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Peguero – Lo Presti Criteria from Electrocardiography to Diagnose Left Ventricular Hypertrophy in Patients with Hypertension in Adam Malik Hospital

Masta N. Ginting*, Cut A. Andra, Ali N. Nasution, Harris Hasan, Nizam Z. Akbar, Abdullah A. Siregar

Department of Cardiology and Vascular Medicine, University of Sumatera Utara, Adam Malik Hospital, Medan, North Sumatera, Indonesia

ARTICLE INFO

*Corresponding author
Email:
mastanovaginting3@yahoo.com
Address:
Department of Cardiology and
Vascular Medicine, University of Sumatera Utara,
Adam Malik Hospital, Medan, Indonesia,
Jalan Bunga Lau, Medan 20138

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ABSTRACT

Background: Left ventricular hypertrophy (LVH) is a preclinical manifestation of cardiovascular disease and a strong predictor of cardiovascular morbidity and mortality. The electrocardiogram (ECG) is an easily available, easy to use and cost effective tool to evaluate LVH. Peguero – Lo Presti criteria is a new criteria to diagnose LVH from ECG that has higher sensitivity than the other ECG criteria.

Aims: To assess the ability of Peguero – Lo Presti criteria to diagnose LVH and obtain new cut-off point criteria to more accurately diagnose LVH in patients with hypertension in Adam Malik Hospital.

Methods: A cross sectional study was conducted on patients with hypertension in cardiac centre Adam Malik Hospital Medan. Electrocardiographic examination was performed to obtain Peguero – Lo Presti point in blinded fashion. LVH was assessed using M-mode method with Cube formula. The analysis of Peguero – Lo Presti criteria was based on the calculation of the deepest S wave in any precordial lead (deepest S wave,S_D) and S wave in lead V4 (SV_4). A $S_D + SV_4 \geq 28$ mm in male and ≥ 23 mm in female subjects were considered positive for LVH. LVH was defined as left ventricular mass index > 115 gr/m^2 in male and > 95 gr/m^2 in female subjects.

Results: Peguero – Lo Presti criteria had 54.8% sensitivity, 97.6% specificity, 55.4% NPV and 97.6% PPV to diagnose LVH. Lowering the cut-off point of Peguero – Lo Presti criteria to 26 mm in male and 22 mm in female subjects improved the sensitivity from 54.8% to 67.1% with 90.5% specificity, 61.3% NPV and 92.5% PPV to diagnose LVH.

Conclusion: Peguero – Lo Presti criteria on ECG could be used to diagnose LVH in patients with hypertension in Adam Malik Hospital Medan.

INTISARI

Latar Belakang: Hipertrofi ventrikel kiri (*left ventricular hypertrophy*, LVH) merupakan manifestasi preklinis dari penyakit kardiovaskular dan merupakan prediktor kuat untuk morbiditas dan mortalitas kardiovaskular. Penggunaan EKG merupakan pemeriksaan yang mudah didapat, mudah digunakan dan berbiaya murah untuk mengevaluasi LVH. Terdapat kriteria baru untuk mendiagnosis LVH dari EKG yakni kriteria Peguero – Lo Presti yang didapati memiliki keakuratan yang lebih baik dibanding kriteria lainnya.

Tujuan: Untuk menilai kemampuan diagnostik kriteria Peguero Lo – Presti untuk mendiagnosis LVH dan mendapatkan nilai titik potong kriteria Peguero Lo – Presti baru yang lebih akurat untuk mendiagnosis LVH pada pasien hipertensi di RS HAM Medan.

Metode: Penelitian ini merupakan studi potong lintang yang dilakukan pada pasien hipertensi di unit rawat jalan PJT RS HAM Medan. Pemeriksaan elektrokardiografi dilakukan untuk memperoleh nilai kriteria Peguero – Lo Presti. LVH dinilai dengan metode M-mode dengan menggunakan formula Cube. Analisa kriteria Peguero – Lo Presti didapat dari penjumlahan dari amplitudo gelombang S yang paling dalam (*deepest S wave*, S_D) pada satu sadapan manapun di sadapan prekordial dan gelombang S di sadapan V4 (SV_4). Bila hasilnya≥ 28 pada laki-laki dan ≥ 23 pada perempuan disangkakan mengalami LVH.Pasien dinyatakan dengan LVH bila LVMi > 115 gr/m² pada laki-laki dan > 95 gr/m² pada perempuan.

Hasil: Kriteria Peguero – Lo Presti memiliki sensitivitas 54,8%, spesifisitas 97,6%, NPV 55,4% dan PPV 97,6% untuk mendiagnosa LVH. Dengan menurunkan titik potong kriteria Peguero – Lo Presti menjadi 26 mm untuk laki-laki dan 22 mm untuk perempuan maka didapati peningkatan sensitivitas dari 54,8% menjadi 67,1% dengan nilai spesifisitas 90,5%, NPV 61,3% dan PPV 92,5% untuk mendiagnosa LVH.

Kesimpulan: Kriteria Peguero – Lo Presti pada EKG dapat digunakan untuk mendiagnosis LVH pada pasien hipertensi di RS HAM Medan.

Introduction

Left ventricular hypertrophy (LVH) is a manifestation of preclinical cardio-vascular disease and a strong predictor of cardiovascular morbidity and mortality.[1] The diagnosis and assessment of left ventricular hypertrophy (LVH) was made with the use of electrocardiography (ECG) and echocardiography.[2]

Resting ECG is a low cost, non-invasive, easy-to-acquire method that is widely available for clinical use.[1] In the United States, screening for LVH in the newly diagnosed hypertensive patient is performed using ECG.[3] Commonly used ECG voltage criteria for LVH include the gender-specific Cornell voltage criteria and gender nonspecific Sokolow-Lyon voltage criteria.[2,4] Many studies have been performed to evaluate these ECG voltage criteria and some have suggested the use of ethnicity and gender-specific criteria.[2,5-10] However, these ECG criteria have been criticized in recent studies for relatively low sensitivity.[1-2,11-12]

Peguero – Lo Presti criteria is a new criteria to diagnose LVH from ECG with higher sensitivity than other ECG criteria, such as Cornell voltage and Sokolow Lyon criteria. The summation of the amplitude of the deepest S wave in any lead with the S wave in lead V_4 will improve upon the other criteria, while maintaining an adequate specificity for the diagnosis of LVH.[13] Furthermore, the aim of this study was to assess the diagnostic value of the Peguero – Lo Presti criteria from ECG to diagnose LVH in patients with hypertension in Adam Malik Hospital Medan.

Methods

This study was a diagnostic study with cross-sectional design. This study was conducted in Cardiac Centre Adam Malik Hospital in Medan from March 2018 to August 2018. Ethical clearance was obtained from Health Research Ethical Committee Medical Faculty of Universitas Sumatera Utara and Ethics Committee of Adam Malik Hospital. All outpatients with hypertension who underwent ECG and echocardiography were included in this study. Patients with history of myocardial infarction, complete AV block, atrial fibrillation, atrial flutter, left or right bundle branch block, valvular heart disease, congenital heart disease, bulging on the ventricular septum, poor echo window and patient with cardiac pacing were excluded from this study. The independent variable was Peguero – Lo Presti criteria point and the dependent variable was LVH.

Standard 12-lead ECGs were recorded at 25 mm/s and 10 mm/mV standardization. All measurements were interpreted by experienced investigators blind to clinical information and echocardiographic measurements. The Peguero-Lo Presti criteria was obtained by adding the deepest S wave in any lead (S_D) and the S wave in lead V_4 (S_{V4}). Cut-off values of $S_D + S_{V4} \geq 2.3$ mV for female subjects and ≥ 2.8 mV for male subjects were considered positive for LVH. In cases in which the S_D was found in lead V4, the S wave amplitude was doubled to obtain the value $S_D + S_{V4}$.

Transthoracic echocardiography was used as a method of reference to estimate left ventricular mass. LVH was assessed using M-mode method with Cube formula, as described by the American Society of Echocardiography (ASE). LVH was defined as left ventricular mass index > 115 gr/m² in male and > 95 gr/m² in female subjects.

Statistical Analysis

The categorical variables were presented as number or rates (n) and percentages (%). Numerical variables were presented as mean ± standard deviation for data that were normally distributed. Groups were compared using chi-square test for discrete variables and one-way analysis of variance for continuous variables. Receiver operating characteristic (ROC) curves were used to determine the optimal cut-off point of Peguero – Lo Presti criteria to diagnose LVH for men and women both separately. Using chi-square table, we obtained new sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) from new Peguero – Lo Presti cut-off point.

Result

The total number of study subjects who met inclusion and exclusion criteria were 115 people, consisting of 73 people (63.5 %) with LVH and 42 people (36.5 %) without LVH. The baseline demographic, anthropometric and ECG were shown in Table 1. The echocardiographic characteristics were shown in Table 2. From 73 people with LVH, 28 people (38.4 %) were men and 45 people (61.6 %) were women. The mean age of the two group were 59 years, there were no statistically significant difference between these groups. The mean duration of hypertension was statistically significant different, 6 years in group without LVH and 7 years in group with LVH (p=0.003).

From echocardiographic characteristics, we found that mean ejection fraction (EF), IVSD, LV EDD, LV PWD, e' septal, e' lateral, E/e' and LVMI were statistically significantly different between these groups. The mean EF were 66% in group without LVH and 62% in group with LVH. IVSD, LV EDD, LV PWD and E/e' were higher in group with LVH. e' septal and e' lateral were higher in group without LVH. The mean LVMI was 85.4 gr/m^2 in group without LVH versus 140.2 gr/m^2 in group with LVH. There was a statistically significant difference between these groups (p<0.001).

Table 1
Demographic, clinical and ECG characteristics

Variable	Without LVH (n = 42)	With LVH (n = 73)	P value
Age (mean±SD), years	59.3 ± 10.7	59.9 ± 8.5	0.729
Gender (n,%)			0.470
Men	19 (45.2)	28 (38.4)	
Women	23 (54.8)	45 (61.6)	
BMI (mean±SD), kg/m^2	26.3 ± 4.5	26.0 ± 3.5	0.687
SBP (mean±SD), mmHg	138.0 ± 16.5	141.9 ± 17.3	0.563
DBP (mean±SD), mmHg	78.6 ± 10.8	81.3 ± 9.9	0.092
Duration of hypertension (mean±SD), years	6.0 ± 4.6	7.1 ± 3.7	0.003
Diabetes mellitus (n,%)	10 (23.8)	19 (26)	0.792
Dyslipidemia (n,%)	15 (35.7)	20 (27.4)	0.351
History of smoking (n,%)	20 (47.6)	26 (35.6)	0.206
Hemoglobin (mean±SD), mg/dL	13.4 ± 1.4	13.2 ± 1.7	0.424
Creatinin (mean±SD), mg/dL	0.94 ± 0.44	1.13 ± 0.7	0.189
History of medication (n,%)			
ACE-I/ARB	39 (92.9)	71 (97.3)	0.353
CCB	9 (21.4)	29 (39.7)	0.045
Diuretic	14 (33.3)	28 (38.4)	0.590
Beta blocker	33 (78.6)	51 (69.9)	0.311
QRS axis (n,%)			0.004
Normal	40 (95.2)	54 (74)	
LAD	2 (4.8)	19 (26)	

Table 2
Echocardiographic characteristics

Variable	Without LVH (n = 42)	With LVH (n = 73)	P value
Ejection fraction (mean±SD), %	66.5 ± 7.5	62.3 ± 7.3	0.004
IVSD (mean±SD), mm	10.6 ± 2.3	13.8 ± 2.5	<0.001
LV EDD (mean±SD), mm	42.4 ± 4.4	45.6 ± 4.9	0.001
LV PWD (mean±SD), mm	9.9 ± 1.9	12.7 ± 2.2	<0.001
LAVI (mean±SD), mL/m^2	32.6 ± 4.1	33.5 ± 4.8	0.054
E (mean±SD), m/s	0.73 ± 0.16	0.71 ± 0.17	0.673
e' Septal (mean±SD), cm/s	7 (5-9)	6 (7-8)	<0.001
e' Lateral (mean±SD), cm/s	10 (8-12)	8 (6-10)	0.004
E/e' (mean±SD), n	8.6 ± 2.6	9.8 ± 2.5	0.003
TR velocity > 2,8 m/s (n,%)	3 (7.1)	9 (12.3)	0.531
LVMI (mean±SD), gr/m^2	85.4 ± 14.4	140.2 ± 29.1	<0.001
Diastolic function (n,%)			<0.001
Normal	22 (52.4)	0 (0)	
Abnormal	20 (47.6)	73 (100)	
LV geometry (n,%)			<0.001
Normal	15 (35.7)	0 (0)	
Concentric Remodeling	27 (64.3)	0 (0)	
Concentric Hypertrophy	0 (0)	66 (90.4)	
Eccentric Hypertrophy	0 (0)	7 (9.6)	

From the Peguero – Lo Presti criteria which stated that values of $S_D + S_{V4} \geq 2.3$ mV for female subjects and ≥ 2.8 mV for male subjects were considered positive for LVH, we found that this criteria could diagnose LVH with 54.8 % sensitivity, 97.6 % specificity, 55.4 % NPV and 97.6 % PPV.

By using ROC curve, we could find the optimal cut-off point of Peguero – Lo Presti criteria for our populations in both sex-stratified. The optimal cut-off point of Peguero – Lo Presti criteria for men was ≥ 26 mm (Table 4) and for women was ≥ 22 mm (Table 5) to diagnose LVH. The modified criteria with new cut-off point could diagnose LVH with 67.1 % sensitivity, 90.5 % specificity, 61.3 % NPV and 92.5 % PPV.

Table 4
Results from ROC analysis in men group

Cut-off point	Sens	Spes	AUC	P value	95% CI
≥ 26 mm	64.3%	94.7%	87.3%	<0.001	77-96%

Table 3
Diagnostic test of Peguero – Lo Presti criteria to diagnose LVH

PLP Criteria	LVH Yes	LVH No	Total	P value	Sens	Spes	NPV	PPV
(+)	40	1	41	<0.001	54.8 %	97.6 %	55.4 %	97.6 %
(-)	33	41	74					
Total	73	42	115					
	(63,5)	(36,5)	(100)					

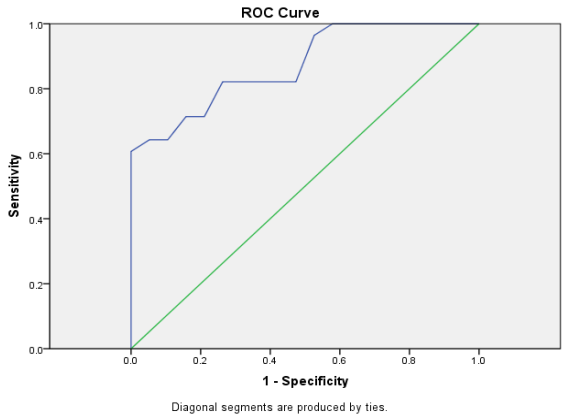

Figure 1. ROC curve of Peguero – Lo Presti point to assess LVH in men

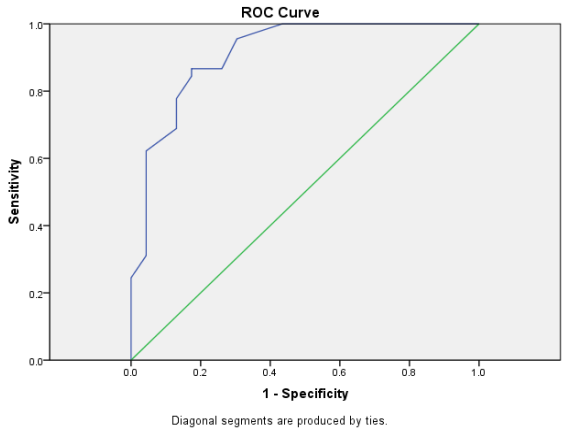

Figure 2. ROC curve of Peguero – Lo Presti point to assess LVH in women

Table 5.
Results from ROC analysis in women group

Cut-off point	Sens	Spes	AUC	P value	95% CI
≥ 22 mm	62.2%	95.7%	91.2%	<0.001	84-99%

Discussion

This study was a cross-sectional diagnostic study which aimed to assess the ability of Peguero – Lo Presti criteria to diagnose LVH and obtained the new cut-off point criteria which more accurately diagnose LVH in patients with hypertension in Adam Malik Hospital.

Most of the subjects of this study on the two groups were women, with the percentage of 54.8 % in group without LVH and 61.6 % in group with LVH. This was in accordance with the prevalence of hypertension in Pedoman Tata Laksana Pencegahan Penyakit Kardiovaskular pada Perempuan compiled by Perhimpunan Dokter Spesialis Kardiovaskular Indonesia. This guidelines stated that in the fifth decade of life, the incidence of hypertension increased more sharply in women, that at the sixth decade of life, the prevalence of hypertension in women is higher than in men.[14]

The duration of hypertension between the two groups was found to be statistically different, with an average of 6 years in the group without LVH and 7.1 years in the group with LVH. This was in accordance with the statement on the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE), which mentioned that the occurrence of LVH in patients with hypertension was associated with duration of hypertension and uncontrolled hypertension.[15]

On the ECG parameters characteristics, it could be seen that patients with LVH more commonly have LAD QRS axis, 26% compared to 4.8% in patients without LVH (p = 0.004). This was in accordance with ACCF/AHA/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram that LAD is associated with LVH. When we found LAD QRS axis on an ECG, these findings could support the presence of LVH diagnosis, although it could not be used to diagnose LVH.[9]

The value of e' septal and e' lateral were lower in the group with LVH, E/e' were higher in the group with LVH and TR velocity > 2.8 m/s were more common on groups with LVH. This indicated that LVH group experienced diastolic dysfunction more often. Diastolic dysfunction occurred on 47.6% subjects in groups without LVH and 100% in the group with LVH (p<0.001). In the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE) in 2015 about echocardiography in hypertension patients mentioned that at the initial phase of hypertension or mild hypertension, LVH would not be found as but the initial manifestation of hypertension is diastolic dysfunction.[15]

Table 6
Diagnostic test of the Modified Peguero – Lo Presti criteria with new cut-off point to diagnose LVH

New PLP	LVH		Total	P value	Sens	Spes	NPV	PPV
	Yes	No						
(+)	49	4	53	<0.001	67.1%	90.5 %	61.3 %	92.5%
(-)	24	38	62					
Total	73 (63.5)	42 (36.5)	115 (100)					

In this study, we found that the Peguero – Lo Presti criteria had 54.8% sensitivity and 97.6% specificity in diagnosing LVH. By lowering the cut-off point of this criteria from 28 mm to 26 mm in males and 23 mm to 22 mm in female, we could increase the sensitivity from 54.8 % to 67.1 %, while maintaining good specificity from 97.6 % to 90.5 %. This finding corresponded with several earlier studies undertaken by Xu et al in Singapore, Park et al in Korea Su and Su et al in Taiwan who found higher sensitivity by lowering the cut-off point of ECG criteria. These previous studies were conducted to assess Sokolow – Lyon criteria and Cornell criteria.[2,6,8]

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