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Original Article

Correlation of Electrocardiographic Left Ventricular Hypertrophy with Echocardiography in Hypertensive Patients

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ABSTRACT

Background: LVH is a significant risk indicator for cardiovascular issues in hypertension. While ECG is straightforward, low-cost, and easily accessible for screening, echocardiography is more effective at identifying structural LVH. Given the scarce evidence in Bangladesh, this research assessed the association between LVH identified through ECG and echocardiography and the diagnostic efficacy of ECG in patients with hypertension. **Methods & Materials:** A cross-sectional study of 100 hypertensive patients aged ≥45 years was conducted at Rangpur Medical College and Hospital and the Hypertension and Research Center during 2024–2025. LVH was assessed by 12-lead ECG using the Sokolow–Lyon criterion and echocardiographic LVMI. Data were analyzed using SPSS 25.0, with $p<0.05$ considered significant. **Results:** In a group of 100 hypertensive individuals, the average age was 57.3 ± 9.1 years, with 64% being male. The average length of hypertension was 7.87 ± 4.02 years. LVH was identified in 22.0% using ECG and 34.0% using echocardiography. Patients with ECG-confirmed LVH showed significantly elevated IVSd, LVPWd, LV mass, and LVMI (all $p<0.001$). Sokolow–Lyon voltage displayed notable positive correlations with LV mass ($r=0.52$), LVMI ($r=0.55$), IVSd ($r=0.43$), and LVPWd ($r=0.39$; all $p<0.001$). ECG demonstrated 52.9% sensitivity, 93.9% specificity, 81.8% positive predictive value, 79.5% negative predictive value, and 80.0% overall accuracy, exhibiting moderate agreement with echocardiography ($\kappa\approx0.50$). **Conclusion:** ECG demonstrated a strong correlation with echocardiographic indicators of LVH and high specificity, although it had restricted sensitivity. Echocardiography identified a higher number of LVH instances and continues to be the preferred method for verifying structural LVH in patients with hypertension.

Keywords: *Hypertension, Electrocardiographic, Left Ventricular Hypertrophy, Echocardiography.*

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INTRODUCTION

Left ventricular hypertrophy (LVH) is a significant predictor of adverse cardiovascular outcomes [1]. It was initially recognized as a consequence of hypertension over 150 years ago via autopsy results and subsequently through chest X-rays [2]. Timely identification of LVH in hypertensive individuals is crucial for precise cardiovascular risk assessment, since LVH correlates with elevated cardiovascular morbidity and mortality [3].

Assessment of cardiovascular risk in hypertensive LVH must take into account LV mass, geometric shape, and ventricular performance. Echocardiography offers an unbiased evaluation of left ventricular structure and functionality [4]. Echocardiography is more sensitive than ECG for detecting LVH, but its availability is limited and examination may be technically difficult in obese and elderly patients [5].

Current recommendations advise using ECG as an initial test for hypertension, even though its sensitivity for LVH is somewhat limited. Identifying LVH enhances cardiovascular risk assessment and treatment choices, while ECG also reveals strain, ischemia, conduction issues, and arrhythmias linked to worse outcomes [6]. Electrocardiogram (ECG) is commonly used for screening and initial assessment of LVH because it is noninvasive, inexpensive, simple, and readily available. However, its sensitivity and specificity for detecting LVH remain relatively low, particularly in patients with mild or early ventricular hypertrophy [7,8].

Worldwide research indicates that ECG-identified LVH is associated with echocardiographic findings of elevated LV mass and wall thickness; however, its sensitivity in identifying LVH is quite low. Echocardiography typically detects a greater number of LVH cases, and both ECG and echocardiographic LVH are linked to higher cardiovascular risk, morbidity, and negative clinical outcomes. These results emphasize the significance of identifying LVH early in hypertensive individuals for improved cardiovascular risk evaluation and handling [9,10].

Echocardiographic research conducted in Bangladesh has shown the significant value of echocardiography in detecting structural and functional heart irregularities, such as elevated ventricular wall thickness and hypertrophic alterations. These results endorse the utilization of echocardiography for precise evaluation of LV structure and distinction of LVH from alternative causes of ventricular hypertrophy [11,12].

In Bangladesh, few studies have assessed the relationship between ECG-identified LVH and echocardiographic LVH in hypertensive individuals. This gap in evidence is significant because ECG is low-cost and commonly accessible, while echocardiography, though more sensitive, is harder to obtain. This study sought to evaluate the relationship between ECG and echocardiographic LVH and analyze the diagnostic capabilities of ECG in patients with hypertension.

METHODS & MATERIALS

This cross-sectional observational study was conducted to assess the correlation between electrocardiographic left ventricular hypertrophy (LVH) and echocardiographic LVH among hypertensive patients. The study was conducted at the Hypertension and Research Center, Rangpur, and the Department of Medicine, Rangpur Medical College and Hospital, Rangpur, over six months during 2024–2025. Hypertensive patients aged ≥45 years with a history of hypertension for more than 3 years were included. Both male and female patients were eligible if they provided written informed consent. Patients with cardiomyopathy, left bundle branch block, significant cardiac arrhythmia, chronic obstructive pulmonary disease, collagen vascular disease, aortic stenosis, or aortic regurgitation were excluded. A minimum sample size of 84 was calculated,

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and 100 eligible patients were recruited using purposive sampling.

Demographic and clinical information, including age, sex, occupation, duration of hypertension, pulse rate, systolic blood pressure, and diastolic blood pressure, was collected using a pre-designed data collection form. Each participant underwent a standard 12-lead resting ECG. LVH was assessed using the Sokolow–Lyon voltage criterion, calculated as the S-wave amplitude in lead V1 plus the greater R-wave amplitude in lead V5 or V6. All participants subsequently underwent two-dimensional and M-mode echocardiography. Interventricular septal thickness in diastole (IVSd), left ventricular posterior wall thickness in diastole (LVPWd), and left ventricular internal diameter in diastole (LVIDd) were measured. Left ventricular mass (LVM) was calculated using the Devereux-modified formula and indexed to body surface area to obtain the left ventricular mass index (LVMI). Echocardiographic LVH was defined according to sex-specific LVMI cutoff values. The correlation between Sokolow–Lyon voltage and echocardiographic parameters, including LVM, LVMI, IVSd, and LVPWd, was assessed.

Data were analyzed using SPSS version 25.0. Continuous variables were presented as mean ± SD and categorical variables as frequency and percentage. Differences in echocardiographic parameters between patients with and without ECG-defined LVH were assessed using an independent-samples t-test. Pearson's correlation coefficient (r) was used to assess the relationship between ECG voltage and echocardiographic parameters. Echocardiography was considered the reference method for secondary diagnostic analysis, and sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of ECG were calculated. Agreement between ECG and echocardiographic LVH was assessed using Cohen's kappa coefficient, and the McNemar test was used for paired categorical comparisons. A p-value <0.05 was considered statistically significant. Ethical approval was obtained from the appropriate authority, and written informed consent was obtained from all participants. Participant confidentiality was maintained throughout the study.

RESULTS

This cross-sectional study was conducted at the Hypertension and Research Center, Rangpur, and the Department of Medicine, Rangpur Medical College and Hospital, Rangpur, over a period of six months during 2024–2025. A total of 100 hypertensive patients fulfilling the eligibility criteria were included in the study. The findings are presented in the following tables.

Table I presents the demographic characteristics of the study participants. The mean age of the patients was 57.3 ± 9.1 years, with a range of 45–79 years. The largest proportion of participants belonged to the 51–60-year age group, comprising 38 (38.0%) patients. Male patients constituted 64 (64.0%), while females accounted for 36 (36.0%). Regarding occupation, housewives represented the largest group (35.0%), followed by service holders (32.0%), farmers (18.0%), and businessmen (15.0%).

Table I

Distribution of hypertensive patients according to age, sex and occupation (*n*=100).

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	≤50	29	29.0
	51–60	38	38.0
	61–70	21	21.0
	>70	12	12.0
	Mean ± SD	57.3 ± 9.1	
	Range	45–79	
Sex	Male	64	64.0
	Female	36	36.0
Occupation	Service holder	32	32.0
	Business	15	15.0
	Housewife	35	35.0
	Farmer	18	18.0

Table II summarizes the clinical characteristics of the participants. The mean duration of hypertension was 7.87 ± 4.02 years, ranging from 3 to 22 years. The mean pulse rate was 76 ± 7 beats/min, with a range of 60–100 beats/min. The mean systolic blood pressure was 138 ± 18 mmHg, while the mean diastolic blood pressure was 86 ± 10 mmHg.

Table II

Clinical characteristics of hypertensive patients (*n*=100).

Variable	Mean ± SD	Range (min–max)
Duration of hypertension (years)	7.87 ± 4.02	3–22
Pulse rate (beats/min)	76 ± 7	60–100
Systolic BP (mmHg)	138 ± 18	100–190
Diastolic BP (mmHg)	86 ± 10	60–110

Figure 1 demonstrate the prevalence of LVH according to ECG and echocardiography. ECG using the Sokolow–Lyon voltage criterion identified LVH in 22 (22.0%) patients, whereas echocardiography identified LVH in 34 (34.0%) patients. Thus, echocardiography detected a greater proportion of LVH than ECG.

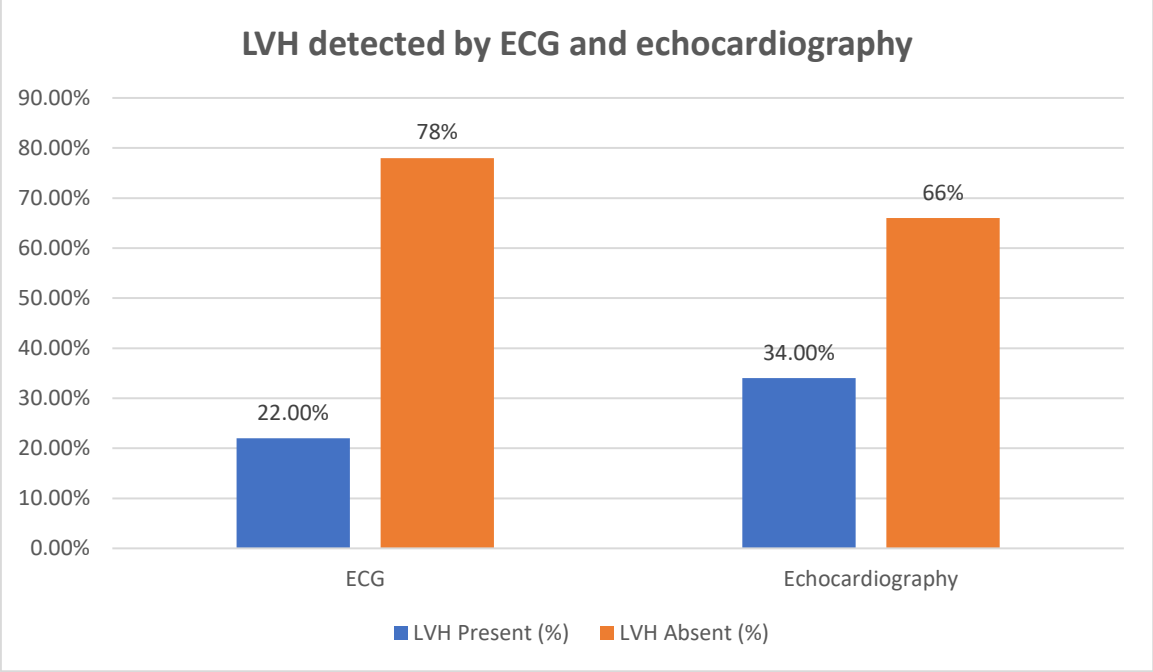


Figure 1 Distribution of LVH detected by ECG and echocardiography (*n*=100).

Table III compares echocardiographic parameters between patients with and without ECG-defined LVH. Patients with ECG-defined LVH had significantly greater IVSd, LVPWd, LV mass, and LVMI than those without ECG-defined LVH. The differences were statistically significant for all assessed parameters.

Table III
Comparison of echocardiographic parameters according to ECG-defined LVH (*n*=100).

Echocardiographic parameter	ECG-LVH Present (n=22) Mean ± SD	ECG-LVH Absent (n=78) Mean ± SD	p-value
IVS thickness (mm)	12.1 ± 1.4	10.5 ± 1.2	<0.001
LVPW thickness (mm)	11.7 ± 1.3	10.2 ± 1.1	<0.001
LV mass (g)	224.6 ± 42.8	185.3 ± 36.7	<0.001
LV mass index (g/m²)	126.8 ± 20.4	104.7 ± 17.9	<0.001

Table IV demonstrates the correlation between Sokolow–Lyon voltage and echocardiographic parameters. A moderate positive correlation was observed between Sokolow–Lyon voltage and LV mass (r=0.52, p<0.001) and LVMI (r=0.55, p<0.001). Sokolow–Lyon voltage also showed significant positive correlations with IVSd (r=0.43, p<0.001) and LVPWd (r=0.39, p<0.001).

Table IV
Correlation between Sokolow–Lyon voltage and echocardiographic parameters (*n*=100).

ECG parameter	Echocardiographic parameter	Pearson's r	p-value
Sokolow–Lyon voltage	LV mass	0.52	<0.001
Sokolow–Lyon voltage	LV mass index	0.55	<0.001
Sokolow–Lyon voltage	IVS thickness	0.43	<0.001
Sokolow–Lyon voltage	LVPW thickness	0.39	<0.001

These findings indicate that higher ECG voltage was associated with greater echocardiographic evidence of left ventricular hypertrophy.

Table V presents the agreement between ECG and echocardiographic classification of LVH. Among the 22 patients with ECG-defined LVH, 18 (81.8%) were also positive for LVH on echocardiography, while 4 (18.2%) were negative on echocardiography. Among the 78 patients without ECG-defined LVH, 16 (20.5%) had LVH on echocardiography, whereas 62 (79.5%) had no echocardiographic LVH.

Table V
Agreement between ECG and echocardiography for detection of LVH (*n*=100).

ECG LVH	Echo LVH,n(%)	Echo No LVH,n(%)	Total,n(%)
Present	18 (52.9)	4 (6.1)	22 (22.0)
Absent	16 (47.1)	62 (93.9)	78 (78.0)
Total	34 (100.0)	66 (100.0)	100 (100.0)

Thus, there were 18 true-positive, 62 true-negative, 4 false-positive, and 16 false-negative cases. The overall observed agreement was 80.0%, and the kappa coefficient was approximately 0.50, indicating moderate agreement between ECG and echocardiography.

Table VI shows the diagnostic performance of ECG using echocardiography as the reference method. ECG demonstrated a sensitivity of 52.9% and a specificity of 93.9%. The PPV was 81.8%, NPV was 79.5%, and overall diagnostic accuracy was 80.0%.

Table VI
Diagnostic performance of ECG compared with echocardiography (*n*=100).

Diagnostic parameter	Estimate (%)
Sensitivity	52.9
Specificity	93.9
Positive predictive value	81.8
Negative predictive value	79.5
Accuracy	80.0

DISCUSSION

In this study, the average age of hypertensive patients was 57.3 ± 9.1 years, where most were between 51 and 60 years old, and there were more males than females. These results closely resemble those of an earlier study, where the majority of participants were middle-aged to older adults, and there was a higher representation of men than women; the four treatment groups also exhibited a similar sex distribution, with men making up around 58–66% of the participants. The earlier research further showed notable regression of left ventricular hypertrophy after standard antihypertensive treatment, especially with successful blood pressure reduction [13].

In this study, the average duration of hypertension was 7.87 ± 4.02 years, with average systolic and diastolic blood pressure of 138 ± 18 and 86 ± 10 mmHg, respectively. These results align with earlier evidence indicating that a longer period of hypertension raises cardiovascular risk. Recent studies also suggest that proper BP control can decrease and encourage regression of left ventricular hypertrophy, highlighting the significance of sufficient BP management in individuals with chronic hypertension [14,15].

In this study, LVH was identified in 22.0% of patients through ECG with the Sokolow–Lyon criterion, whereas echocardiography revealed a detection rate of 34.0%, signifying that echocardiography has a greater detection rate. These results align with an earlier study, indicating that the occurrence of LVH varied between ECG and echocardiography, showing only moderate concordance between the two techniques. Echocardiography demonstrated greater sensitivity in detecting structural LVH, indicating that ECG might underestimate the true extent of LVH [16].

In the current research, individuals with ECG-confirmed LVH exhibited notably higher IVS thickness, LVPW thickness, LV mass, and LV mass index compared to those without ECG-confirmed LVH, highlighting a distinct link between ECG voltage criteria and enhanced left ventricular structural measurements. These results align with an earlier study that demonstrated traditional ECG criteria for LVH were linked to echocardiographic measures of ventricular structure, although their diagnostic accuracy differed among young Asian women [17]. This reinforces the use of ECG as a straightforward preliminary method for detecting patients with potentially elevated LV mass who might benefit from further echocardiographic evaluation.

In the current research, Sokolow–Lyon voltage exhibited notable positive correlations with LV mass, LVMI, IVSd, and LVPWd. These results align with an earlier investigation that demonstrated a notable correlation between Sokolow–Lyon voltage and LVMI (r=0.27, p=0.01), indicating elevated LVMI in patients with ECG-defined LVH (142.1 ± 35.6 vs. 124.1 ± 22.5 g/m²). A separate study indicated that ECG criteria showed restricted sensitivity for identifying echocardiographic LVH, emphasizing the supportive function of echocardiography [18,19].

In this study, 81.8% of patients with ECG-identified LVH were also found to have LVH on echocardiography, whereas 20.5% of patients without ECG-identified LVH exhibited echocardiographic LVH. These results align with earlier studies indicating that there is limited concordance between ECG and echocardiography, with echocardiography identifying more instances of LVH that ECG overlooked. Both prior studies indicated that echocardiography detected LVH more often than ECG, demonstrating its superior sensitivity for evaluating structural LVH in patients with hypertension [10,20].

In this study, ECG demonstrated a sensitivity of 52.9%, specificity of 93.9%, PPV of 81.8%, NPV of 79.5%, and an overall accuracy of 80.0% in identifying LVH when compared to echocardiography. These results align with earlier studies indicating that ECG criteria typically exhibit high specificity but restricted sensitivity in detecting echocardiographic LVH. The earlier research also showed differences in diagnostic accuracy across various ECG criteria, suggesting that while ECG serves as an effective basic screening method, it might overlook certain instances of LVH [21].

In general, ECG is an effective and highly specific screening method for identifying LVH in patients with hypertension, whereas echocardiography is more sensitive for recognizing structural LVH and should be utilized for verification.

CONCLUSION

This study showed a notable link between ECG-identified LVH and echocardiographic assessments of left ventricular structure in hypertensive individuals. The Sokolow–Lyon voltage displayed positive associations with LV mass, LVMI, and thickness of the ventricular wall. While ECG showed high specificity and fair overall accuracy, it had limited sensitivity, and echocardiography identified a larger percentage of LVH cases. Consequently, ECG serves as an easy and readily available first-line screening method, whereas echocardiography should be utilized for more precise validation and evaluation of structural LVH, especially in individuals with heightened cardiovascular risk.

REFERENCES

1. Xie L, Wang Z. Correlation between echocardiographic left ventricular mass index and electrocardiographic variables used in left ventricular hypertrophy criteria in Chinese hypertensive patients. Hellenic J Cardiol. 2010 Sep 1;51(5):391-401.
2. Schillaci G, Battista F, Pucci G. A review of the role of electrocardiography in the diagnosis of left ventricular hypertrophy in hypertension. Journal of electrocardiology. 2012 Nov 1;45(6):617-23.
3. Nardi E, Palermo A, Mule G, Cusimano P, Cerasola G, Rini GB. Prevalence and predictors of left ventricular hypertrophy in patients with hypertension and normal electrocardiogram. European journal of preventive cardiology. 2013 Oct 1;20(5):854-61.
4. Adegoke O, Adebiyi AA. A comparative and correlation study of electrocardiographic and echocardiographic left ventricular parameters in hypertension. Nigerian Journal of Cardiology. 2018 Jan 1;15(1):33-40.

5. Petersen SS, Pedersen LR, Pareek M, Nielsen ML, Diederichsen SZ, Leosdottir M, Nilsson PM, Diederichsen AC, Olsen MH. Factors associated with diagnostic discrepancy for left ventricular hypertrophy between electrocardiography and echocardiography. Blood Pressure. 2017 Jan 2;26(1):54-63.
6. Cuspidi C, Rescaldani M, Sala C, Negri F, Grassi G, Mancia G. Prevalence of electrocardiographic left ventricular hypertrophy in human hypertension: an updated review. Journal of hypertension. 2012 Nov 1;30(11):2066-73.
7. Bacharova LM, Schocken D, H Estes E, Strauss D. The role of ECG in the diagnosis of left ventricular hypertrophy. Current cardiology reviews. 2014 Aug 1;10(3):257-61.
8. Bult MM, van de Ree TF, Wind AM, Hurley KM, van de Ree MA. The use of echocardiography compared to electrocardiogram when screening for left ventricular hypertrophy in hypertensive patients: A cross-sectional study. The Journal of Clinical Hypertension. 2024 Aug;26(8):977-85.
9. Narayanan K, Reinier K, Teodorescu C, Uy-Evanado A, Chugh H, Gunson K, Jui J, Chugh SS. Electrocardiographic versus echocardiographic left ventricular hypertrophy and sudden cardiac arrest in the community. Heart Rhythm. 2014 Jun 1;11(6):1040-6.
10. Đurović V, Vulin A, Petrović M, Popović M. Correlation between electrocardiographic and echocardiographic parameters in the diagnosis of left ventricular hypertrophy in hypertensive patients. Med Pregl. 2023 May 1;76(5-6):156-61.
11. Islam MS, Sakib MA, Talukder R, Yusuf SM. Spectrum of heart diseases on Echocardiography in a Rural tertiary care Medical college hospital in Bangladesh. KYAMC Journal. 2012;3(1):223-34.
12. Islam AM, Adhikary DK, Rahman S, Ahmed M, Rahman MT, Ullah M, Majumder AA. Echocardiographic Profile of Hypertrophic Cardiomyopathy–A Single-Centre, Observational study. Cardiovascular Journal. 2021 Sep 15;14(1):5-11.
13. Ahmed SN, Jhaj R, Sadasivam B, Joshi R. Regression of the left ventricular hypertrophy in patients with essential hypertension on standard drug therapy. Discoveries. 2020 Sep 30;8(3):e115.
14. Soliman Y, Nazir A, Abuelazm M, Seri A, Mahmoud A, Abdelazeem B. The effect of intensive blood pressure lowering on left ventricular hypertrophy in patients with hypertension: a systematic review and meta-analysis of randomized controlled trials. InBaylor University Medical Center Proceedings 2024 Jul 3 (Vol. 37, No. 4, pp. 700-704). Taylor & Francis.
15. Zheng Y, Gao X, Jia HY, Li FR, Ye H. Influence of hypertension duration and blood pressure levels on cardiovascular disease and all-cause mortality: a large prospective cohort study. Frontiers in Cardiovascular Medicine. 2022 Oct 17;9:948707.
16. Zhang W, Zhou Y, Bai B, Yu S, Xiong J, Chi C, Teliewubai J, Li J, Blacher J, Zhang Y, Xu Y. Consistency of left ventricular hypertrophy diagnosed by electrocardiography and echocardiography: the Northern Shanghai Study. Clinical Interventions in Aging. 2019 Mar 11:549-56.
17. Su FY, Lin YP, Lin F, Yu YS, Kwon Y, Lu HH, Lin GM. Comparisons of traditional electrocardiographic criteria for left and right ventricular hypertrophy in young Asian women: The CHIEF heart study. Medicine. 2020 Oct 16;99(42):e22836.
18. Budkiewicz A, Surdacki MA, Gamrat A, Trojanowicz K, Surdacki A, Chyrchel B. Electrocardiographic versus echocardiographic left ventricular hypertrophy in severe aortic stenosis. Journal of Clinical Medicine. 2021 May 27;10(11):2362.
19. Bula K, Ćmiel A, Sejud M, Sobczyk K, Ryszkiewicz S, Szydło K, Wita M, Mizia-Stec K. Electrocardiographic criteria for left ventricular hypertrophy in aortic valve stenosis: Correlation with echocardiographic parameters. Annals of Noninvasive Electrocardiology. 2019 Sep;24(5):e12645.
20. Park BE, Lee JH, Jang SY, Lee HY, Lee JY, Shin HG, Park KI, Lee SP, Lee HS, Kim KI, Kang SH. Comparison of the efficiency between electrocardiogram and echocardiogram for left ventricular hypertrophy evaluation in patients with hypertension: Insight from the Korean Hypertension Cohort Study. The Journal of Clinical Hypertension. 2022 Nov;24(11):1451-60.
21. Marcato JP, Santos FS, Palone AG, Marques GL. Evaluation of different criteria in the diagnosis of left ventricular hypertrophy by electrocardiogram in comparison with echocardiogram. Cureus. 2022 Jun 27;14(6).