Research Article

Assessment of Peguero Lo-Presti Criteria for Electrocardiographic Diagnosis of LVH in Indian Subjects

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Abstract

Background and objectives: The sensitivity of ECG to diagnose LVH (Left ventricular hypertrophy) is low. Peguero Lo-Presti have proposed new ECG criteria for LVH to improve the sensitivity of ECG while maintaining the high specificity when compared to older well-established criterion like Cornell voltage and Sokolow Lyon. The objective of this study was to evaluate Peguero Lo-Presti criteria in the diagnosis of LVH in patients with hypertension.

Methodology: 400 consecutive patients with hypertension who have visited the cardiology OPD (Out Patient Department) and have undergone ECG and 2D echocardiography were included in the study. Patients with valvular regurgitation (Grade II or higher), myocardial infarction, valvular stenosis, LV dysfunction, pericardial disease, COPD (Chronic obstructive pulmonary disease), bundle branch blocks, atrial fibrillation or flutter were excluded from the study.

Results: LVH was diagnosed in 192 (48%) of the patients by 2D echocardiography. Of the 192 patients, 104 patients had LVH based on Peguero Lo-Presti criteria with a sensitivity of 54.17%. Cornell Voltage criteria was positive in 76 out of 192 patients with a sensitivity of 39.58% and Sokolow-Lyon criteria was positive in 56 out of 192 with a sensitivity of 29.17%. The Peguero Lo-Presti ECG criteria had a higher sensitivity (54.17%) and specificity (91.35%) in the diagnosis of LVH by ECG.

Conclusion: Peguero Lo-Presti criteria to diagnose LVH has higher sensitivity and specificity compared to Sokolow-Lyon and Cornell voltage criteria.

1. Introduction

Left ventricular hypertrophy is a marker of subclinical cardiac disease and helps in prognostication. It is a common finding in patients with hypertension and can be diagnosed either by electrocardiography or by echocardiography [1].

Population based studies have shown a strong association between hypertension and LVH. In fact, in severe forms of hypertension there is a >50% incidence of LVH while in milder forms it is <25% [2]. The Framingham studies have also established an age linked prevalence of LVH [3].

Left ventricular hypertrophy (LVH) secondary to arterial hypertension is a complex cardiac phenotype resulting from the response of myocyte and non-myocyte components to mechanical and neuro-humoral stimuli [4].

Various studies have shown that LVH independently predicts morbidity and mortality. LVH predisposes to heart failure, ventricular tachyarrhythmia, atrial fibrillation, ischemic stroke, embolic stroke and sudden cardiac death [5].

The sensitivity of all the well-established ECG criteria to diagnose LVH is low and is in the range of 7-35% with mild LVH and only 10-50% with moderate to severe LVH whereas the overall specificity is >90% [6].

To improve the sensitivity of ECG to diagnose LVH we evaluated the novel Peguero Lo-Presti criteria which has shown higher sensitivity when compared to older well established criterion like Cornell voltage and Sokolow Lyon criteria

2. Materials and Methods

This one cross-sectional study was conducted in the Department of Cardiology of a tertiary care centre in North Karnataka from May 2017 to December 2017. A total of 400 patients aged above 30 years presenting with hypertension to the cardiology OPD who underwent ECG and 2D echocardiography were included in the study. Patients with myocardial infarction, valvular heart disease (Grade II or higher), valvular stenosis, LV dysfunction, pericardial disease, COPD, bundle branch blocks, atrial fibrillation or flutter were excluded from the study. The patients fulfilling selection criteria were informed in detail about the nature of the study and a written informed consent was obtained before enrolment.

Detailed history was obtained and thorough clinical examination was done and the findings were recorded on a predesigned and pretested proforma. All patients have undergone 12 lead electrocardiography and transthoracic echocardiography.

2.1 2D echocardiography

Left ventricular mass was estimated by transthoracic echocardiography [7]. The LV was visualised with the patient lying in a modified left lateral decubitus position, with the ultrasound probe at the left parasternal window angled to

visualise the heart in the long axis view. All the M-mode and 2D measurements were performed by the leading-edge-to-leading edge method, as described by the American Society of Echocardiography (ASE).

Left ventricular end-diastolic and end-systolic measurements were obtained according to recommendations by the American Society of Echocardiography [8,9]. Left ventricular mass was calculated by using the Devereux formula: left ventricular mass (g) = 0.80 x {1.04 x [(septal thickness + internal diameter + posterior wall thickness)^3 – (internal diameter)^3]} + 0.6 g. The LV mass index was calculated according to body surface area. LVH was defined as a left ventricular mass index >115 g/m^2 in male subjects and >95 g/m2 in female subjects [10].

2.2 ECG criterion

12 lead ECG was obtained from every patient. Using the PR segment as baseline, the tallest R and the deepest S wave in all the precordial and limb leads were recorded. The largest complex was selected if voltage differences within the same lead was present. The Peguero Lo-Presti criteria was calculated by adding SD to the S amplitude in V4 (SD + SV4). Cutoff values of SD + SV4 ≥ 2.3 mV for female subjects and ≥2.8 mV for male subjects were considered positive for LVH based on the recent study by Peguero JG et al. In cases in which the SD was found in lead V4, the S wave amplitude was doubled to obtain the value SD + SV4.

The Cornell voltage criteria was used as the main comparison given its reputation as the most accurate of the reported measurements [11]. The sex-specific Cornell voltage criteria was computed as the amplitude of R in aVL plus the amplitude of S or QS complex in V3 (RaVL + SV3) with a cutoff of >2.8 mV in men and >2.0 mV in women [12].

The Sokolow-Lyon voltage was obtained by adding the amplitude of S in V1 and the amplitude of R in V5 or V6 ≥ 3.5 mV (SV1 + RV5 or RV6) [13,14].

2.3 Statistical analysis

The categorical data was expressed as rates, ratios and percentages and comparison was done using chi-square test. Continuous data was expressed as mean ± standard deviation. The agreement between ECG criteria and 2D echocardiography was analysed with McNemar's test and a 'p' value of less than or equal to 0.05 was considered as statistically significant. The accuracy of Peguero Lo-Presti criteria for the assessment of LVH was determined by estimating sensitivity, specificity, positive predictive value and negative predictive value.

3. Results

In this study 73.5% of the patients were males with male to female ratio of 2.77:1 (Graph 1). Age ranged between 35 to 89 years [Table 1] and most of the patients were aged between 61 to 70 years (38.50%) and the mean age was 63.79±10.36 years (Table 2 and 3). The clinical profile of the study population that is mean height, weight, ECG and 2D echocardiography parameters are as shown in Table 3. Based on 2D echocardiography, LVH was diagnosed in 48% of the patients (Graph 2). Based on ECG criteria that is, Peguero Lo-Presti, Cornell Voltage and Sokolow-Lyon criteria 30.50%, 24.50% and 21% of the patients were diagnosed to have LVH respectively (Table 3).

26.50%

73.50%

Male Female
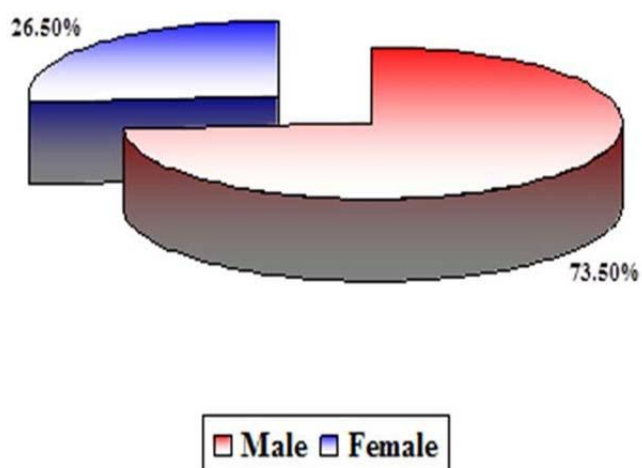
Graph 1: Distribution of patients according to sex

52.00%

48.00%

Yes No
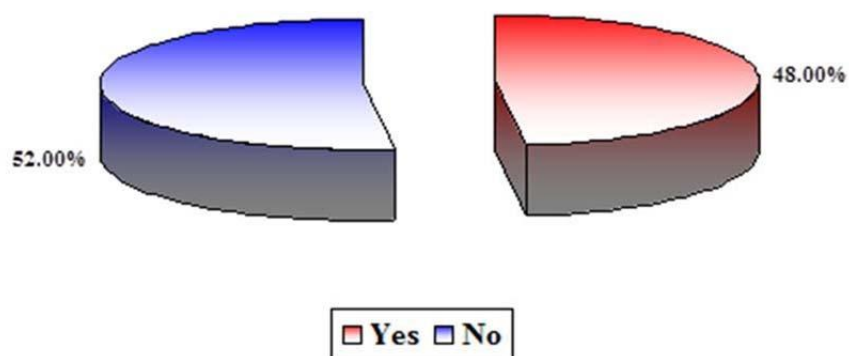
Graph 2: Distribution of patients according to the diagnosis of LVH based on LV mass index

Age (Years)	Distribution (n=400)	
	Number	**Percentage**
30 or less	0	0.00
31 to 40	6	1.50
41 to 50	36	9.00
51 to 60	110	27.50
61 to 70	154	38.50
71 to 80	66	16.50
81 to 90	28	7.00
91 to 100	0	0.00
Total	**400**	**100.00**

Table 1: Distribution of patients according to the age

Variables	Distribution (n=400)		Median	Range	
	Number	Percentage		Minimum	Maximum
Age (Years)	63.79	10.36	63.50	35.00	89.00
Height (cms)	160.36	4.35	160.00	150.00	170.00
Weight (Kg)	63.21	6.31	62.00	51.00	84.00
Body Surface Area	1.67	0.10	1.64	1.44	1.99
Duration of Hypertension (Years)	7.78	6.62	7.00	0.08	76.00
Systolic blood pressure (mmHg)	143.49	17.20	140.00	110.00	200.00
Diastolic blood pressure (mmHg)	86.43	8.11	90.00	70.00	110.00
Pulse rate (/Minute)	81.78	8.85	82.00	60.00	110.00
LVIDd	4.13	0.35	4.10	3.20	4.90
PWTd	1.25	0.12	1.25	1.00	1.50
IVSd	1.31	0.15	1.30	0.50	1.60
LV mass by 2D	193.63	39.65	189.50	97.00	283.00
LV mass Index	115.98	25.06	113.00	59.00	172.00
SD	1.48	0.34	1.40	1.00	2.60
SV4	0.97	0.25	0.90	0.10	1.60
SD + SV4	2.45	0.44	2.50	1.50	3.50
RaVL	1.34	0.37	1.30	0.60	2.50
SV3	1.02	0.25	1.00	0.60	1.80
RaVL + SV3	2.36	0.47	2.30	1.50	3.40
SV1	1.20	0.28	1.20	0.60	2.00
RV5 or RV6	1.76	0.41	1.70	0.70	3.10
SV1 + RV5 or RV6	2.96	0.55	2.90	1.40	4.20

Table 2: Clinical profile of the study population

ECG criteria	Findings	Distribution (n=400)	
		Number	Percentage
Peguero Lo-Presti criteria	Yes (Raised SD + SV4)	122	30.50
	No (Normal SD + SV4)	278	69.50
	Total	**400**	**100.00**
Cornell Voltage criteria for LVH	Yes (Raised RaVL + SV3)	98	24.50
	No (Normal RaVL + SV3)	302	75.50
	Total	**400**	**100.00**
Sokolow-Lyon criteria for LVH	Yes (Raised SV1 + RV5 or RV6)	84	21.00
	No (Normal SV1 + RV5 or RV6)	316	79.00
	Total	**400**	**100.00**

Table 3: Distribution of patients according to the diagnosis based on Peguero Lo-Presti criteria

Out of 192 patients with LVH based on 2D echocardiography, 104 were diagnosed to have LVH based on Peguero Lo-Presti criteria with strong agreement (p<0.001) between Peguero Lo-Presti criteria and 2D echocardiography for the diagnosis of LVH with sensitivity of 54.17%. Likewise, based on Cornell Voltage criteria 76 out of 192 were diagnosed to have LVH with sensitivity of 39.58% while based on Sokolow-Lyon criteria, 56 out of 192 were diagnosed to have LVH with sensitivity of 29.17%. The Peguero Lo-Presti ECG criteria yielded higher sensitivity (54.17%) and specificity (91.35%) in the diagnosis of LVH in patients with hypertension (Table 4).

ECG criteria	ECG finding	Coronary angiography findings		Total	Sensitivity (%)	Specificity (%)	(%)	(%)	p value
		Yes	No						
Peguero Lo-Presti criteria	Yes	104	18	122	54.17	91.35	85.25	68.35	**<0.001**
	No	88	190	278					
	Total	192	208	400					
Cornell Voltage criteria	Yes	76	22	98	39.58	89.42	77.55	61.59	**<0.001**
	No	116	186	302					
	Total	192	208	400					
Sokolow-Lyon criteria	Yes	56	28	84	29.17	86.54	66.67	56.96	**<0.001**
	No	136	180	316					
	Total	192	208	400					

Table 4: Accuracy of ECG criteria in predicting LVH considering LV mass index as gold standard

4. Discussion

The present study showed that, Peguero Lo-Presti criteria has higher sensitivity (54.17%), while maintaining higher specificity (91.35%) with higher diagnostic accuracy (73.50%) in the diagnosis of LVH among the patients with hypertension compared to the other two criterions that is Sokolow-Lyon criteria and Cornell Voltage criteria (Table 5).

Criterion	Sensitivity	Specificity	PPV	NPV	Diagnostic accuracy
Peguero Lo-Presti criteria	54.17	91.35	85.25	68.35	73.5
Cornell Voltage criteria	39.58	89.42	77.55	61.59	65.50
Sokolow-Lyon criteria	29.17	86.54	66.67	56.96	59.00

Table 5: Comparison of accuracy of ECG criterion in predicting LVH considering LV mass index as gold standard

The Sokolow-Lyon criteria [14] has been evaluated in various studies to give sensitivity of 32% [14], 33% [14], 43% [15], while in this study the sensitivity was 29.17% which was in agreement with the previous studies. The Cornell voltage criteria has been evaluated to give sensitivity of 41% [16], and 28% [14] which was found to be 39.58% in the present study.

A retrospective study by Peguero JG et al. [17] in 2017 which devised the Peguero Lo-Presti criteria also reported sensitivity of 62% with specificity of 90% with strong agreement (p<0.011). The cut-off values determined by ROC obtained were ≥2.3 mV for females and ≥2.8 mv for males. In this study we used the same cut off values as that of

Peguero JG et al. [17] and found higher sensitivity and specificity compared to other two criterions viz. Sokolow-Lyon and Cornell voltage criteria [14].

LVH is determined by an increase in LV mass, which can be estimated by the electrical voltage changes detected on 12 lead ECG. This makes 12 lead ECG an acceptable surrogate to detect LVH [17].

The sum of SD + SV4 had a better diagnostic value to detect LVH over the traditional LVH criteria [17].

The cardiac electrical voltage does not depend on the amount of myocardium alone, But, it also depends on the distance of LV cavity – lead electrode, the location of the surface electrode, individual differences of antrophometry, myocardial fibrosis, and pulmonary pathology [17,18]. Day to day variation of ECG voltage has been described [13,20]. All of these factors may reduce the diagnostic accuracy of surface electrocardiography to diagnose LVH. Given the above drawbacks, any single lead showing the maximum voltage increase is more sensitive in identifying an LV mass, instead of using any fixed lead criteria.

Overall our study showes that, Peguero Lo-Presti criteria[17] has higher sensitivity and specificity in the electrocardiographic diagnosis of LVH compared to Sokolow-Lyon [14] and Cornell voltage criteria considering LV mass index by 2D Echocardiography as reference standard. However, these observations require further validation due to the potential limitations of this study that it is a single centre study and relatively smaller sample size. Another limitation is that the LV mass and LV mass index were estimated by using two-dimensional echocardiography and the main determinant of LVH in this study was the left ventricular mass. Though, echocardiography is known to have good reproducibility for the diagnosis of LVH and remains the most frequently used method in clinical practice [21]. It is reported that, 2D echocardiography ignores the left ventricular hypertrophy that occurs in initial stages and this may contribute to the discrepancies [22,23].

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