

S-Wave Amplitude in Lead V3 Identifies Other Electrocardiography Criteria of Left Ventricular Hypertrophy

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Introduction

Electrocardiographic (ECG) criteria for detecting left ventricular hypertrophy (LVH) are integral to clinical decision-making.¹ Although these methods are quick to apply, low cost, and widely available, their sensitivity is modest.² Multiple voltage-based criteria exist, such as the Sokolow-Lyon, Cornell, and Peguero-Lo Presti criteria, but accurate use often requires familiarity with several indices and can be time-consuming for trainees. Simple, reliable markers could improve the efficiency and consistency with which ECGs are flagged as possibly indicating LVH.

The S-wave amplitude in lead V3 (SV3) is a plausible single-lead marker. It is a component of the Cornell criterion (SV3 + RaVL),³ and it is closely related to the Peguero-Lo Presti criterion (SV4 plus the deepest precordial S).⁴ Because the largest precordial S wave often occurs in V3, a single SV3 measurement could serve as a rapid screening tool to identify the presence of established LVH criteria, especially for those with less experience interpreting ECGs.

The aim of this study was not to propose a new LVH criterion but rather to determine whether a single measurement, the SV3 amplitude, can accurately identify the presence of any established LVH ECG criterion.

Methods

We conducted a retrospective analysis of a 12-lead ECG dataset from the PhysioNet repository.^{5,6} The database provides standard ECG tracings with limited demographic and clinical information.

Keywords

Electrocardiography; Left Ventricular Hypertrophy

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Eligibility criteria

ECGs were eligible if an adequate-quality standard 12-lead recording was available. ECGs were excluded if they exhibited any of the following: incomplete data, significant artifacts, a pathologic Q wave in V3, right or extreme frontal-plane axis deviation, posterior-inferior fascicular block (right axis deviation with RIII > RII by amplitude), complete left bundle branch block (QRS > 130 ms in women or > 140 ms in men with mid-QRS notching in left-sided leads), right bundle branch block (QRS > 120 ms with an rsR', pure R, or qR pattern in V1 and a slurred S wave in left-sided leads), ventricular pacing, or pre-excitation.

LVH reference definition

The presence of LVH by any established ECG criterion was considered a positive reference standard. The criteria were i) Sokolow-Lyon: SV1 + RV5 or RV6 ≥ 35 mm;⁷ ii) Cornell voltage: RaVL + SV3 ≥ 28 mm for men or ≥ 20 mm for women;³ iii) Sokolow aVL: RaVL ≥ 11 mm;⁸ iv) Peguero-Lo Presti: deepest precordial S + SV4 > 23 mm for women or > 28 mm for men.⁴

Adjudication in left anterior fascicular block

For ECGs exhibiting left anterior fascicular block, which is defined as a left axis deviation greater than −45° with an SIII amplitude greater than an SII amplitude, only the Cornell and Sokolow aVL criteria were considered applicable.

ECG review and blinding

Each ECG was reviewed by a single investigator with access to the clinical data provided in PhysioNet. However, because the reference standard (any classical LVH criterion) and the index test (SV3 amplitude) were derived from the same ECG, blinding to the reference standard was not feasible.

Data analysis

Data were compiled in Microsoft Excel and analyzed using GraphPad Prism version 10.1.0 for Windows, GraphPad Software, Boston, Massachusetts USA, www.graphpad.com. The index test was the S-wave amplitude in lead V3

(SV3). Receiver operating characteristic (ROC) curves were constructed, and the area under the curve (AUC) summarized overall diagnostic performance. Sensitivity, specificity, and likelihood ratios were calculated from contingency tables at the optimal cutoff identified by ROC analysis.⁹ The optimal cutoff was selected using the Youden index¹⁰ and the Alencar index.¹¹ Predictive values were not reported because the dataset does not approximate a cross-sectional population sample with representative prevalence. All reporting follows Standards for Reporting of Diagnostic Accuracy Studies statement.¹²

Institutional review board approval was not required because the PhysioNet database contains only de-identified, publicly available data.

Results

Of 294 ECGs screened, 204 met eligibility criteria and were included in the analysis. A total of 58 participants were women. The cohort's median age was 57 years (± 14). Baseline characteristics are summarized in Table 1. Participant flow is shown in Figure 1.

The AUC for SV3 was 0.8170 (95% CI, 0.7557-0.8783), which indicates good discriminative ability. The optimal cutoff was ≥ 13 mm. At this threshold, sensitivity was 74.7% (95% CI, 64.4%-82.8%) and specificity was 78.5% (95% CI, 70.4%-84.9%). The positive likelihood ratio (LR+) was 3.476 and the negative likelihood ratio (LR-) was 0.32. The ROC curve is presented in Figure 2.

Discussion

Using a cutoff of ≥ 13 mm for the S wave in lead V3 to flag the presence of established LVH ECG criteria demonstrated practical value. The associated positive and negative likelihood ratios supported clinical utility, offering a fast, single-lead screening approach that may be especially useful for less experienced interpreters and can streamline ECG assessment for LVH-related features.

Table 1 – Baseline characteristics of participants included in the analysis

Characteristic	Value
Participants, n	204
Age, median (SD), y	57 $\pm$ 14
Women, n (%)	58 (28.4)
Hypertension, n (%)	53 (26.0)
Diabetes, n (%)	18 (8.8)
Acute myocardial infarction, n (%)	98 (48.0)
Prior myocardial infarction, n (%)	21 (10.3)
Left anterior fascicular block, n (%)	21 (10.3)

SD: standard deviation.

This cutoff is not a diagnostic criterion for LVH itself; rather, it indicates the likely presence of at least one established LVH ECG criterion. The use of an anonymized, publicly available dataset may have limited access to complete clinical information for some patients, although cases with incomplete data were excluded. The retrospective design and reliance on a database not originally constructed for hypothesis-driven

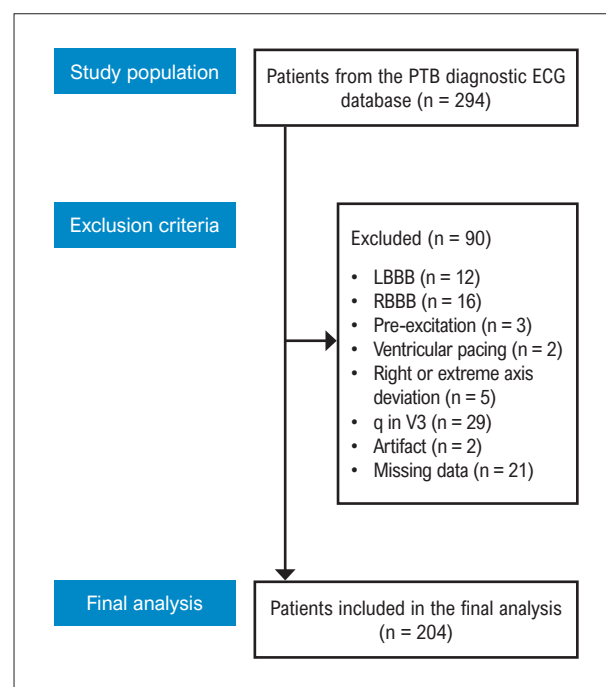


Figure 1 – Flow diagram of participant selection and exclusion criteria. ECG: electrocardiography; LBBB: left bundle branch block; PTB: Physikalisch-Technische Bundesanstalt; RBBB: right bundle branch block.

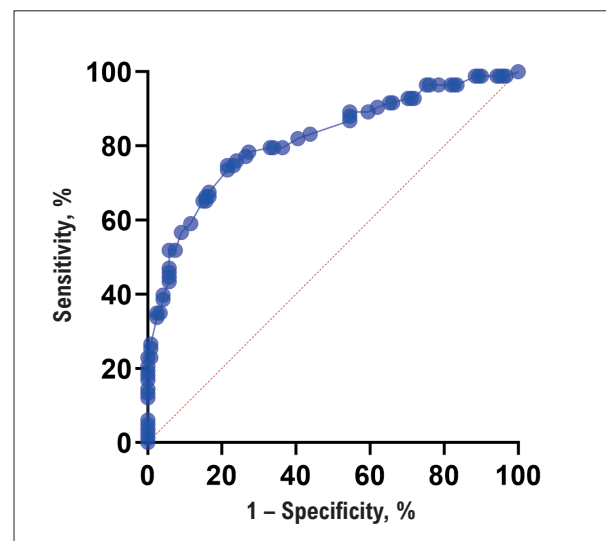


Figure 2 – ROC curve showing the diagnostic performance of SV3 at a cutoff of ≥ 13 mm. ROC receiver operating characteristic.

Brief Communication

research may also constrain generalizability. Prospective validation in diverse populations is warranted.

Conclusion

A single-lead SV3 cutoff of ≥ 13 mm demonstrated good diagnostic accuracy and practical utility for identifying the presence of LVH-related ECG criteria. This simplified approach enables rapid, reliable screening—particularly useful for less experienced clinicians—without requiring familiarity with multiple complex indices.

Author Contributions

Conception and design of the research: Corrêa BAS, Alencar JN; acquisition of data and analysis and interpretation of the data: Corrêa BAS, Silva GPSA, Miranda FC, Oliveira MHJ, Barbosa GS, Borges VHL, Alencar JN; statistical analysis, writing of the manuscript and critical revision of the manuscript for intellectual content: Alencar JN

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any thesis or dissertation work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

Use of Artificial Intelligence

During the preparation of this work, the author(s) used ChatGPT (OpenAI) to provide language editing to improve clarity and flow in American English. After using this tool/service, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the published article.

Availability of Research Data

The content is available at the link <https://physionet.org/content/ptbdb/1.0.0/>, under DOI 10.13026/C28C71.



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