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# Assessment of sensitivity of ECG criteria for diagnosis of left ventricular hypertrophy in hypertension patients

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**Abstract**
**Introduction:** Hypertension is one of the important public health problems. Proper assessment of left ventricular hypertrophy in patients with hypertension is not only important but also of therapeutic and prognostic relevance. This study, therefore, compared 3 ECG criterias with echocardiography to evaluate their role for diagnosis of LVH in adult hypertensive patients.
**Material and Methods:** The present study was conducted among 90 patients who had hypertension. The standard 12-lead resting ECGs were evaluated according to the Sokolow–Lyon criterion, Romhilt–Estes scoring system and total QRS voltage criteria. Sensitivity and specificity were calculated accordingly.
**Results:** In this study out of 90 patients with hypertension 58 patients had echocardiographic evidence of LVH. The Sokolow-lyon criteria detected only 22 of them. The Romhilt - Estes point score system detected 28.Whereas the total QRS voltage criteria detected 41 patients with LVH. The study found 37% sensitivity with Sokolow-Lyon criteria, 48% sensitivity with Romhilt-Estes system and 70% sensitivity with total QRS voltage criteria in patients with hypertension.
**Conclusion:** The present study concludes that total QRS criteria showed a high sensitivity. Although ECHO is the gold standard for the diagnosis of left ventricular hypertrophy, but due to inadequate facilities in the remote and rural areas**,** ECG criteria such as total QRS voltage can be recommended as a routine investigation for LVH due to its less cost and easy availability.

**Keywords:** echocardiography (ECHO); hypertension; left ventricular hypertrophy (LVH); romhilt-estes; sokolow-lyon; total QRS criteria

## Introduction

Hypertension is one of the important public health problems. Hypertension is defined as the presence of a blood pressure elevated to a level that places patients at increased risk for target organ damage in several vascular beds. Clinically hypertension is characterized by a blood pressure more than 140/90 mmHg [1]. It is common, asymptomatic, readily detectable, usually easily treatable, and often leads to lethal complication if left untreated [2].

Left ventricular hypertrophy (LVH) is an important and consistent complication of high blood pressure (BP) [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]. LVH is not only an adaptation to increased hemodynamic load in hypertension, but is also independently associated with an enhanced risk for myocardial infarction, cardiac sudden death, congestive heart failure, and stroke in the general population, as well as in patients with systemic hypertension, coronary heart disease, chronic kidney disease, and atrial fibrillation [5].

Proper assessment of left ventricular hypertrophy in patients with hypertension is not only important but also of therapeutic and prognostic relevance [6]. A set of criteria based on electrocardiogram (ECG), a more readily available, simple, affordable, easy to use and portable tool has been developed for assessment of LVH. This study, therefore, compared 3 criteria with echocardiography to evaluate their role for diagnosis of LVH in adult hypertensive patients.

## Material and Methods

The present study was conducted among 90 patients who had hypertension. Patients suffering from ischemic heart disease, aortic stenois 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. Detailed history, clinical examination, 12-lead ECG and echocardiography was carried out. The standard 12-lead resting ECGs were evaluated according to the Sokolow–Lyon criterion [7] (S in V1+R in V5 or V6>35 mm); Romhilt–Estes scoring system [8] for left ventricular hypertrophy assigned as definite left ventricular hypertrophy - 5 or more points, left ventricular hypertrophy, probably – 4 points; and total QRS voltage criteria - Any value 175 mm or more of total QRS voltage was taken as significant indicating left ventricular hypertrophy. Sensitivity and specificity were calculated according to the variables given in the table 1 using formulas for sensitivity and specificity.

| | | Echocardiogram | | |
|---|---|---|---|---|
| Electrocardiogram | | + | - | |
| | + | a (true+ve) | b (false +ve) | a + b |
| | - | c ( false –ve) | d ( true –ve) | c +d |
| | | a + c | b + d | |

A True positivity

**Sensitivity** =---------- x 100 = ----------x100

a+c True positivity+False negativity

d Truenegativity

**Specificity** = ---------- x 100 = ----------x100

b+d False positivity+ True negativity

## Results

**Sokolow-Lyon index:** In this study out of 90 patients with hypertension 58 patients had echocardiographic evidence of LVH. Out of these 58 patients Sokolow-lyon criteria detected 22 patients. This gives the Sensitivity for hypertension with Sokolow-lyon criteria is 37%. The numbers of false positive cases were 8 (table 2 and 5).

**Table 2:** Interpretation of data according to Sokolow-Lyon index

| | | Echo | | Total |
|---|---|---|---|---|
| | | + | - | |
| ECG | + | 22 | 8 | 30 |
| | - | 36 | 24 | 60 |
| | Total | 58 | 32 | 90 |

**The Romhilt–Estes Point score system**

In this study, out of 90 patients with hypertension 58 had echocardiographic evidence of LVH. Out of these 58 patients the Romhilt-Estes system detected 28 patients (table 3 and 5).

**Table 3:** Interpretation of data according to The Romhilt–Estes Point score system

| | | Echo | | Total |
|---|---|---|---|---|
| | | + | - | |
| ECG | + | 28 | 08 | 36 |
| | - | 30 | 24 | 54 |
| | Total | 58 | 32 | 90 |

So the Sensitivity for hypertension with The Romhilt-Estes system is 48%. The numbers of false positive cases were 8.

**Total QRS voltage criteria**

In this study out of 90 patients with hypertension 58 had echocardiographic evidence of LVH. Out of these 58 patients the total QRS voltage criteria detected 41. This gives the sensitivity for hypertension with total QRS voltage criteria is 70%. The number of false positive cases was 2 (table 4 and 5).

**Table 4:** Interpretation of data according to Total QRS voltage criteria

| | | ECHO | | Total |
|---|---|---|---|---|
| | | + | - | |
| ECG | + | 41 | 02 | 43 |
| | - | 17 | 30 | 47 |
| | Total | 58 | 32 | 90 |

**Table 5:** Sensitivity for Hypertension of various ECG criterias

| Criteria | Sensitivity for Hypertension |
|---|---|
| Sokolow-Lyon index | 37 % |
| The Romhilt –Estes system | 48 % |
| Total QRS voltage criteria | 70 % |

## Discussion

Hypertension remains a major public health problem associated with considerable morbidity and mortality. Hypertensive heart disease is a constellation of abnormalities that includes left ventricular hypertrophy, systolic and diastolic dysfunction, and their clinical manifestations including arrhythmias and symptomatic heart failure. The classic paradigm of hypertensive heart disease is that the left ventricular wall thickens in response to elevated blood pressure as a compensatory mechanism to minimize wall stress [9]. The presence of left ventricular hypertrophy in a hypertensive patient is evidence of hypertensive target organ damage, although a number of factors other than blood pressure are known to be involved in the development of LVH. Left ventricular hypertrophy has been shown to be associated with a significant increase in risk of cardiovascular mortality among the general population and hypertensive patients, independently of whether it is determined by electrocardiogram, echocardiography or radiology [10].

In this study out of 90 patients with hypertension 58 patients had echocardiographic evidence of LVH. The Sokolow-lyon criteria detected only 22 of them. The Romhilt - Estes point score system detected 28.Whereas the total QRS voltage criteria detected 41 patients with LVH. The study found 37% sensitivity with Sokolow-Lyon index, 48% sensitivity with Romhilt–Estes system and 70% sensitivity with total QRS voltage criteria in patients with hypertension.

Dollar AL *et al* [11]. compared the sensitivity of the total 12-lead QRS amplitude with the sensitivity of certain standard electrocardiographic criteria for LV hypertrophy in necropsy patients with hypertrophic cardiomyopathy and found that the Sokolow-Lyon index had a sensitivity of 39%; the Romhilt-Estes point score system had a sensitivity of 49% and concluded that total 12-lead QRS amplitude more than 175 mm is a useful indicator of LV hypertrophy and, among patients with hypertrophic cardiomyopathy, it is more sensitive than other more commonly employed criteria. Kumar D *et al* [12]. Found sensitivity of 73% and specificity of 67% of total QRS voltage of 123 mm on ECG for diagnosing LVH. Antikainen RL *et al* [10]. assessed the clinical usefulness of the Sokolow-Lyon voltage criteria in the assessment of electrocardiographic left ventricular hypertrophy (ECG LVH) and reported that the greater the baseline ECG voltage sum, the greater the associated CVD mortality risk. Women tended to have a high risk of stroke mortality owing to LVH despite adjustments. Odom *et al* [13]. Found that the upper limit of 175 mm yielded

specificity of 100% for diagnosing LVH in subjects with heart weight less than 400 g.

On the contrary, Pewsner *et al* [14]. Revealed a low diagnostic value of electrocardiographic criteria to interpret left ventricular hypertrophy and recomended that electrocardiographic criteria should not be used to rule out left ventricular hypertrophy in patients with hypertension.

The prevalence of LV hypertrophy increases with the severity of hypertensive disease. By and large, one third to one half of hypertensive patients have LV hypertrophy. Obviously, the partition values used for the definition of an abnormal LV mass and the diagnostic procedures are critical. The actual prevalence of structural changes of the myocardium in hypertension may, however, be higher.[15] Echocardiography is more sensitive than electrocardiogram in diagnosing LVH and may help in the more precise stratification of overall risk and in the determination of therapy for hypertensive patients [16, 17].

## Conclusion

The present study concludes that total QRS criteria showed a high sensitivity than Sokolow-Lyon index and the Romhilt-Estes point score system. Although ECHO is the gold standard for the diagnosis of left ventricular hypertrophy but due to inadequate facilities at the remote and rural places in developing countries**,** ECG criteria such as total QRS voltage can be recommended as a routine investigation for LVH due to its less cost and easy availability.

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