Diagnostic Performance of Electrocardiographic Criteria Compared With Echocardiographic Diagnosis of Left Ventricular Hypertrophy in Patients at the Outpatient Department

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Abstract

INTRODUCTION: Several electrocardiographic (ECG) criteria have previously been suggested to diagnose left ventricular hypertrophy (LVH). Studies on diagnostic performance of each criterion in Asian population were limited and this study was done to determine the diagnostic performance of the six different ECG criteria, including the newly developed Peguero–Lo Presti criterion, in diagnosing LVH in Filipino patients.

METHODOLOGY: A single-center retrospective cohort study was conducted. The comparison of ECG to echocardiographic diagnosis of LVH was assessed by Spearman ρ correlation. The area under the curve analysis was used to evaluate discrimination ability of ECG-LVH criteria to identify echocardiography-LVH. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the six criteria were described with 95% confidence interval, with $P < 0.05$ considered statistically significant.

RESULTS: A total of 325 patients were included in the final analysis; 56.61% had LVH, 23.07% of which were both ECG-based and echocardiography-based LVH. The Peguero–Lo Presti criterion had the highest sensitivity (53.1%), a lower specificity (75.5%), and a lower accuracy (68.6%), compared with the other criteria. Sokolow-Lyon index had highest specificity (97.2%) and positive predictive value (75.0%). Cornell voltage had relatively better discriminative performance (area under the curve, 0.73).

CONCLUSION: Having a higher sensitivity, the Peguero–Lo Presti criterion can be used as a screening tool for LVH more than the Sokolow-Lyon and Cornell voltage. Cornell voltage criterion has higher correlation with left ventricular mass index and better discriminative ability for the detection of LVH. Further studies with the possibility of combining different ECG criteria are suggested to increase the sensitivity of the ECG criteria.

KEYWORDS: Cornell voltage, electrocardiographic LVH criteria, left ventricular mass index, Peguero–Lo Presti criteria, Sokolow-Lyon voltage

INTRODUCTION

Left ventricular hypertrophy (LVH) is a condition in which there is an increase in left ventricular mass (LVM), either due to an increase in wall thickness or due to left ventricular cavity enlargement, or both.[1] It is present in 15% to 20% of the general population and an independent risk factor for increased cardiovascular morbidity and mortality and therefore a major public health burden, especially in the light of an aging population. The detection of LVH is important because the risk of cardiovascular morbidity and mortality in the patients with increased LVM is increased by twofold to fourfold compared with patients with normal LVM. In terms of specific testing, cardiac magnetic resonance (CMR) imaging is the current criterion standard for the evaluation of LVH, as it is even more precise and provides high-resolution images.[2] However, given its limited availability and high cost, CMR is not practical for routine evaluation of patients. Echocardiography can visually measure every parameter of cardiac structure noninvasively and has long been established as the method of choice for the diagnosis of LVH.[3] Although there are differences in estimates by echocardiography and CMR, studies have shown that CMR and echocardiography have high correlation. Studies concluded that LVH assessed by both echocardiography and CMR is a reliable cardiovascular event predictor, but echocardiography is more practical on a clinical basis, and CMR would be preferable for research and specific clinical conditions requiring higher accuracy and reproducibility.[4] Echocardiography is less expensive and more available compared with CMR. However, not all institutions have echocardiography, particularly in hospitals in the far-flung areas. On the other hand, 12-lead electrocardiogram is a cost-effective, most readily available test for routine screening of LVH and more convenient in routine clinical practice than echocardiogram and CMR. It continues to be extensively used as one of the most reliable and reproducible diagnostic tests. Studies have shown that LVH detected by electrocardiography (ECG) has been predictive of outcomes as LVH detected by imaging. Both LVH diagnosed by ECG (ECG-LVH) and LVH by echocardiography (echo-LVH) have been independently associated with an increased risk of cardiovascular events.[5]

Several ECG criteria have previously been suggested to diagnose LVH, with differences in the degree of accuracy among them. Among the various criteria, the commonly recognized established criteria are the Sokolow-Lyon index, Cornell voltage, and the Cornell voltage product. Many of the traditional criteria had emphasized measuring the tallest amplitude of the R wave in various leads, but according to the recent study by Peguero et al,[6] S waves of the precordial and limb leads had a better association with an increased LVM. They reported that the sum voltage of the deepest S wave and S wave in lead V4 outperformed Cornell voltage with a significantly higher sensitivity. Peguero–Lo Presti is a newly developed ECG-LVH criteria that, according to validation studies, had superior diagnostic accuracy compared with the traditional ECG-LVH criteria. According to the meta-analysis done by Noubiap et al[7], wherein 10 studies were included with data from 5984 individuals, and results showed that Peguero–Lo Presti had the highest pooled sensitivity (43.0%; 95% confidence interval [CI], 30.2%–56.9%), followed by Cornell (26.1%; 95% CI, 16.9%–37.9%) and Sokolow-Lyon (22.0%; 95% CI, 14.1%–32.7%). However, Peguero–Lo Presti had the lesser pooled specificity (90.5%; 95% CI, 86.3%–93.5%), and Cornell had the highest (94.9%; 95% CI, 90.3%–97.3%). Peguero–Lo Presti had the best accuracy according to summary receiver operating characteristic curves, with an area under the curve (AUC) of 0.827 compared with 0.715 for Cornell and 0.623 for Sokolow-Lyon.[7]

LVH is defined as LVM index (LVMI) ≥115 g/m^2 for male and ≥95 g/m^2 for female according to the American Society of Echocardiography (ASE). Although these normative values are used as reference worldwide, they are derived from data reflecting a predominantly white population that is not representative of patients from other races, particularly Asians. Recent reports suggest that “normal” hearts from Asians are smaller compared with those reported in American and European studies.[8] The World Alliance Societies of Echocardiography (WASE) Normal Values Study evaluates individuals from multiple countries and races, including the Philippines, with the aim of describing normative values that could be applied to the global community worldwide and to determine differences and similarities among people from different countries and races. Based on the results of the WASE study, the normal ranges for LVMI in male and female Filipino patients are 48 to 100 and 39 to 99 g/m^2, respectively.[8]

It remains unclear which ECG criterion performed better in diagnosing LVH. Although it is known that the ECG-LVH criteria might be ethnic dependent, few studies explored this issue, and most studies of these ECG-LVH criteria, particularly the newly proposed Peguero–Lo Presti criteria, were conducted in Caucasians, and studies that evaluate the performance of these criteria in Asian population were limited. Because of ethnic differences in ECG characteristics found in several studies, the applicability of these criteria to Filipino patients remains to be demonstrated. In this study, we aimed to determine the diagnostic performance of the six different ECG criteria in diagnosing LVH in Filipino patients, using echocardiography as a method of reference in measuring LVM and using the Devereux formula for calculating LVMI as the recommended formula of the ASE with the ranges set by the WASE study for LVMI of Filipino patients. We aimed to analyze the association between ECG-LVH and LVH diagnosed by transthoracic two-dimensional echocardiography (echo-LVH) in Filipino patients. The data that were gathered from this study have important clinical implications. The expenditure of diagnosing LVH by echocardiography is much greater than by ECG. Electrocardiography is cost-effective and more convenient in routine clinical practice than echocardiogram or magnetic resonance imaging. Data from this study can help clinicians in determining which ECG criteria will be more appropriate to use in clinical practice.

METHODS

Study Design, Setting, and Population

This is a single-center retrospective cohort study of patients who underwent both ECG and echocardiography performed during the same visit at the outpatient department from January 2021 to April 2021. Electrocardiography and echocardiography databases were reviewed and analyzed. Data for this study were obtained at the cardiovascular unit, and review of patient's demographics, body mass index (BMI) calculated as the weight in kilograms divided by the height in meters squared, body surface area (BSA) calculated according to Dubois formula [BSA = 0.007184 × height (m)$^{0.725}$ × weight (kg)$^{0.725}$], ECG, and transthoracic two-dimensional echocardiography were done. The study was reviewed and approved by the research ethics and review committee.

Inclusion criteria: Patients 18 to 99 years old who had both an ECG and a two-dimensional echocardiography done at the outpatient department

Exclusion Criteria:

(1) Patients who had ECG and echocardiography that are admitted
(2) Patients with ECG but do not have echocardiogram
(3) Patients with poor-quality ECG such as those with baseline wander, electrical interference/grounded ECG, incorrect ECG lead placement, and faded ECG tracings
(4) Patients with technically poor echo window, presence of pericardial effusion, and valvular heart disease
(5) Patients with nonsinus rhythm, including atrial fibrillation, atrial flutter, junctional rhythm, and ventricular tachycardia
(6) Patients with frequent premature ventricular contraction or aberration
(7) Patients with ventricular conduction abnormalities, such as complete left or right bundle-branch blocks, QRS duration ≥120 milliseconds
(8) Patients with pacemaker rhythm

Electrocardiography

Standard 12-lead ECGs that were acquired were at 10 mm/mV calibration and speed of 25 mm/s. All 12-lead ECG interpretations were independently reviewed by the primary investigator and another cardiologist. A metal ECG caliper was used for the measurements. LVH diagnosed by ECG was defined based on the following ECG-LVH criteria mainly used in clinical practice:

1. Sokolow-Lyon voltage (Sokolow and Lyon, 1949)
   - $S_{V1} + R_{V5/V6}$ = ≥ 35 mm
2. Sokolow-Lyon index (Sokolow and Lyon, 1949)
   - R in aVL = ≥11 mm
3. Sokolow-Lyon voltage product (Molloy et al, 1992)
   - $S_{V1} + R_{V5/V6}$ × QRS duration = ≥3000 mm · ms for women and ≥4000 mm · ms for men
4. Cornell voltage (Casale et al, 1987)
   - R in aVL + S in V3 = >28 mm in men, >20 mm in women
5. Cornell voltage product (Molloy et al, 1992)
   - $(R_{aVL} + S_{V3})$ × QRS duration = >2440 mm · ms (in women 6 mm is added to Cornell voltage)
6. Peguero–Lo Presti (Peguero et al, 2017)
   - Deepest S wave in any single lead S_D + S_{V4} = ≥28 mm for men, ≥23 mm for women

Transthoracic Two-Dimensional Echocardiogram

Using the transthoracic echocardiogram database, the digital records of the echocardiographic study done were independently reviewed by two level III echocardiographers to ensure that standardization techniques were followed in image and measurement acquisitions. Two-dimensional guided M-mode echocardiographic study of the left ventricle was performed at the parasternal long-axis view, and interventricular septum (IVS), left ventricular internal diameter (LVID), and posterior wall thickness (PWT) were measured. LVM was calculated using the Devereux formula as recommended by the ASE:

$$LVM(g) = 0.8 \times 1.04 \times [(IVSd + LVIDd + PWTd)^3 - LVIDd^3] + 0.6g$$

LVMI is LVM indexed by BSA, calculated by Dubois formula [BSA = 0.007184 × height (m)$^{0.725}$ × weight (kg)$^{0.725}$]. For this study, we used the ranges for LVMI in the WASE study for Filipino patients. LVH were defined as LVMI >100 g/m^2 for male patients and >99 g/m^2 for female patients.[8]

Statistical Analysis

Baseline characteristics were described according to LVH group (ECG-based LVH, echo-based LVH, both ECG- and echo-based) and non-LVH groups. Numerical variables are reported as mean ± standard deviation for normally distributed variables and median for non–normally distributed variables. Categorical variables are reported as percentages. Analyses between the LVMI and ECG-LVH criteria were done by Spearman ρ correlation. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy described the performance of each ECG-LVH criteria. Area under the curve analysis was used to evaluate the discrimination ability of the ECG-LVH criteria against echo-LVH. Results are reported as percentage with 95% CI. $P < 0.05$ was considered statistically significant. The statistical analyses were performed using Epi Info version 7 (Centers for Disease Control and Prevention, Atlanta, Georgia) and Jamovi statistical software.

Ethical Considerations

All data that were used for the study were obtained after the research ethics and review committee approved the protocol and the requirement for written informed consent was waived. All information was kept confidential to the extent allowed by law. All study data were coded and a unique code number was given to each patient's data that were included in the study.

Table 1. Baseline Clinical Characteristics of Sample Population

Characteristics	Total (n = 325)	Non-LVH (n = 141)	Both ECG-Based and Echo-Based LVH (n = 75)	Only ECG-Based LVH (n = 71)	Only Echo-Based LVH (n = 38)	*P*
Clinical Characteristics						
Age (y)	325	53.41 ± 14.02	57.52 ± 13.98	53.38 ± 16.4	55.24 ± 12.43	0.203
Male	189	76 (40.21%)	50 (26.46%)	37 (19.58%)	26 (13.76%)	0.112
Female	136	65 (47.79%)	25 (18.38%)	34 (25%)	12 (8.82%)	
BMI (kg/m^2)	325	25.2 (22.9–29.1)	25.7 (23.35–27.55)	24 (22.5–27.65)	26.35 (24.33–29.22)	0.142
BSA (m^2)	325	1.73 ± 0.19	1.72 ± 0.21	1.69 ± 0.2	1.79 ± 0.22	0.085

BMI=body mass index; BSA=body surface area; ECG=electrocardiography; Echo=echocardiography; LVH=left ventricular hypertrophy.

Table 2. Linear Correlation Between LVMI and ECG-LVH Criteria

Variable	Correlation Coefficient (r)	*P*
Sokolow-Lyon voltage	0.260	<0.001
Sokolow-Lyon index	0.298	<0.001
Sokolow-Lyon product	0.249	<0.001
Cornell voltage	0.357	<0.001
Cornell voltage product	0.310	<0.001
Peguero–Lo Presti	0.342	<0.001

ECG-LVH=left ventricular hypertrophy diagnosed by electrocardiography; LVMI=left ventricular mass index.

More specifically, personal identifying information, including hospital unit numbers, subject names/initials, phone numbers, and addresses, was removed. Only the research staff related with this study was allowed to look at the data gathered. Subject's name or other facts that might point to the patient will not appear when the researcher talked about this study or published its results.

RESULTS

A total of 1149 patients had ECG done at the outpatient department from January 2021 to April 2021 and 325 patients who satisfied the inclusion criteria were included in the final analysis. Among the sample population, 184 patients (56.61%) had LVH, 71 (21.85%) of whom were ECG-based LVH, 38 (11.69%) were echo-based LVH, and 75 (23.07%) were both ECG-based and echo-based LVH. Echo-LVH was detected by ECG-LVH criteria in 23.07% of the sample population. LVH prevalence was higher among men, age older than 57 years, and overweight (BMI 23–27.5 kg/m^2) classified by the World Health Organization Asian criteria for nutritional status, but the differences between groups were not statistically significant.

Using the Spearman ρ correlation analysis, the six ECG-LVH criteria were significantly associated with LVMI ($P < 0.05$) as shown in Table 2. The Cornell voltage had the highest correlation (r = 0.357), followed by Peguero–Lo Presti criteria (r = 0.342).

We evaluated the diagnostic performance of ECG-LVH criteria when echo-LVH was taken as reference. As presented in Table 3, generally, the ECG-LVH criteria had low sensitivity and positive predictive value, but high sensitivity and negative predictive value. Peguero–Lo Presti criteria had the highest sensitivity (53.1%; 95% CI, 43.5%–62.5%), followed by Cornell voltage product (46.9%; 95% CI, 37.5%–56.5%), Cornell voltage (38.1%; 95% CI, 29.1%–47.7%), Sokolow-Lyon voltage (29.2%; 95% CI, 21.0%–38.5%), Sokolow-Lyon product (27.4%; 95% CI, 19.5%–36.6%), and lastly Sokolow-Lyon index (15.9%; 95% CI, 21.0%–38.5%). Peguero–Lo Presti criterion was found to have correspondingly lower specificity (75.5%; 95% CI, 69.2%–81.0%) and lower accuracy (68.6%; 95% CI, 63.3%–73.6%), compared with the other criteria. Sokolow-Lyon index, although with the lowest sensitivity (15.9%; 95% CI, 21.0%–38.5%) and negative predictive value (68.4%; 95% CI, 62.9%–73.7%), had the highest specificity (97.2%; 95% CI, 93.9%–99.0%) and positive predictive value (75.0%; 95% CI, 53.3%–90.2%). Sokolow-Lyon product and Cornell voltage had relatively better accuracy compared with the other criteria. All criteria performed fair with AUC ranging from 0.66 to 0.73, where Cornell voltage had relatively better performance (AUC, 0.73), and Sokolow-Lyon index had relatively poor performance (AUC, 0.66).

DISCUSSION

Despite the availability and cost-effectiveness of ECG, its diagnostic performance to detect LVH has been shown to be poor, leading to the development of several ECG criteria to improve its diagnostic accuracy. Studies comparing these criteria have shown inconsistent results, and most of these studies were done on Caucasians. Study populations in whom these criteria were developed may therefore differ from the Asians.[13] Hence, in our study, we used the LVMI values (>99 g/m^2 for female patients, >100 g/m^2 for male patients) for Filipino patients indicated in the WASE Normal Values Study

Table 3. Diagnostic Statistics of ECG-LVH Criteria for Echo-LVH

ECG Criteria	AUC	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Accuracy (95% CI)
Sokolow-Lyon voltage	0.69	29.2 (21.0–38.5)	91.5 (86.9–94.9)	64.7 (50.1–77.6)	70.8 (65.0–76.1)	69.8 (64.5–74.8)
Sokolow-Lyon index	0.66	15.9 (9.7–24.0)	97.2 (93.9–99.0)	75.0 (53.3–90.2)	68.4 (62.9–73.7)	68.9 (63.6–73.9)
Sokolow-Lyon product	0.70	27.4 (19.5–36.6)	93.4 (89.2–96.3)	68.9 (53.4–81.8)	70.7 (65.0–76.0)	70.5 (65.2–75.4)
Cornell voltage	0.73	38.1 (29.1–47.7)	87.7 (82.5–91.8)	62.3 (49.8–73.7)	72.7 (66.8- 78.0)	70.5 (65.2–75.4)
Cornell voltage product	0.71	46.9 (37.5–56.5)	80.2 (74.2–85.3)	55.8 (45.2–66.0)	73.9 (67.7–79.5)	68.6 (63.3–73.6)
Peguero–Lo Presti	0.70	53.1 (43.5–62.5)	76.9 (70.6–82.4)	55.0 (45.2–64.6)	75.5 (69.2–81.0)	68.6 (63.3–73.6)

AUC=area under the curve; CI=confidence interval; ECG-LVH=left ventricular hypertrophy diagnosed by electrocardiography; Echo-LVH=left ventricular hypertrophy echocardiography; NPV=negative predictive value; PPV=positive predictive value.

than the reference values set by the ASE (>95 g/m^2 for female patients, >115 g/m^2 for male patients) in diagnosing LVH by echocardiography.[13] Our study is different from the previous studies as we compared the recently proposed Peguero–Lo Presti criterion to the other commonly used ECG-LVH criteria in Filipino patients. In determining which ECG criterion can provide the best net benefit compared with the other criteria, we could optimize the use of echocardiography in diagnosing LVH particularly in areas with low resources and could serve as a guide in determining which criterion will be best to use in routine clinical practice.

The results of this study showed that a substantial proportion of patients (21.85%) diagnosed with LVH based on ECG criteria had no LVH on echocardiography, and those with echo-based LVH have higher BMI (26.35 kg/m^2, 24.33–29.22 kg/m^2). Based on the World Health Organization criteria of nutritional status in Asian patients, the mean BMI falls into overweight category, which is a risk factor for the development of LVH. The differences in age, gender, and BMI in between groups were not statistically significant. In this study, we demonstrated that, generally, all the six ECG-LVH criteria had low sensitivity and positive predictive value but high specificity and negative predictive value in the diagnosis of echocardiographic LVH, which is consistent with the results of previous studies.

In the meta-analysis done by Noubiap et al[7] comparing the different ECG-LVH criteria, the sensitivity of Peguero–Lo Presti criteria ranged from 14.5% to 73.3% (pooled sensitivity, 43.1%; CI, 30.2%–56.9%), and the specificity ranged from 75.6% to 96.3% (pooled specificity, 90.5%; CI, 86.3%–93.5%). In our study, Peguero–Lo Presti criteria had the highest sensitivity (53.1%; 95% CI, 43.5%–62.5%) but with correspondingly lower specificity (75.5%; 95% CI, 69.2%–81.0%) and lower accuracy (68.6%; 95% CI, 63.3%–73.6%), which is consistent with the results of previous studies. The development of Peguero–Lo Presti criteria is supported by the assumptions that the detection of an increase in the LVM would be improved by the measurement of the highest increase in voltage in any single lead rather than in a fixed lead and that the S wave, the second deflection of the QRS complex, might be a better representation of the myocardial and epicardial left ventricular free wall, which occurs after 50 milliseconds of the left ventricular depolarization.[7] Flexible lead selection has the potential to alleviate the pitfalls related to the variations in the distance between the heart and the torso, as well as the position of the surface electrode and body habitus, unlike fixed lead selection.[7] Electrical cardiac changes shown by the S wave might be more sensitive to detect alterations in LVM. These assumptions were in contrast to the several previous criteria, which were based on the measurement of the highest amplitude of the R wave in various leads alone or in combination with other features, and most of them utilized fixed leads.[7] In the study by Peguero et al[6], they found out that the S waves of the precordial and limb leads had a better association with an increased LVM as compared with the R waves and suggested that focusing more on the S wave was the main reason why their criterion had better performance than the Sokolow-Lyon and Cornell criteria, which include an amplitude of both R and S waves in different leads.[6]

In a recent study on general Chinese population, they found out that the diagnostic performance of Cornell voltage was better than the Sokolow-Lyon and Peguero–Lo Presti criteria.[9] In the meta-analysis of Noubiap et al[7], the sensitivity of Cornell voltage ranged from 5.8% to 56.0% (pooled sensitivity, 26.1%; CI, 16.9%–37.9%), and the specificity ranged from 82.5% to 99.0% (pooled specificity, 94.9%; CI, 90.3%–97.3%). A study also showed Cornell voltage criterion showed higher correlation with LVMI. In our study, Cornell voltage has the highest correlation with LVMI (r = 0.357), with sensitivity of 38.1% (CI, 29.1%–47.7%), specificity of 87.7% (CI, 82.5%–91.8%), and accuracy of 70.5% (CI, 65.2%–75.4%) with relatively better performance (AUC = 0.73). Our findings on the slightly higher sensitivity, higher correlation, and better performance in AUC analysis are in line with the results of studies in Asian population. The Cornell voltage, which combines the projection of the cardiac cross-sectional and frontal planes, can fully reflect the spatial vector of LVH.[10] It includes a limb lead in addition to precordial lead and hence is less dependent on the thickness of the chest wall.

For Sokolow-Lyon voltage, results in the meta-analysis showed sensitivity ranging from 3.9% to 57.8% (pooled sensitivity, 22.0%; CI, 14.1%–32.7%) and specificity ranging from 58.0% to 97.8% (pooled specificity, 92.1%; CI, 86.2%–95.6%).[7] Our results showed that Sokolow-Lyon voltage and Sokolow-Lyon index have higher specificity (91.5% and 97.2%) but lower sensitivity (29.2% and 15.9%) compared with Cornell voltage and Peguero–Lo Presti criteria. Sokolow-Lyon voltage reflects the condition of LVH from the horizontal section of the heart, and factors affecting the electrical voltage changes may lead to the fluctuation in the ECG voltage.[10] The duration of QRS complex is less dependent on these factors and mostly affected by inherent properties of the heart, conduction system properties, and cardiac remodeling. Therefore, adaptation for the QRS duration combined with voltage criteria may overcome limitations in ECG diagnosis of LVH. In our study, Sokolow-Lyon voltage product and Cornell voltage product have better accuracy (70.5% and 68.6%) than the other criteria.

The inconsistent results from different population in different studies may be explained by the sample population, racial differences, and the different echocardiographic criteria for the diagnosis of LVH used in this study. A study found that the Peguero–Lo Presti criterion may not be a good screening tool for LVH for Asian population.[9] However, in our study, the criterion had the highest sensitivity among other criteria. The higher sensitivity of Peguero–Lo Presti over Cornell and Sokolow-Lyon is clinically significant. Sensitivity is the most important parameter to consider when looking at a screening test with the goal of identifying the maximum number of individuals with LVH (being true positive) who need confirmation of the diagnosis with echocardiography. It can potentially be used to guide early diagnosis of LVH and selective approach to echocardiogram ordering in settings where there are low resources.

This was a retrospective single-center study, and several limitations were acknowledged. First, the criterion standard for LVH diagnosis is magnetic resonance imaging. Two-dimensional echocardiography that was used as a reference in this study is known to be operator-dependent and inferior to magnetic resonance imaging. Because of the retrospective nature of the study, some data in the demographics such as comorbidities and medications were not taken into account. We excluded patients with bundle-branch blocks, wide QRS, atrial fibrillation, premature ventricular contractions, and valvular heart disease; therefore, our findings cannot be extrapolated in these groups. Our study examined only six of the numerous ECG criteria. Being single-center, our study might be less representative than a multicenter study. Despite these limitations, the researchers consider that our method is aligned with the current clinical practice, where echocardiogram is the most frequent method to assess for LVH, and the ECG criteria that were used are the most commonly used with the convenient acquisition by ECG devices. Nonetheless, the findings in our study could provide data for future studies on possible new ECG-LVH diagnostic criteria or validation studies of the current ECG-LVH criteria for Asian population. We recommend a multicenter prospective study with a larger sample size to further confirm our findings.

CONCLUSION

In general, the ECG criteria for the diagnosis of LVH had low sensitivity and positive predictive value but high specificity and negative predictive value in the diagnosis of echocardiographic LVH. Having a higher sensitivity, the recently developed Peguero–Lo Presti criterion can be used as a screening tool for LVH more than Sokolow-Lyon and Cornell voltage. The Cornell voltage criteria have a higher correlation with LVMI and better discriminative ability for the detection of LVH using ECG compared with other criteria. Further studies with the possibility of combining different ECG criteria are suggested to increase the sensitivity of the ECG criteria.

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