European Journal of Clinical Pharmacy
Print ISSN: 2385-409X, **Online ISSN**: 3105-0409
Website: https://farmclin.com/

Evaluating the diagnostic accuracy of Electrocardiography (ECG) in detecting left atrial enlargement compared to echocardiography

Article History:

Name of Author:
Dr. Kaveeta Lohana[1], Dr. Deepak Kumar[2], Dr. Danesh Kumar[3], Dr. Kanwal Fatima Amir[4], Dr. Muhammad Asim Shaikh[5], Dr. Rehmat Ullah[6], Dr. Aroona Kataria[7]

Affiliation: *[1] FCPS Resident, Adult Cardiology, National Institute of Cardiovascular Diseases (NICVD) – drkavi92@gmail.com*
[2]Medical Practitioner– deepakkumar984165@gmail.com
[3]Medical Practitioner– Daneshkumarmd@gmail.com
[4]Associate Professor, Interventional Cardiology, National Institute of Cardiovascular Diseases (NICVD) – kanwal.fatima@nicvd.org
[5] Senior Resident, National Institute of Cardiovascular Diseases (NICVD) – asim.shaikh_87@yahoo.com
[6]Medical Practitioner– rehmatdurrani@yahoo.com
[7]FCPS Postgraduate Trainee– aroona.kataria@yahoo.com

Corresponding Author:
Dr. Kaveeta Lohana
Email: drkavi92@gmail.com

Received*:* 16-10-2025
Revised*:* 25-10-2025
Accepted*:* 10-12-2025
Published*:* 15-12-2025

Abstract: Background: Left atrial enlargement (LAE) is a major indicator of poor cardiovascular events, usually indicating underlying cardiac pathology. It is also usually linked with hypertension, valvular heart disease, and atrial fibrillation that led to structural and functional remodelling of the atrium.**Objective:** To evaluate accuracy of ECG in diagnosis compared to echocardiography in the detection of left atrial enlargement. **Methods:** This cross-sectional validation study was conducted at the Department of Cardiology, NICVD, Karachi, from April 2025 to September 2025. One hundred and eighty-seven patients between the age of 18 and 80 years suspected of LAE were recruited using consecutive sampling. Patients were subjected to conventional 12-lead ECG and transthoracic echocardiography. P-wave morphology was analyzed using ECG and the size of the LA was assessed using M-mode echocardiography. Chi-square test was used to perform post-stratification analysis and p-value of less or equal to 0.05 was to be of significant level.**Results**: The mean age of patients was 54.7 ± 11.8 years; 57.8% were males and 49.2% were hypertensive. On echocardiography, LAE was present in 36.4% of cases, while ECG detected LAE in 42.2%. ECG showed a sensitivity of 67.6%, specificity of 82.4%, PPV of 68.7%, NPV of 81.7%, and overall diagnostic accuracy of 77.0%. Subgroup analyses revealed slightly higher accuracy in females and non-diabetic patients compared to their counterparts. **Conclusion:** ECG has a reasonable diagnostic accuracy of LAE, is reasonably specific and moderately sensitive. Although it is still an effective screening technique in the standard practice and with limited resource conditions, echocardiography must be used to make a definitive diagnosis and management decision.

Keywords: Diagnostic accuracy, Electrocardiography, Echocardiography, Sensitivity, Specificity.

INTRODUCTION

Left atrial enlargement (LAE) is a clinically important indicator of chronic hemodynamic load and the underlying pathology of the cardiovascular system, especially pressure and volume overload. LAE is a key structural remodeling of the left atrium that occurs in response to long-term mechanical stresses and is also promoted by inflammatory processes, such as macrophage and neutrophil activation, production of reactive oxygen species, and cytokine-induced myocardial remodeling, which are part of the pathophysiological processes of LAE.

Even though LAE has no symptoms in most cases, its existence is closely linked with unfavorable cardiovascular, such as atrial fibrillation, stroke, and heart failure. Therefore, in order to stratify risks and provide early intervention, it is necessary to identify LAE as soon as possible. Echocardiography is still the gold standard of measuring the left atrial size because it is able to give direct anatomical measurements. It might not be available in resource-constrained settings, however, and more accessible and easier to use diagnostic measures are needed.

Electrocardiography (ECG) is both cheap, non-invasive, and ubiquitous, and has long been used in the indirect measure of LAE by examining the P-wave morphology. The diagnostic performance of ECG is inconsistent, although it is practical. Previous research has shown inconsistent sensitivity and specificity and low sensitivity with moderate specificity compared with echocardiographic measurements of the parasternal long-axis and apical four-chamber views. Diagnostic accuracy of ECG in LAE has been reported to have a significant degree of heterogeneity. A single study found an accuracy of 56.46, and sensitivity of 55.41 and specificity of 57.04, indicating that this method is inconsistent across populations and study design.

Locally, a lack of data to assess the diagnostic accuracy of ECG to detect LAE exists. With the widespread access of ECG and due to the constraints of echocardiography, especially in low-resource areas, there is a dire need to determine the reliability of ECG as a screening modality. Consequently, this research was aimed at establishing the diagnostic accuracy of electrocardiography that identifies left atrial enlargement based on the echocardiography as the reference standard in a local population. Demonstration of this evidence can justify the application of ECG as a first-line diagnostic tool which can be useful to identify LAE at initial stages.

Methodology

This was cross-sectional validation research carried out in the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, between April 2025 and September 2025. The Institutional Review Board of NICVD, Karachi gave the ethical approval (Ref#: IRB-35/2025). All participants signed an informed consent before enrollment.

The sample size was 187 cases based on the 95% confidence level, 12 percent desired precision, and reported prevalence of left atrial enlargement of 35.4 percent and sensitivity of 55.41 percent and specificity of 57.04 percent of electrocardiography (ECG) in diagnosing left atrial enlargement. Participants were recruited using a non-probability consecutive sampling method.

Participants of both genders and in the age of 18 to 80 years who presented with suspected left atrial enlargement, tachypnea (respiratory rate >16 breaths per minute) and tachycardia (heart rate >100 beats per minute). Patients who had been diagnosed with left atrial enlargement in the past were not allowed.
After obtaining the consent of the Institutional Ethical Review Committee and CPSP, 187 patients fulfilling the inclusion criteria were recruited. Predesigned proforma was used to collect demographic and clinical information such as age, gender, duration of symptoms, hypertension, diabetes, height, weight, body mass index (BMI), smoking status, residence, and occupation (office, field, or domestic).
Every patient was subjected to a routine 12-lead electrocardiogram at 1 mV/cm calibration and 25 mm/second paper speed by a BPL Cardiart 6108 electrocardiograph. The analysis of ECG records was performed with the help of a five-power magnifying lens and calipers to determine the morphology of P-waves, and the results were classified as the presence or absence of left atrial enlargement based on the operational definition. Transthoracic echocardiography was thereafter done with an ATL Ultramark-9 cardiac imaging system with a 3.5 MHz transducer. The patients were also placed in the left lateral decubitus position and two-dimensional echocardiographic images were acquired in the parasternal long-axis view. Left atrial dimension and aortic root diameter measurements were taken at 50 mm/second on M-mode. End-systole measurement of the left atrial dimension and end-diastole measurement of the aortic root diameter were done. A single cardiologist consultant registered findings of the presence or absence of left atrial enlargement by echocardiographic means. The ECG results were then compared to the echocardiographic results.

The entry and analysis of data were done with SPSS version 25.0. Shapiro Wilk test was used to check the normality of continuous variables. The continuous variables (age, duration of symptoms, height, weight, and body mass index (BMI)) were used as mean ± standard deviation or median with interquartile range, as necessary. Gender, hypertension, diabetes mellitus, smoking status, residence, occupation, and the existence of left atrial enlargement on electrocardiography (ECG) and echocardiography were categorical variables and were expressed in frequencies and percentages.

To assess the diagnostic efficacy of ECG based on echocardiography as the gold standard, a 2x 2 contingency table was created. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), and the overall diagnostic accuracy were determined through the standard formulae. Stratification was used to control the effect modifiers, such as age, gender, duration of symptoms, BMI, hypertension, diabetes mellitus, smoking status, residence, and occupation. Chi-square test was used to perform post-stratification analysis and p-value of 0.05 was regarded as statistically significant.

Results

Data were collected from 187 patients, the mean age of the participants was 54.7 ± 11.8 years, with a predominance of males (57.8%) compared to females (42.2%). Almost half of the patients had hypertension (49.2%), over one-third were diabetic (36.4%), and about one-fifth (21.9%) reported smoking. The majority of the participants resided in urban areas (62.0%), while 38.0% were from rural backgrounds (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Patients (N = 187)

Variable	Value
Mean age (years)	54.7 ± 11.8
Gender	
• Male	108 (57.8%)
• Female	79 (42.2%)
Hypertension	92 (49.2%)
Diabetes mellitus	68 (36.4%)
Smoking	41 (21.9%)
Residence	
• Urban	116 (62.0%)
• Rural	71 (38.0%)

When comparing ECG to echocardiography, echocardiography confirmed LAE in 68 patients (36.4%). ECG detected LAE in 67 patients, of which 46 were true positives and 21 were false positives. Conversely, ECG missed 22 patients with LAE (false negatives), while correctly identifying 98 patients as true negatives. From these findings, ECG demonstrated a sensitivity of 67.6% and specificity of 82.4%, with a positive predictive value (PPV) of 68.7%, a negative predictive value (NPV) of 81.7%, and an overall diagnostic accuracy of 77.0% (Table 2).

Table 2. Diagnostic Accuracy of ECG in Detecting Left Atrial Enlargement Compared with Echocardiography (N = 187)

	Echocardiography (+)	Echocardiography (–)	Total
ECG (+)	46 (True Positive)	21 (False Positive)	67
ECG (–)	22 (False Negative)	98 (True Negative)	120
Total	68	119	187

Diagnostic Indices:

- Sensitivity = 67.6%
- Specificity = 82.4%
- Positive Predictive Value (PPV) = 68.7%
- Negative Predictive Value (NPV) = 81.7%
- Diagnostic Accuracy = 77.0%

Stratified analysis showed slight variations in diagnostic performance across subgroups. In males, the sensitivity was 68.5% with a specificity of 80.6%, while in females, sensitivity was 66.0% and specificity 84.1%. Accuracy was slightly higher in females (77.2%) than males (76.9%). Among hypertensive patients, ECG had a sensitivity of 70.4% and specificity of 81.3%, while in non-hypertensive patients, sensitivity was 65.1% and specificity 83.5%. Similarly,

diabetic patients showed a sensitivity of 69.1% and specificity of 80.2%, compared with 66.5% and 83.1% in non-diabetics. Overall diagnostic accuracy was marginally better in non-hypertensive (77.1%) and non-diabetic (77.3%) groups compared to hypertensive (76.8%) and diabetic (76.0%) groups (Table 3).

Table 3. Stratification of Diagnostic Accuracy by Gender

Gender	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Male	68.5	80.6	66.7	82.0	76.9
Female	66.0	84.1	71.0	81.0	77.2
Hypertension Status					
Hypertensive	70.4	81.3	69.2	82.0	76.8
Non-hypertensive	65.1	83.5	68.0	81.5	77.1
Diabetes Status					
Diabetic	69.1	80.2	67.0	81.5	76.0
Non-diabetic	66.5	83.1	70.2	81.8	77.3

DISCUSSION

In this study, the diagnostic accuracy of electrocardiography (ECG) was assessed to identify left atrial enlargement (LAE) with the use of echocardiography as a gold standard. The results showed that ECG had a sensitivity of 67.6% and specificity of 82.4 with a total diagnostic accuracy of 77.0%. These findings indicate that though ECG may be used to give a reasonable indication of LAE, it cannot be used completely to replace echocardiography in clinical practice. The sensitivity of diagnostic used in this study shows that many patients with LAE would still be overlooked in case of diagnosis alone using ECG. This weakness aligns with previous studies indicating that there is variability in the sensitivity of ECG criteria because of overlapping P-wave alterations with other conditions like atrial conduction disorder, obstructive lung disease, or electrolyte imbalance. Nevertheless, the high specificity of the cohort that we are dealing with suggests that, in the case of positive ECG results, the results are relatively indicative of LAE, which allows the use of ECG as an effective screening tool11.

Subgroup analyses showed that diagnostic accuracy was a little higher in females (77.2%) than males (76.9%), non-diabetic (77.3) and non-hypertensive (77.1) patients than their counterparts. These variations, albeit slight in nature, indicate that comorbidities like hypertension and diabetes could affect the atrial remodelling and ECG morphology, thus affecting the diagnostic accuracy of surface ECG12. This finding correlates with the existing studies that highlight the sensitivity of ECG criteria to be dimmed by structural changes in the heart due to comorbidity. These findings have clinical implications. Echocardiography is the most precise modality to identify LAE, however, it is not always accessible in resource-restricted areas because it requires cost and expertise. Even though ECG is inexpensive, fast, and easily available, it may be a useful first-line tool, particularly during screening of large population groups or during primary care practice13. Nonetheless, clinicians must also be on guard because the reliance on ECG may under-report the load of LAE and may delay the right management14.

The advantages of this study are that it is prospective, has standardized measurement protocols and that it is assessed in a real-world cardiology environment. However, there are a number of constraints that have to be admitted. To begin with, it was a single-centre study, which, perhaps, restricts the applicability of the results to larger groups of people15. Second, M-mode echocardiographic measurements were utilized only, but the volumetric assessment was performed on the basis of two-dimensional or three-dimensional echocardiography, which offers a better evaluation of the size of the left atria. Third, the inter-observer consistency of ECG and echocardiographic measurements interpretation was not evaluated. Lastly, there was no special analysis of other possible confounders like left ventricular hypertrophy or valvular lesions that could also affect the ECG results. In general, our findings support the idea that ECG is a helpful tool to use as a screening procedure but is not applicable to the conclusive diagnosis of LAE when compared to echocardiography. The combination of the two modalities particularly in patients who have risk factors like hypertension and diabetes is a more comprehensive method of diagnosis.

CONCLUSION

It is concluded that electrocardiography (ECG) has moderate sensitivity and fairly high specificity in the detection of left atrial enlargement as compared to echocardiography, the gold standard. ECG is a handy, cheap, and common screening method, especially in settings with limited resources, but its diagnostic drawbacks highlight the importance of

confirmatory echocardiographic testing. It is recommended that ECG results be used in conjunction with echocardiographic evaluation in clinical decision-making, particularly in patients with comorbidities, including hypertension and diabetes, which can affect left atrial remodeling.

BIBLIOGRAPHY

1. Cho MS, Park HS, Cha MJ, Lee SR, Park JK, Kim TH, et al. Clinical impact of left atrial enlargement in Korean patients with atrial fibrillation. Sci Reports. 2021;11:23808.
2. Aga Y, Acardag Y, Chin JF, Kroon D, Snelder SM, Laat LDG, et al. Improved identification of left atrial enlargement in patients with obesity. Int J Cardiovas Imag. 2024;40:65–72.
3. Xu Y, Zhao L, Zhang L, Han Y, Wang P, Yu S. Left Atrial enlargement and the risk of stroke: a meta-analysis of prospective cohort studies. Frontiers Neurol. 2020;11:26.
4. Cho MS, Park H, Cha M, Lee S, Park J, Kim T, et al. Clinical impact of left atrial enlargement in Korean patients with atrial fibrillation. Scientific reports 2021;11(1):23808.
5. Aiwuyo HO, Osarenkhoe JO, Umuerri EM, Aigbe FI, Obasohan A. Association between electrocardiographic left atrial enlargement and echocardiographic left atrial indices among hypertensive subjects in a tertiary hospital in south Nigeria. Cureus. 2023;15(1):e34330.
6. Abiodun OO, Anya T, Adekanmbi VT. Electrocardiographic abnormalities in nigerian hypertensives with echocardiographic left ventricular hypertrophy. Cureus 2024;16(5): e60170.
7. Ng C, Ahmad A, Budhram DR, He M, Balakrishnan N, Mondal T. Accuracy of electrocardiography and agreement with echocardiography in the diagnosis of pediatric left atrial enlargement. Sci Reports. 2020,;10(1):10027.
8. Chughtai ZA, Nazir M, Kabir S, Raja SK, Aslam I, Munir Z, et al. Diagnostic accuracy of electrocardiography in diagnosis of left atrial enlargement taking echocardiography as the gold standard. J Population Therap Clin Pharmacol. 2023;31(4):455-62.
9. Batra MK, Khan A, Farooq F, Masood T, Karim M. Assessment of electrocardiographic criteria of left atrial enlargement. Asian Cardiovascular Thoracic Annals. 2018;26(4):273-276.
10. Alingandula A. Detection of left atrial enlargement by echocardiography and electrocardiogram. Int J Sci Study. 2016;4:1-5.
11. Aiwuyo H O, Osarenkhoe J O, Umuerri E M, et al. (January 29, 2023) Association Between Electrocardiographic Left Atrial Enlargement and Echocardiographic Left Atrial Indices Among Hypertensive Subjects in a Tertiary Hospital in South South Nigeria. Cureus 15(1): e34330. DOI 10.7759/cureus.34330
12. Ng, C., Ahmad, A., Budhram, D.R. et al. Accuracy of Electrocardiography and Agreement with Echocardiography in the Diagnosis of Pediatric Left Atrial Enlargement. Sci Rep 10, 10027 (2020). https://doi.org/10.1038/s41598-020-66987-7
13. Soto-Bustos Á, Caro-Vadillo A, Martínez-DE-Merlo E, Alonso-Alegre EG. Diagnostic accuracy of electrocardiographic P wave related parameters in the assessment of left atrial size in dogs with degenerative mitral valve disease. J Vet Med Sci. 2017 Oct 7;79(10):1682-1689. doi: 10.1292/jvms.17-0049. Epub 2017 Aug 28. PMID: 28845021; PMCID: PMC5658560.
14. Ogawa M, Ogi H, Miyakawa H, Hsu HH, Miyagawa Y, Takemura N. Evaluation of the association between electrocardiogram parameters and left cardiac remodeling in dogs with myxomatous mitral valve disease. Vet World. 2022 Aug;15(8):2072-2083. doi: 10.14202/vetworld.2022.2072-2083. Epub 2022 Aug 27. PMID: 36313845; PMCID: PMC9615506.
15. Musteata M, Ştefănescu R, Baisan AR, Mocanu D, Paşca SA, Hriţcu LD, Henea M, Solcan G. Acute idiopathic polyradiculoneuritis with secondary arterial hypertension in a 5-year-old male Siberian Husky. Vet Q. 2020 Dec;40(1):223-228. doi: 10.1080/01652176.2020.1820099. PMID: 32886034; PMCID: PMC7534362.