Comparison of Electrocardiographic Criterias for LVH using Echocardiography as Standard

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ABSTRACT

Introduction: Although newer diagnostic tools are available, the electrocardiogram (ECG) remains the most common mean for evaluating cardiac disease. Electrocardiographic evidence of left ventricular hypertrophy (LVH) is a major marker of cardiovascular morbidity and mortality. Though the specificities of these criteria are typically high (>90%), the sensitivities are lower and in the range of 20-60%. Emerging data suggest that echocardiographically defined LVH is also predictive of cardiovascular disease risk. The present study was designed to compare electrocardiographic criterias for left ventricular hypertrophy, using echocardiography as standard.

Material and Methods: The present study was conducted among 100 patients with history and clinical profile suggestive of cardiac morbidities such as essential hypertension, aortic stenosis leading to LVH with evidence of concentric LVH by echocardiographic criteria and/or evidence of LVH by electrocardiographic criteria. Electrocardiographic criteria used in left ventricular hypertrophy were Sokolow-Lyon index, Romhilt and Estes scoring system and total QRS voltage criteria. Diagnostic validity tests (specificity and sensitivity) and Kappa measure of agreement were performed.

Results: Using Sokolow-Lyon criteria ECG could diagnose LVH in 26(38%) of patients with 75% specificity. Using Romhilt and Estes scoring system ECG could diagnose LVH in 32 (47%) patients with 75% specificity. Using total QRS criteria ECG could diagnose LVH in 46 (67%) patients with 93% specificity. The present study found sensitivity 38% by Sokolow Lyon index, 47% by Romhilt and Estes point score system and found sensitivity 67% and specificity 93% by total QRS voltage criteria.

Conclusion: The sensitivity was in the range of 67% for total QRS voltage criteria to 38% for Sokolow Lyon criteria. Among the different criteria used, Total QRS criteria showed better sensitivity compared to others. In the evaluation of patients for LVH, the role of ECG with all the commonly used criteria is of limited value and ECHO is the method of choice.

Keywords: Left Ventricular Hypertrophy; Sokolow-Lyon Index, Romhilt and Estes Scoring System, Total QRS Voltage Criteria

INTRODUCTION

Left ventricular hypertrophy (LVH) is an important and consistent complication of high blood pressure (BP).[1] It is thought that this occurs as a result of increased after load imposed on the heart in high BP, which forces structural and functional adaptation. The later results in LVH involving an increase in muscle mass achieved by hypertrophy of the myocytes accompanied by high degree of polyploidy[2] as well as hyperplasia of cardiac connective tissue cells.[6] In addition, functional adaptation involves increase in heart rate, minute volume and initially contractility.[3] With persistence of high BP and maintenance of LVH, functional adaptation decompensate and unless effective therapy is interjected, left ventricular failure ensues as the major cardiac haemodynamic consequence.[4]

Left ventricular hypertrophy is no longer considered as an adaptive mechanism that compensates the pressure imposed on the heart and has been identified as an independent and significant risk factor for sudden death, acute myocardial infarction, congestive cardiac failure, and stroke.[5]

Although newer diagnostic tools are available, the electrocardiogram (ECG) remains the most common mean for evaluating cardiac disease.[6] Electrocardiographic evidence of left ventricular hypertrophy (LVH) is a major marker of cardiovascular morbidity and mortality.[7] In particular, several ECG criteria have been proposed for the detection of left ventricular hypertrophy (LVH) both in clinical practice and in epidemiological studies.[6] Though the specificities of these criteria are typically high (>90%), the sensitivities are lower and in the range of 20-60%. The advent of echocardiography has provided a noninvasive means of estimating left ventricular mass with close correlation to autopsy values (r>0.90). Emerging data suggest that echocardiographically defined LVH is also predictive of cardiovascular disease risk.[7]

Electrocardiographic criteria used in left ventricular hypertrophy are

Sokolow-Lyon index[8]

In 1949, Sokolow and Lyon pointed out that the presence of ventricular hypertrophy in adult is suggested when the sum of S wave in VI and R wave in V5 or V6 totals more than 35 mm.

Romhilt and Estes scoring system for left ventricular hypertrophy[9]

Romhilt and Estes in 1968 developed a point scoring system. A score of five or more points on ECG is diagnostic of left ventricular hypertrophy. A score of 4 points indicates that there is probably left ventricular hypertrophy.

Total QRS voltage criteria[10]

The total QRS voltage is obtained by adding the QRS amplitude in each lead in a 12-lead electrocardiogram. The amplitude of the QRS complex is measured from the peak of the R wave to the dip of the S wave according to the method of Siegel and Roberts. The total QRS voltage of 174 mm is taken as normal.

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Any value 175 mm or more will be taken as significant indicating left ventricular hypertrophy. The present study was designed to compare electrocardiographic criterias for left ventricular hypertrophy, using echocardiography as standard.

MATERIAL AND METHODS

The present study was conducted among 100 patients with history and clinical profile suggestive of cardiac morbidities such as essential hypertension, aortic stenosis leading to LVH with evidence of concentric LVH by echocardiographic criteria and/or evidence of LVH by electrocardiographic criteria. Patients suffering from ischemic heart disease and bundle branch blocks were excluded from the study. Ethical clearance was obtained from the ethical committee of the institute and informed consent was obtained from the patients before the commencement of the study. Patients were undergone detailed history, clinical examination, 12-lead ECG and echocardiography.

Electrocardiographic criteria used in left ventricular hypertrophy:

ECG Criteria	Points
Voltage Criteria (any of): R or S in limb leads ≥ 20 mm S in V1 or V2 ≥ 30 mm R in V5 or V6 ≥ 30 mm	3 points
ST-T Abnormalities: Without digitalis With digitalis	3 points 1 point
Left Atrial Enlargement in V1	3 points
Left axis deviation	2 points
QRS duration 0.09 sec	1 point
Delayed intrinsicoid deflection in V5 or V6 (>0.05 sec)	1 point
Maximum score= 13; Definite left ventricular hypertrophy -5 or more points; Left ventricular hypertrophy, probably – 4 points	

Table-1: Romhilt and Estes scoring system for left ventricular hypertrophy

Linear Method		
LV Mass:	Male	> 224g
	Female	> 162 g
Left ventricular mass index: (LV Mass/ BSA)	Male	>115 g/m^2
	Female	> 95 g/m^2
Septal Thickness (cm):	Male	>1.0cm
	Female	>0.9cm
LV posterior wall thickness (Diastole):	Male	> 1.0 mm
	Female	> 0.9 mm
2D Method		
LV Mass:	Male	> 200g
	Female	> 150 g
Left ventricular mass index: (LV Mass/ BSA)	Male	>102 g/m^2
	Female	> 88 g/m^2

Table-2: Criteria for LVH by echocardiography

1. Sokolow-Lyon index

S in V1+R in V5 or V6>35 mm.

2. Romhilt and Estes scoring system for left ventricular hypertrophy

3. Total QRS voltage criteria

The total QRS voltage is obtained by adding the QRS amplitude in each lead in a 12-lead electrocardiogram. The amplitude of the QRS complex is measured from the peak of the R wave to the dip of the S wave according to the method of Siegel and Roberts.

The total QRS voltage of 174 mm is taken as normal. Any value 175 mm or more will be taken as significant indicating left ventricular hypertrophy. Table 2 shows criteria for LVH by echocardiography.

After obtaining results of electrocardiogram and echocardiography diagnostic validity tests (specificity and sensitivity) and Kappa measure of agreement were performed. Table 3 shows interpretation of results.

RESULTS

Using Sokolow-Lyon criteria ECG could diagnose LVH in 26(38%) of patients with 75% specificity. Using Romhilt-Estes scoring system ECG could diagnose LVH in 32 (47%) patients with 75% specificity. Using total QRS criteria ECG could diagnose LVH in 46 (67%) patients with 93% specificity

Tables 4-6 shows results according to interpretation in table 3. Sensitivity was revealed 38%, specificity was 75%, positive predictive value was 76%, negative predictive value was 36%, accuracy was 50% and kappa measure of agreement was found to be 0.10 by Sokolow Lyon index (electrocardiographic criteria) for diagnosis of LVH (table 4,7).

Sensitivity was found to be 47%, specificity was 75%, positive predictive value was 80%, negative predictive value was 40%, accuracy was 56% and kappa measure of agreement was found to be 0.18 using Romhilt - Estes point score system (electrocardiographic criteria) for diagnosis of LVH (table 5,7).

Sensitivity was found to be 67%, specificity was 93%, positive predictive value was 95%, negative predictive value was 57%, accuracy was 76% and kappa measure of agreement was 0.52 by Total QRS voltage criteria (electrocardiographic criteria) for diagnosis of LVH (table 6 and 7).

DISCUSSION

Left ventricular hypertrophy (LVH) results from adaptation of the heart to increased haemodynamic burden. Therefore, early detection of LVH is important, although the 12-lead electrocardiogram (ECG) is still valued as an initial diagnostic test for LVH, its sensitivity in this respect leaves to be desired.[12] Echocardiography has been clinically employed for more than 30 years, becoming one of the most important non-invasive imaging methods in the evaluation of cardiac morphology and

		Echocardiogram (Echo)		
Electrocardiogram (ECG)		+	-	
	+	True positivity	False positivity	True positivity+ False positivity
	-	False negativity (false –ve)	True negativity (true –ve)	False negativity + True negativity
		True positivity+ False negativity	False positivity+ True negativity	

Table-3: Interpretation of results

dynamics.[13]

Left ventricular mass tends to increase with age, mainly in elderly due to increase in electrically-inactive fibrous tissue. Furthermore, in the elderly the ECG abnormalities that are commonly attributed to LVH often depend on conduction defects rather than on increase of muscular tissue, making the ECG diagnosis of LVH less precise. ECG tests of LVH have particularly been accused of having low sensitivity, leading particularly in the elderly to underestimation of LVH, to errors in detecting LVH regression in clinical trials, and to inclusion of a great number of subjects in erroneous percentiles in epidemiological studies. This problem is still open. In fact, the only way to clarify whether or not ECG criteria are reliable in diagnosing LVH in the elderly is to test them against a echocardiography in a population-based frame, but only a very limited number of epidemiological studies were specifically dedicated to this question in the elderly.[7] In view of this, the present study compared three most important electrocardiographic criterias for left ventricular hypertrophy, using echocardiography as diagnostic standard.

Sokolov - Lyon criteria is the oldest, simplest and quickest method for the diagnosis of left ventricular hypertrophy which was described in 1949 by Sokolow M and Lyon TP.[14] The Kappa measure of agreement was found to be 0.10 by Sokolow Lyon criteria, suggesting that there was a poor measure of agreement between electrocardiography and echocardiography in diagnosing left ventricular hypertrophy. The present study found sensitivity 38% and specificity 75% of Sokolov-Lyon index. Reichek et al[15] reported sensitivity 21% and specificity 95%. Murphy et al[16] reported sensitivity 60% and specificity 80%. Jaggy et al[17] reported sensitivity 61% and specificity 68%. Martin et al[18] reported sensitivity 31% and specificity 75%.

		Echocardiogram		Total
		+	-	
Electrocardiogram	+	26	08	32
	-	42	24	68
	Total	68	32	100

Table-4: Evaluation of Sokolow Lyon index (electrocardiographic criteria) for diagnosis of LVH

		Echocardiogram		Total
		+	-	
ECG	+	32	08	40
	-	36	24	60
	Total	68	32	100

Table-5: Evaluation of Romhilt and Estes point score system (electrocardiographic criteria) for diagnosis of LVH

		Echo		Total
		+	-	
ECG	+	46	02	48
	-	22	30	50
	Total	68	32	100

Table-6: Evaluation of Total QRS voltage criteria (electrocardiographic criteria) for diagnosis of LVH

Romhilt and Estes point score system involves complicated data acquisition for scoring. In the present study Kappa measure of agreement is 0.18 suggesting a poor measure of agreement between echocardiogram and electrocardiogram in diagnosing left ventricular hypertrophy. However, a better sensitivity compared to Sokolov-Lyon index was found. The present study found sensitivity 47% and specificity 75% by **Romhilt and Estes point score system.** Reichek et al[15] reported sensitivity 50% and specificity 95%. Kansal et al[19] reported sensitivity 57% and specificity 81%. Murphy et al[16] reported sensitivity 60% and specificity 90%. Hameed et.al[20] reported sensitivity 35% and specificity 90%.

Total QRS voltage criteria with the normal upper limit for total QRS amplitude of 175 mm was first determined by Roberts and Day[21] and later validated by Odom et al.[22,23] Odom et al[22] found that the upper limit of 175 mm yielded specificity of 100% for diagnosing LVH in subjects with heart weight less than 400 g.[23] Compared to Sokolov-Lyon and Romhilt-Estes criteria the total QRS criteria showed better sensitivity, specificity, accuracy and a fair Kappa measure of agreement. The Kappa measure of agreement was found to be 0.52 which suggests that there is a fair measure of agreement between electrocardiogram and echo diagnosing left ventricular hypertrophy. The present study found sensitivity 67% and specificity 93% by **total QRS voltage criteria.** Odom et al[22] reported sensitivity 70% and specificity 90%. Jaggy et al[17] reported sensitivity 42% and specificity 78%. Martin et al[18] reported sensitivity 30% and specificity 86%.

There is an increased risk of cardiac morbidity and mortality associated with left ventricular hypertrophy (LVH), so its detection is of major importance, especially for individuals with hypertension or other cardiovascular risk factors. It has been identified as an independent and significant risk factor for sudden death, acute myocardial infarction, and congestive heart failure. The increase in left ventricular mass represents a common final pathway towards the adverse effects on the cardiovascular system and represents a higher vulnerability to complications.[20]

CONCLUSION

The sensitivity was in the range of 67% for total QRS voltage criteria to 38% for Sokolow Lyon criteria. Among the different criteria used Total QRS criteria showed better sensitivity compared to others. In the evaluation of patients for LVH, the role of ECG with all the commonly used criteria is of limited value and ECHO is the method of choice.

S. No.	ECG Criteria	Sensitivity	Specificity	Accuracy	PPV	NPV	Kappa
1	S.L Criteria	38	75	50	76	36	0.10
2	R.E point	47	75	56	80	40	0.18
3	Total QRS	67	93	76	95	57	0.52

Table-7: Senstivity, specificty, accuracy, positive predictive value, negative predictive value and kappa measure of agreement of different electrocardiographic criteria for LVH

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