingham Heart Study" as well as various other studies. In 1979, the Framingham Heart

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study incorporated Echocardiography into the assessment of Cardiovascular risk and subsequently demonstrated the prognostic importance of increased Left Ventricular Mass. Left Ventricular Mass is a more sensitive prognostic indicator of morbidity and mortality in coronary artery disease, than the conventional methods of evaluation of cardiovascular risk factors like office measurement of blood pressure and weight. So, Left Ventricular Mass is a marker of risk by serving as a sensitive indicator of cardiac end organ damage. Electrocardiography and Echocardiography are the two very common modalities used to detect Left Ventricular Hypertrophy. Both these modalities are non invasive and safe. The question that arises is which is better of the two in terms of sensitivity and specificity.

MATERIAL AND METHODS

Fifty hypertensive patients satisfying the following inclusion and exclusion criteria who had echocardiographic evidence of left ventricular hypertrophy were stdies. Study period was from June 2015 to December 2015.

Inclusion Criteria

Patients with blood pressure more than 140/90 mmHg or known hypertensive on treatment were included in the study.

Patients of age group 31-65 years of both sexes were included.

Exclusion Criteria

- Patients with myocardial infarction, ventricular aneurysm, severe right ventricular volume overload or hypertrophic cardiomyopathy or valvular heart disease were excluded from the study.
- Patients showing complete bundle branch block, evidence of myocardial infarction, Wolf Parkinson White Syndrome or atrial fibrillation on electrocardiography were excluded from the study.

OBSERVATIONS AND RESULTS

A total of 50 patients had Echocardiography of adequate quality and fulfilled the Echocardiographic diagnostic criteria for Left Ventricular Hypertrophy. Of these 40 were males and 10 females. The characteristics of the study population are listed in Table 1 for males and Table 2 for females. As expected the Left Ventricular Mass was more in males (mean 295.56gms) when compared to females (males 240.14gms), but when indexed for the body surface area the Left Ventricular Mass Index calculated was almost equal in both (mean 169.48 gm/m^2 in men and 168.199m/m^2 in women) the groups.

Table 1: Descriptive statistics – Male

	Mean	Standard Deviation
Age	59.65	11.24
Height	172.63	7.66
Weight	68.68	9.10
Systolic BP	164.20	23.35
Diastolic BP	97.65	13.82
LVM	295.56	61.65
LVMI	169.48	27.93

Table 2: Descriptive statistics – Female

	Mean	Standard Deviation
Age	58.30	10.24
Height	153.40	5.58
Weight	58.60	14.18
Systolic BP	173.10	32.66
Diastolic BP	101.70	19.45
LVM	240.14	60.28
LVMI	168.19	53.17

Sensitivity of electrocardiography: The sensitivity of Sokolow Lyon Voltage Criteria for detection of left ventricular hypertrophy keeping the echocardiographic diagnostic criteria as gold standard was 22%. The sensitivity of Romhilt Estes Point Scoring System was found to be 42%. Both criteria had 100% specificity.

Table 3: Sensitivity of Romhilt Estes point scoring system and Sokolow Lyon voltage criteria

		LVMI		
	All cases	Positive	Negative	Total
R and E	Positive	21	0	21
	Negative	29	0	29
	Total	**50**	**0**	**50**

Sensitivity – 42%

		LVMI		
	All cases	Positive	Negative	Total
SLV	Positive	11	0	11
	Negative	39	0	39
	Total	**50**	**0**	**50**

Sensitivity – 22%

Those patients diagnosed as having Left Ventricular Hypertrophy using Sokolow Lyon voltage criteria (11 out of 50) had Left Ventricular Mass (mean-291.33gms) and Left Ventricular Mass Index (mean 171.206 gms/m^2) slightly higher than those who were not diagnosed (mean Left Ventricular Mass- 282.629 gms; means Left Ventricular Mass index -168.666 gms/m^2). However comparison between the two groups was done using student 't' test which showed that the difference was statistically not significant (P_{LVM} = 0.708; P_{LVMI} = 0.82 respectively).

Table 4: Descriptive statistics – Sokolow-Lyon voltage criteria

	SLV	Cases	Mean	Standard deviation	Student 't' test
LVM	Negative	39	282.629	59.893	t=0.377
	Positive	11	291.033	82.815	$p=0.708^{NS}$
LVMI	Negative	39	168.666	34.785	t=0.218
	Positive	11	171.206	31.364	$p=0.82^{NS}$

NS – Not significant

Similarly the patients diagnosed as having Left Ventricular Hypertrophy using Romhilt and Estes Point Scoring system(21 out of 50) had Left Ventricular Mass (mean - 296.488 gms/m^2) and Left Ventricular Mass Index (mean 176.277 gm/m^2) higher than those who were not diagnosed (mean Left Ventricular Mass 275.782 gms and mean Left Ventricular Mass Index - 164.118 gms/m^2). The difference between the two groups was statistically insignificant [P_{LVM} - 0.269; P_{LVMI} = 0.209] when compared using t-test.

Table 5: Descriptive statistics – Romhilt Estes point scoring system

	RandE	Cases	Mean	Standard deviation	Student 't' test
LVM	Negative	29	275.282	65.491	t=1.119
	Positive	21	296.488	63.391	$p=0.269^{NS}$
LVMI	Negative	29	164.118	34.211	t=1.264
	Positive	21	176.277	32.636	$p=0.209^{NS}$

NS – Not significant

Influence of sex: Sensitivity of electrocardiograph was lower in women when compared to men. The difference was found to be more while using Sokolow-Lyon voltage criteria (odds ratio -3). Table 6 than while using ROIJ) hilt Estes point scoring system (odds ratio - 1.909). The difference was calculated using Chi-square Test and was found to be statistically insignificant.

Table 6: Influence of Sex on sensitivity pattern of Sokolow Lyon voltage criteria

		LVMI		
	Males	**Positive**	**Negative**	**Total**
SLV	Positive	10	0	10
	Negative	30	0	30
	Total	**40**	**0**	**40**

Sensitivity – 40%

		LVMI		
	Females	**Positive**	**Negative**	**Total**
SLV	Positive	1	0	1
	Negative	9	0	9
	Total	**10**	**0**	**10**

Sensitivity – 10%, Chi-square - 1.049, p-0.306 (p>0.05), Odds Ratio=3, (95%CI=0.337-26.710) [CI=Confidence Interval] [Not Significant]

Table 7: Influence of sex on sensitivity pattern of Romhilt Estes Point scoring system

		LVMI		
	Males	**Positive**	**Negative**	**Total**
RandE	Positive	18	0	18
	Negative	22	0	22
	Total	**40**	**0**	**40**

Sensitivity – 45%

		LVMI		
	Females	**Positive**	**Negative**	**Total**
RandE	Positive	3	0	3
	Negative	7	0	7
	Total	**10**	**0**	**10**

Sensitivity – 30%, Chi-Square = 0.739, p=0.39 (p>.05), Odds ratio = 1.909, (95% CI = 0.431 - 8.463) (Not Significant)

Influence of smoking: The two groups i.e. smokers and non smokers were not matched for their gender, age and blood pressure. Hence we got contradictory results stating that Electrocardiography was more sensitive in smokers than in non-smokers. The difference was however, statistically not significant (P_{SLV} = 0.793; P_{RandE} = 0.152).

Table 8: Influence of smoking on sensitivity pattern of Sokolow Lyon Voltage Criteria

		LVMI		
	Males	**Positive**	**Negative**	**Total**
SLV	Positive	6	0	6
	Negative	19	0	19
	Total	**25**	**0**	**25**

Sensitivity – 24%

		LVMI		
	Females	**Positive**	**Negative**	**Total**
SLV	Positive	5	0	5
	Negative	20	0	20
	Total	**25**	**0**	**25**

Sensitivity – 20%, Chi- Square = 0.117, p = 0.793 (p>0.05), Odds Ratio = 1.263, (95% CI = 0.330 - 4.783) (Not significant)

Table 12: Patients not on any drugs

		LVM	LVMI
Pearson's correlation (r)	Systolic BP	-0.203	0.145
	Diastolic BP	-0.271	-0.108
Significance (p)	Systolic BP	0.507	0.637
	Diastolic BP	0.371	0.726

Linear Regression Analysis was estimated and scatter diagram showed large degree of scatter with no correlation either between the Systolic Blood Pressure and Left Ventricular Mass (SBP= 189.072-(0.772)(LVM) r - 0.203; p = 0.507) (Figure 3) or between the Diastolic Blood Pressure and Left Ventricular Mass. (DBP = 114.662 - (0.064) (LVM); r = 0.271; p = 0.371) (Figure 4)

Profile of the Drugs used

The pattern of drug prescription of the hypersensitive patients were also analyzed. Among the patients studied 26% of them were not on any treatment. Among the 74% of the patients on treatment 62% were on mono drug therapy and 38% on multi drug therapy. (Figure 5) Of those patients on mono drug therapy the most commonly used drugs were Calcium Channel Blocker and Beta Blockers (30% each), followed by Angiotensin Converting Enzyme Inhibitors (21.7%). (Figure 6) Of those patients on multi drug therapy the commonest combination used was calcium channel blockers with Angiotensin Converting Enzyme Inhibitors (43%), followed by Calcium Channel Blockers with diuretics (21%), and Calcium Channel Blockers with Beta Blockers (21%). (Figure 6)

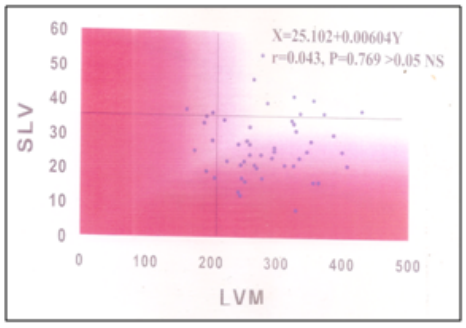
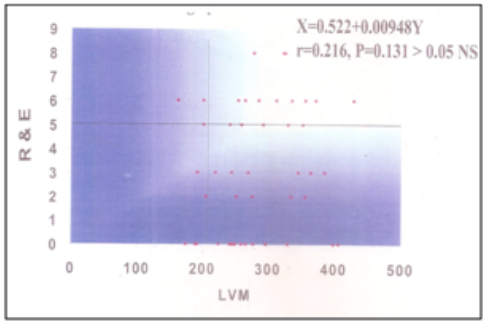


Figure 1



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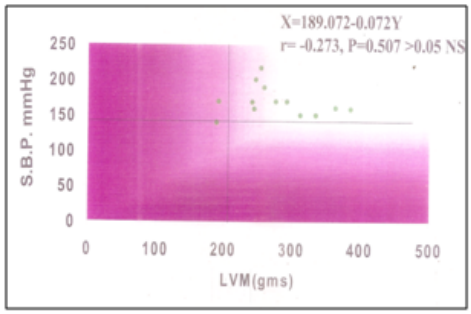

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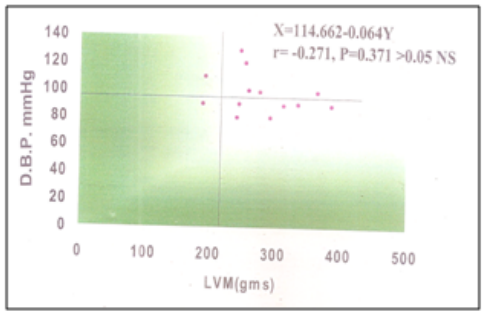
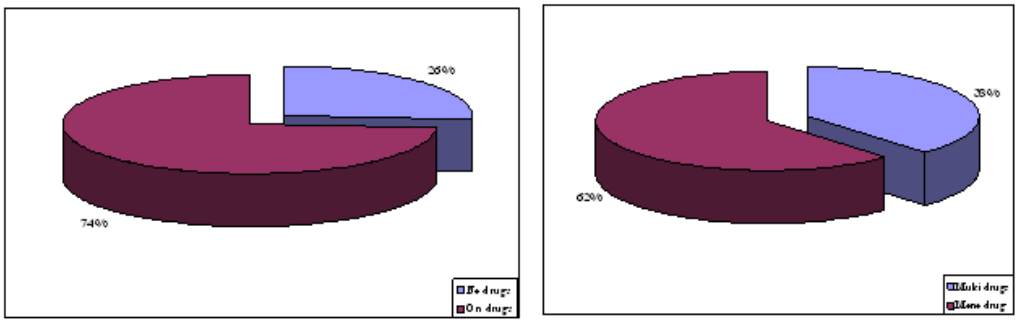


Figure 4



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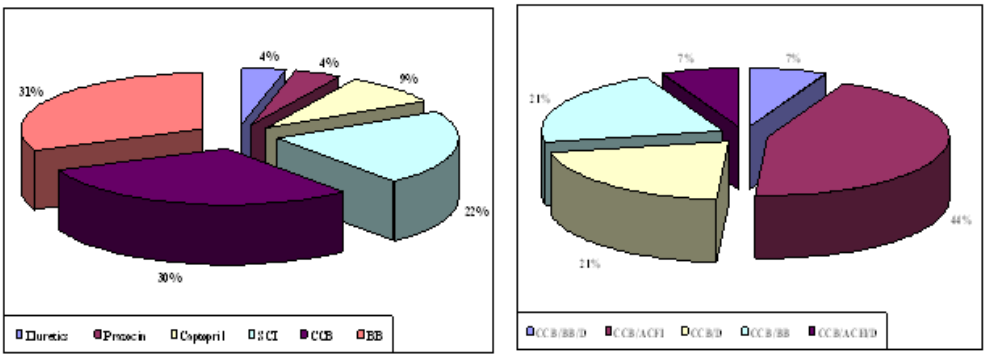

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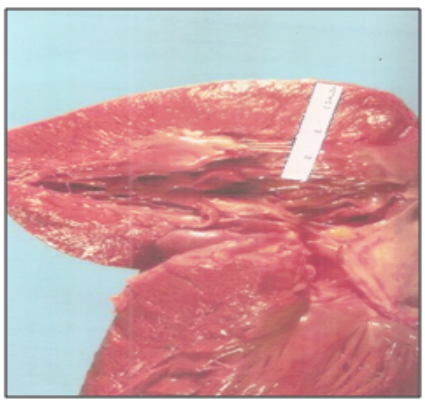

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Figure 7: **Figure 8**

Figure 1: Correlation between Sokolow Lyon voltage criteria and Left ventricular mass
Figure 2: Correlation between Romhilt Estes Point Scoring System and Left ventricular mass
Figure 3: Correlation between Systolic BP and Left ventricular mass
Figure 4: Correlation between Diastolic BP and Ventricular mass
Figure 5: Profile of drug usage in Hypertension Total number of patients All patients on drugs
Figure 6: Profile of drug usage in Hypertension A) Patients on mono drug therapy B) Patients on multi drug therapy
Figure 7: Autopsy specimen showing Left ventricular hypertrophy
Figure 8: Electrocardiography of one of the patients showing Left ventricular hypertrophy

DISCUSSION

Our study data confirms that Romhilt-Estes point score is specific but insensitive. In contrast, our study data on Sokolow-Lyon voltage criteria did not support the widespread impression that it is more sensitive and less specific than Romhilt-Estes point score. Rather, Sokolow-Lyon Voltage Criteria was less sensitive than Romhilt-Estes Point Score, with comparable specificity. The baseline gold standard used for the comparison of the Electrocardiographic criteria was M-mode Echocardiographically diagnosed two Left Ventricular Mass using Devereux formula. The excellent sensitivity, specificity and accuracy obtained using Echocardiographic criteria for diagnosis of Left Ventricular Hypertrophy when compared with anatomic Left Ventricular Mass, clearly show that this method is highly reliable. Nixon have also confirmed the reliability of this method angiographically. The Romhilt-Estes Point Scoring System, first devised from an analysis of the Electrocardiographic changes noted in Left Ventricular Hypertrophy, was originally reported to be 60% sensitive and 95% specific. In diagnosing Left Ventricular Hypertrophy. Our values are 42% and 100% respectively. Specificity though almost the same, the sensitivity was much lower in our study. Although other Point Scoring Systems have been proposed, they have not improved on the Romhilt Estes point score in diagnosing Left Ventricular Hypertrophy Sokolow-Lyon in their original study claimed the sensitivity of their voltage criteria to be 32% and specificity 100%. However, our study showed much lower sensitivity (22%) with same specificity (100%). Okin PM, Roman MJ (1995) found that Electrocardiographic criteria for Left Ventricular Hypertrophy has lower sensitivity in women when compared to men even when the gender difference like Left Ventricular Mass, height and weight were taken into account. Our study was consistent with the above findings. The sensitivity of both our electrocardiographic

criteria were more in men when compared to women. However, the difference when analysed using Chi-square test was not statistically significant. Schillaci G, Verdecchia P (1999) showed that electrocardiography had lower sensitivity for diagnosing Left Ventricular Hypertrophy in hypertensive smokers when compared to hypertensive non smokers. The two groups were matched by their gender, age, systolic blood pressure and diastolic blood pressure. In sharp contrast, our study showed higher sensitivity in hypertensive smokers when compared to hypertensive non smokers. This was probably because the two groups were not matched for other confounding factors like gender, age and blood pressures. This was not possible because out of 40 males, 25 were smokers and among the 10 females none were smokers. Our study showed that the sensitivity of both the electrocadiographic criteria for diagnosing Left Ventricular Hypertrophy increased with increasing body mass index. At higher body mass index i.e. patients who were overweight and obese had equal sensitivity for both electrocardiographic criteria. However, larger well controlled studies will be required to prove such associations. Clinical studies (Mansoor GA, Massie BM, 1999; Feala M, Boffano GM, 1998), have consistently showed that the ambulatory blood pressure is a strong correlate of Left Ventricular Mass than office blood pressure. In our study, we correlated the office blood pressure with the M-mode Echocardiographically diagnosed Left Ventricular Mass and found no correlation either with the systolic or diastolic blood pressures. Woythaler (1983)37 showed that Sokolow-Lyon Electrocardiographic voltage measurements correlated well with necropsy left ventricular mass. In our study, even though the mean Left Ventricular Mass of those patients diagnosed as having Left Ventricular Hypertrophy using Sokolow-Lyon voltage criteria \vas higher than the mean value of those who were not diagnosed no such correlation was seen in the Scatter diagram when compared with M-mode Echocardiographically diagnosed Left Ventricular Mass. Romhilt-Estes Point Score system does not lend itself to linear regression analysis, because it is a measure of the probability that Left Ventricular Hypertrophy is present rather than a grading scale for its severity. Our study did not show any correlation between the Romhilt-Estes point score and Echocardiographically diagnosed Left Ventricular Hypertrophy.

CONCLUSIONS

Our study suggests that Echocardiography is a better modality for the detection of Left Ventricular Hypertrophy when compared to Electrocardiography because of lack of sensitivity of the Electrocardiographic criteria. Even though this Echocardiography is slightly more expensive, in view of its prognostic implication, routine use of Echocardiography for detection of Left Ventricular Hypertrophy could be justified. However Electrocardiography should keep its place in the diagnosis of Left Ventricular Hypertrophy keeping in view its high predictive value for morbidity and mortality, its availability at most of the health centres, the relative ease with which it can be performed and its cost effectiveness. Hence we suggest that the two modalities be regarded as complementary to each other rather than mutually exclusive.

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