Best LVH-ECG criteria for Indonesian hypertensives

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Abstract. Most of available left ventricular hypertrophy electrocardiographic (LVH-ECG) criteria which have different sensitivities and specificities have not been applied in Indonesian population. Left ventricular hypertrophy (LVH) happens as a pathophysiologic adjustment to the increased afterload in arterial hypertension. There are ECG and echocardiogram data gained including 19 hypertensive persons and 6 for control measurements. These criteria were Sokolov Lyon (SL), Cornell Voltages (SV), and Romhilt Estes (SE). ECG LVH was pronounced as mass of LV with index for height at 95 percent as the control. The value of electrocardiographic LVH prevalence found in the hypertensive sick persons with electrocardiographic criteria as 47% for SL, 21% for CV, and 16% for RE. SL criteria had the best sensitivity (80%) while the RE score with specificity of 93% as the best. The best ECG LVH for sensitivity and specificity is Sokolov Lyon criteria which could be the best in ECG criteria for LVH diagnosis in Indonesia.

1. Introduction
LVH had consistently become main risk point for cardiovascular disease and mortality. Previous studies show that LVH diagnosed by the electrocardiogram (ECG) is sustained arterial hypertension with a danger factor that does not depend on blood pressure which cause acute myocardial infarction, rapid cardiac mortality, or cardiovascular illness and deadness [1,2,3]. Hence, the imaging and detecting of LVH become a significant segment in cardiovascular procedures of patients with hypertension. For a long time electrocardiogram was the main tools for identifying LHV, before the echocardiography was invented. Because ECG is cheap, fast, available, various criteria for ECG had been developed to diagnose LHV. Although they had distinctive sensitivity and specificity if we compare it to a good standard tool and it is insufficiently correct to diagnose LVH. In spite of the fact that echocardiography are more costly, it has been standardized and had a closed relation with measurements of mass of the left ventricular that is validated with autopsy. It is then having more preferable dominance to diagnose LVH [4]. Nonetheless, because echocardiography is at a high cost and relative unavailable like x-ray linear accelerator[5], in most emergent nations people depends on electrocardiographic tools to diagnose LHV. There are also important differences on structural and functional from the LVH based on the human race [6,7]. Almost all of the criteria defined before for detecting LVH had been succeed for African population [8]. Hence, this study purposed to evaluate a few of criteria in ECG to diagnose LVH. The evaluation will help to suggest which from these criteria be best suitable to make a LVH diagnosis for Indonesian hypertensive, in which the echocardiographic tools is limited of its regular utilize to diagnose LVH.
2. Material and Methods
The research using the electrocardiography and echocardiography recording procedure was carried out in Hasanuddin University Education Hospital and Wahidin Sudirohusodo Hospital, Makassar. All hypertensive patients were more than 18 years and were checked in the cardiology clinic in the Wahidin Sudirohusodo Hospital.

2.1 Electrocardiographic Data Measurement
Standard ECG with 12 leads was used for each person with a 12 Channel Cardio Touch 3000 Bionet with calibrated scales of 1 mV/cm & 25 mm/s. Each electrocardiogram had been read with calipers manually. LVHs were analyzed with calculation based from the next ECG criteria: a) Sokolov Lyon criteria (summation of amplitudes of the voltage SV1 (S in V1-lead) and RV5 (R in V5-lead) or RV6 (R in V6-lead) more than 3.5 mV), b) Romhilt Estes points more than 5 points, c) Cornell criteria with sexual specific defined (summation of amplitude of S in V3-lead and R in aVL-lead with 2.0 mV for women and 2.8 mV for men).

2.2 Echocardiographic Data Measurement
The examination of echocardiographic data was conducted using a standard machine. The complete examined echocardiographic data was conducted following the standard Indonesian recommendation. ECG records was traced simultaneously during all tests. For the measurement the area and the height of body surface we used LV mass index. Two-dimensional images were used to derive M-mode images. Measurements of the graphics were averaged over five cardiac cycles.

2.3 Data Handling and Analysis
In this research ECG data recordings retrieved from healthy patients and patients suspected of having LVH. The sensitivity and specificity data measurements from echocardiographic LVH was defined as the reference against the each performance of every compared ECG criteria. From the continuous variables we have mean values to be compared with an unpaired t-test and we use x²-analysis to compare the differences for each prevalence between all the groups. It is considered to be statistically significant if the value of P is less than 0.5. Data management and analysis were performed with Excell Program from Windows Corporation. The presented data were the mean average and standard deviation for all continuous data variable and with proportion for categorical data variable.

3. Results
ECG recordings from 25 patients were divided into 6 types based on 4 parameters: heart rate, QRS complex, q wave to R and PQRST complex. Temporal characteristics of the ECG QRS complex in P2, P3, P4, P5 and P6 type hearts were increased due to the presence of LVH, especially the distance from Q wave to the peak of R wave in leads II, with distances of more than 40 ms which indicate ventricular depolarization of cardiac abnormalities. The maximum amplitude from the R waves was higher than 1.6 mV for the left chest leads (V5 leads), with S wave amplitude increases of more than 1.7 mV in the right chest leads (V2 leads) in P2, P3, P5, and P6. The P1 and P4 have the R wave amplitude and normal S wave, which showed that LVH cardiac abnormalities, resulted an increase in the electrical potential character, especially on the left chest, leads. Temporal characteristics of the ST segment of P2, P4 and P5 were less than 90 ms, while the ST segments from P3 and P6 were more than 90 ms. In addition, the resting phase of the heart after ventricular repolarization was shorter, especially in P2, P3, P4, P5, and P6. Changes in ST segment elevation and depression higher than 0.1 mV were mainly seen in the chest leads in all cases, but only P1 had no elevation in the chest leads while P2, P3, P4, P5 and P6 had elevation and depression which was higher than or equal to 0.1 mV in the chest leads, showing abnormal cardiac repolarization. The P1 patients had a normal heart rhythm, and patients with abnormalities had an irregular heart rhythm as seen in P5 and P6.
From 19 patients with hypertension (9 men and 10 women) and 6 healthy people for control (2 men 4 women) were sampled, there is no significant differences in their ages. We were using 95% as the control as points for cut-off to determine the partition values for left ventricular hypertrophy by echocardiography. Correlation of LHV Prevalence and ECG criteria was shown in Table 1. The sensitivity by echocardiography of LVH among patients with hypertension were 47% for Sokolov-Lyon’s criteria, 21% for Cornel criteria and 16% for Romhilt-Estes criteria.

| Electrocardiography criteria | SL    | CV    | RE    |
|-----------------------------|-------|-------|-------|
| Hypertensives (n=19)        | 9 (47%) | 4 (21%) | 3 (16%) |
| Controls (n=6)              | 1 (16%) | 0 (0%)  | 0 (0%)  |
| Specificity                 | 76%    | 88%    | 93%    |
| Sensitivity                 | 80%    | 25%    | 25%    |

4. Discussion
The central point in the paper is that from all the groups of Indonesian patients with hypertension and normal healthy person as controls, the criteria from Sokolov Lyon appears to have the best values criteria for sensitivities and specificities to be applied in normal ECG-LVH diagnosis. From diagnosis of LVH by ECG, we can see that the performance of standard electrocardiographic criteria is that of having low sensitivities but with high specificities. For Indonesian people, standard ECG criteria for LVH had demonstrated elevated sensitivities simultaneously with a decline in specificities if we compare to western and african people [8]. The values of specificities and sensitivities from different ECG criteria for LVH found in this study correspond well to findings from other studies [12]. The Sokolov Lyon criteria that primarily sum of the amplitudes SV1 and RV5 or RV6 more than 3.5 mV) was the best criteria that gives the largest sensitivities and specificities that might be the best fit for the procedure of LHV electrocardiographic diagnosis for Indonesian. Other criteria, for example Cornel criteria and Romhilt Estes criteria owned larger specificities, but they were having very little sensibility compared to one from Sokolov Lyon. We can see also in this study that the Romhilt Estes criteria was criteria with the highest specificity. The less specific of results from many ECG criteria in Indonesian hypertensive population might produce a clue that a formal accepted ECG criteria with ethnic-based specificity is required for an effective electrocardiographic diagnosis for suspected LVH in Indonesians. Increasing the standard point for cut-off in Sokolov Lyon LVH criteria would reduce the sensitivity and raise the specificity. Moreover, in order to justify the predictive importance of various partition values of the ECG criteria, more longitudinal researches in Indonesian populace would be needed.

5. Current and Future Perspectives
Since the relatively cheap price of the ECG and the large frequency with its perform for other reasons, the results of Levy et al [10-12] to recommend not a call for abandonment of the ECG as the main tools of detecting LVH, but rather to improve of ECG methods by considering biological variables[13]. Clinicians and investigators should continue to investigate other ECG criteria (e.g., Sokolow-Lyon voltage alone or Romhilt Estes criteria [14]) that are known to have more reasonable sensitivity for LVH. Moreover, a variety of voltage combinations and multivariate equations have been developed that appear to be more successful criteria for detecting LVH in clinical populations and deserve further prospective evaluation.
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