

# Study of Detection of Left Atrial Enlargement by Echocardiography and ECG Correlation in Cardiac and Non-Cardiac Diseases

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DOI: <https://doi.org/10.52403/ijshr.20220426>

## ABSTRACT

Evidences highlight the importance of enlarged left atrium (LA) as a barometer of diastolic burden. Detection of left atrial enlargement or its progression is frequently important in clinical medicine. It is well established that LAE has close relationship with atrial fibrillation, systemic thromboembolism events and heart failure<sup>4</sup>.

ECG assessment of left atrial enlargement is a non-invasive and universally available method<sup>12</sup>. ECG analysis for left atrial enlargement includes configuration, amplitude and duration of 'P' wave<sup>55</sup>. Echocardiographic LA dimension is the best non-invasive test of left atrial size<sup>25</sup>. This prospective study was carried out in Ramakrishna care hospital Raipur for 24 months to study the detection of left atrial enlargement by echocardiography with ECG correlation in cardiac and non-cardiac diseases. Rheumatic mitral and aortic valve disease was the most common cause of left atrial enlargement accounting for 26.67% in this study. Next in this order were atrial fibrillation 20%, Hypertension 18.33%, IHD 13.34%, isolated aortic valve diseases 10%, cardiomyopathies 05%. MVP and Thyrotoxicosis each accounting for 3.33%. Echo was simple, non invasive technique to detect LAE from mild to severe grade and help for therapeutic purpose, prevent complications.

So, echo was found to be more specific in detection of LAE than ECG.

**Keywords:** LA-Left atrium, LV-Left ventricle, AF-Atrial fibrillation

## INTRODUCTION

Left atrium is an important muscular contractile chamber located in the inflow path to the ventricle, functions as a pump, and as a blood reservoir<sup>1</sup>. Left atrial geometry and mechanical functions exert a profound effect on left ventricular filling and overall cardiovascular performance<sup>2</sup>. It also helps in the propagation of impulse of depolarization and the closure of mitral valve<sup>3</sup>.

Left atrial enlargement is an important pathologic change in many forms of heart disease<sup>4</sup>. Detection of left atrial enlargement or its progression is frequently important in clinical medicine<sup>5</sup>. There is growing recognition of the importance of left atrial enlargement and its association with increased morbidity and mortality in patients with cardiovascular diseases<sup>6</sup>.

The left atrium is affected directly by increased ventricular filling pressure, increased resistance across the mitral valve, or volume overload<sup>7</sup>. Left atrial enlargement occurs in various conditions

like mitral valve disease, aortic valve disease, combined valvular lesions, Hypertension, Ischemic heart disease, mitral valve prolapse, cardiomyopathy is, congenital heart diseases, pericardial effusion<sup>7</sup>. Enlargement of left atrium is well known as one of the earliest manifestations of Rheumatic mitral valvular disease. This chamber may become enormous; expanding to the right and posteriorly to form a huge sac that encroaches upon adjacent structures and may eventually rest against right chest wall<sup>8</sup>.

Many numbers of studies has shown that a chronic hemodynamic burden initially produces atrial dilatation and structural damage to atrial wall, this in turn increases likelihood of the development of atrial fibrillation. Once atrial fibrillation is present, atrial dilatation could progress as a consequence of continued hemodynamic burden, the less of atrial systole or both<sup>9</sup>. Left atrial enlargement has been found to be a significant predictor of recurrent and chronic atrial fibrillation<sup>10</sup>. An increase in left atrial size in the presence of atrial fibrillation has been independently associated with an increased risk of stroke as well as increased mortality. Left atrial dimension therefore has a diagnostic and prognostic significance in clinical practice<sup>11</sup>.

ECG assessment of left atrial enlargement is a non-invasive and universally available method<sup>12</sup>. Echocardiography has proven to be a valuable non-invasive tool for quantitatively assessing left atrial size<sup>9</sup>.

The present study is an attempt to detect the left atrial enlargement by Echocardiography and ECG correlation in cardiac and non cardiac diseases.

## LITERATURE REVIEW

### Electrocardiographic features of left atrial enlargement

Left atrial enlargement will result in three basic electrocardiographic effects. 5, 38, 39, 40, 55

1. Prolongation and delay of the terminal or left atrial component of atrial activation.
2. Increased posterior deviation of the left atrial vector.
3. Left axis deviation of the mean manifest frontal plane P wave axis; and especially left axis deviation of the left atrial component of atrial activation.

### Prolongation and delay of the left atrial component of atrial activation

With left atrial enlargement, the P wave is prolonged due to delay of the left atrial or terminal component of the P wave. The characteristic features will manifest in standard lead II, or in standard lead I or even lead aVL when there is left axis deviation of the P wave. The P wave shows: (i) a double peaked, notched or camel humped P wave (P mitrale) and (ii) an increased duration of the P wave to longer than 0.11 sec. The duration of the notch-the distance between the camel humps is longer than 0.04. The manifestation of these features in a particular frontal plane lead will depend upon the frontal plane P wave axis. Thus, if the P wave axis is, for example, directed to  $+50^{\circ}$ , it will be most aligned with the lead axis of standard lead II, and the aforementioned manifestations are best seen in this lead. If, however, the P wave axis is deviated leftwards, for example, to  $0^{\circ}$  or further leftward, which is not an uncommon occurrence with left atrial enlargement, it will then be most aligned with standard lead I and lead aVL, and the aforementioned manifestations will be best seen in these leads. These features may also be evident in the left precordial leads lead V5 and V6.

### Increased Posterior deviation of the left atrial vector

With left atrial enlargement, the left atrial component of atrial activation is prolonged, increased in magnitude and directed further posteriorly. The left atrial vector is consequently orientated more directly away from the lead V1 electrode. Lead V1 will consequently reflect a relatively deep, delayed and widened terminal negative component.

### The P terminal Force (Morris and Macruz index)

This measurement is an evaluation of the terminal negative component of the P wave in lead V1. It is derived by multiplying the depth of the terminal P wave deflexion (in millimeters) by the duration (in seconds). The value is expressed in millimeter – seconds (mm sec). If the P terminal force exceeds 0.03 mm. sec, it constitutes a sign of left atrial enlargement. This is also known as the Morris index. These are some sensitive indices for early detection of LA

enlargement. LAE does not increase the overall amplitude of the P wave, but increases only the amplitude of the terminal, negatively directed portion of the wave in lead V1 to >0.10 mV. With extreme LAE, the P-wave amplitude may increase and the terminal portion of the wave may become negative in leads II, III, and a VF.

Morris Index=Depth of terminal P wave deflection (in mm) X duration (in secs) in lead V1. >0.03mm.sec indicates LAE.

Macruz Index=Ratio of the duration of P wave to PR segment in lead II >1:1.6 indicates LAE.

### Left axis deviation of the manifest frontal plane P wave axis

Left atrial enlargement is usually associated with left axis deviation of the P wave axis. When this occurs, the P wave is directed to the region of +45<sup>0</sup> counter – clockwise to -30<sup>0</sup> on the frontal plane.

Table-1: American society of echocardiography in conjunction with European association of echocardiography has given guidelines for left atrial enlargement

	Reference range	Mild	Moderate	Severe
LA diameter (cms) for men	3.0 – 4.0	4.1 – 4.6	4.7 – 5.2	≥5.2
LA diameter(cms) for women	2.7 – 3.8	3.9 - 4.2	4.3 – 4.6	≥4.7

## MATERIALS & METHODS

### Study Setting

This study was carried out in Ramakrishna care hospital.

### Study Duration

This study was carried out for 24 months from September 2017 to September 2019

### Study Design

A two year prospective study was carried out.

### Source of Data

All inpatients admitted to ICCU and cardiac wards in a tertiary care hospital.

### Study Population

60 cases of left atrial enlargement were studied in the present study.

### Inclusion Criteria

- Rheumatic mitral and aortic valvular diseases
- Isolated aortic valve diseases
- Hypertension
- Coronary artery diseases(IHD)
- Mitral valve prolapse
- Cardiomyopathy
- Thyrotoxicosis
- Atrial fibrillation

### Exclusion Criteria

- Age < 14 yrs
- Pericardial effusion
- Chronic obstructive pulmonary diseases (COPD)
- Chest trauma

### Method of Collection of Data

By using simple random method, 60 patients having 'p' wave ECG changes in lead II and V<sub>1</sub> submitted for Echocardiographic evaluation over a period of 2 – years.

An informed consent was taken from all the 60 patients in the study group who were then subjected to the following:

- a. Detailed history taking
- b. Thorough General Physical Examination
- c. Systemic Examination
- d. Investigations like 12 lead ECG and Echocardiography.

The proforma was designed based on the objective of the study and it was pretested and used after modification.

### Electrocardiogram

A standard 12 lead ECG was recorded in all patients and was analyzed for evidence of Left atrial enlargement and/or AF.

### Echocardiography

Echocardiography was performed in all the cases. Left atrial size was measured by 2D echo guided M-mode echocardiography.

Measurements were obtained as per the recommendations of American Society of Echocardiography as shown in table - 1. Left atrium was measured at end systole in parasternal long axis as a maximum distance between the anterior margin of posterior aortic root echo and the anterior margin of a posterior wall of left atrial echo at the aortic valve levels.

### STATISTICAL ANALYSIS

The collected data was analyzed with the aid of calculator and presented in

the form of tables, figures, graphs and diagrams wherever necessary.

### RESULTS

1. In our study, age of the patients ranged from 17 years to 90 years with mean age of 49.21 years. There were 40% females and 60% males with a ratio of 1:1.5 showing male preponderance.
2. Rheumatic mitral and aortic valve disease was the most common cause of left atrial enlargement accounting for 26.67% in this study. Next in this order were atrial fibrillation 20%, Hypertension 18.33%, IHD 13.34%, isolated aortic valve diseases 10%, cardiomyopathies 05%. MVP and Thyrotoxicosis each accounting for 3.33%.
3. In our study, all the atrial fibrillation cases were of rheumatic heart disease. So, both rheumatic mitral and aortic valve disease and atrial fibrillation in total forms 46.66% patients.
4. Left atrial size varied from 40 mm to 76 mm with a mean left atrial size 46.88 mm in this study. AF was more common (66.66%) when left atrial enlargement was 47mm with a mean LA size 54.41mm.
5. In this study, out of 26.67% rheumatic mitral and aortic valve disease patients, 62.5% of them were with mild LAE with mean left atrial size 44.75 mm. 20% patients were of atrial fibrillation, Of them 66.66% had severe LAE with mean left atrial size 58mm. 13.34% patients were of IHD, of them 62.5% had moderate LAE with mean left atrial size of 44.62mm.
6. In the present study, when p' wave duration alone was taken as ECG criteria for LAE, ECG shown positivity in 85.41% patients, when Morris and Macruz index were taken in to consideration separately, positivity was seen in 79.16% patients each. ECG has shown left atrial enlargement in echo confirmed LAE in 75% patients when all criteria considered in this study. ECG

positivity was seen in 60% of mild 73.88% of moderate and 93.75% of severe left atrial enlargement. As LA enlarged from mild to severe, AF sets in and also ECG predictability of LAE has increased.

## DISCUSSION

The period of this study was from the period of 2 years. 60 patients admitted in a tertiary care hospital were included in study. Left atrium is a muscular contractile chamber located in the inflow path to the ventricle, and functions as a pump as well as a blood reservoir. Left atrial geometry and mechanical functions exert a profound effect on left ventricular filling and overall cardiovascular performance. Left atrial enlargement is an important pathologic change in many forms of heart disease

In our study, age of the patients ranged from 17 years to 90 years with mean age of 49.21 years. There were 40% females and 60% males with a ratio of 1:1.5 showing male preponderance. Waggoner AD et al<sup>24</sup> in their study involving 339 patients, 58.99% were females and 41.01% were males. In a study by Levy et al,<sup>33</sup> F:M was 1.3 : 1. So this study is comparable to Levy et al study.

Rheumatic mitral and aortic valve disease was the most common cause of left atrial enlargement accounting for 26.67% in this study. Next in this order were atrial fibrillation 20%, Hypertension 18.33%, IHD 13.34%, isolated aortic valve diseases 10%, cardiomyopathies 05%. MVP and Thyrotoxicosis each accounting for 3.33%. Hamid Ikram et al<sup>5</sup> found Rheumatic mitral and aortic disease as the most common cause of left atrial enlargement (48.64%), next in this order was Hypertension (7.02%).

In our study, all the atrial fibrillation cases were of rheumatic heart disease. So, both rheumatic mitral and aortic valve disease and atrial fibrillation in total forms

46.66% patients and can be comparable with Hamid Ikram et al study.

Left atrial size varied from 40 mm to 76 mm with a mean left atrial size 46.88 mm in this study. AF was more common (66.66%) when left atrial enlargement was 47mm with a mean LA size 54.41mm.

Kulkarni AG et al<sup>57</sup> has shown in their study 97.14% of population had LA size >40mm with a mean LA size 55.58mm, and patients with AF also had left atrial size 55.58mm. In a study by Levy et al<sup>33</sup> patients with AF had left atrial size of  $43.8 \pm 8.6$ mm. The findings of present study are comparable to the above mentioned studies.

In this study, out of 26.67% rheumatic mitral and aortic valve disease patients, 62.5% of them were with mild LAE with mean left atrial size 44.75 mm. 20% patients were of atrial fibrillation, Of them 66.66% had severe LAE with mean left atrial size 58mm. 13.34% patients were of IHD, of them 62.5% had moderate LAE with mean left atrial size of 44.62mm. There were 18.33% were of hypertension, of them 45.46% were mild LAE with mean LA size of 40.72mm. 5% were of cardiomyopathy, All of them were of severe left atrial enlargement with mean LA size of 56.33 mm. 3.33% cases were of thyrotoxicosis, of the 50% each of mild and moderate LAE with mean LA size 42 mm with a mean age of 60 years. 10% were of isolated aortic valve disease of which 50% were mild LAE with mean LA size 44.83 mm. 3.33% patients were of mitral valve prolapse, both were of mild left atrial enlargement with mean LA size of 43 mm. In study of Levy et al, cardiomyopathy accounted for 5.06% of cases with a mean LA size of  $43.8 \pm 8.6$ mm. Coronary artery disease accounted for 16.3% of patients with mean left atrial size of  $43.8 \pm 8.6$ mm. Hypertensive heart disease accounted for 2 1.44% patients with a mean LA size of  $43.8 \pm 8.6$ mm.

In the present study, when p' wave duration alone was taken as ECG criteria

for LAE, ECG shown positivity in 85.41% patients, when Morris and Macruz index were taken in to consideration separately, positivity was seen in 79.16% patients each. ECG has shown left atrial enlargement in echo confirmed LAE in 75% patients when all criteria considered in this study. ECG positivity was seen in 60% of mild 73.88% of moderate and 93.75% of severe left atrial enlargement. As LA enlarged from mild to severe, AF sets in and also ECG predictability of LAE has increased.

So, ECHO was found to be more specific investigation to detect LAE compared to ECG. Echo was noninvasive simple technique to detect positive LAE than ECH. As LA enlarged from mild to severe grade, ECG predictability of LAE was also increased (93.75% in severe LAE group). In the study it was found that complications of LAE like CCF, AF, Embolic stroke and mortality were increased as size of LA increased. Thus, early detection of LAE using ECHO and ECG will help in reducing further complications.

## CONCLUSION

In our study 60 inpatients aged from 17 to 90 years were included. Among them 36 were males and 24 were females. Left atrial enlargement was common in >40 years age group with male preponderance. More number of left atrial enlargement was seen in patients of RHD with mitral and aortic valve disease, atrial fibrillation, hypertension and IHD. 2D-echocardiography was able to detect all 60 cases of LAE and able to categorize them into mild, moderate and severe LAE. But ECG was able to predict LAE only in 75% cases. So, 2D echo is superior to ECG in detecting LAE.

Severity of LAE was found to be associated with congestive cardiac failure, atrial fibrillation, neurological deficits (stroke) and mortality. So, this has got some therapeutic implications like prophylactic anticoagulation to prevent embolic stroke.

Early diagnosis of LAE and appropriate management will help in reducing or delaying the occurrence of complications like CCF, neurological deficits AF and in turn mortality.

## SUMMARY

The present study was undertaken to study LAE by echocardiography and ECG correlation in cardiac and non-cardiac diseases. From the results observed thereof and discussion outlined in the previous chapters are summarized as follows.

1. In the present study, 60 cases ranged from 17 years to 90 years with a mean age of 49.21 years with Female: Male ratio was 1:1.5.
2. LAE was found common in 40 years age group (71.66%)
3. RHD with mitral and aortic valvular disease was the most common cause of LAE (26.67%). LAE varied from 40 mm to 76 mm with a mean LA size of 46.88 mm.
4. Maximum number of patients with LAE was seen in the group 40-50 years (31.66%). More number of severe LAE was seen in AF group (50%).
5. 2D-echo was able to recognize LAE in all cases. Among them 41.67% were mild LAE. ECG was able to predict LAE in 75% patients when all the criteria for LAE considered. ECG was able to show AF characteristics features in all cases of AF category.
6. When P wave duration alone was taken in to consideration, ECG was able to predict LAE in 85.41% patients. When Morris index and Macruz index were considered separately, ECG predicted LAE in 79.16% patients each.
7. ECG was able to predict LAE more in severe LAE category (93.75%).
8. Severity of LAE significantly associated with CCF ( $P < 0.025$ ), neurological deficits ( $P < 0.05$ ) and highly significant in mortality ( $P < 0.005$ ).
9. 8.33% patients died during the hospital course. Of them 4 had severe LAE with mean LA size 60.8 mm. Severity

of LA size had an association with AF origin 50% of severe LAE category patients had developed AF.

10. Echo was simple, non-invasive technique to detect LAE from mild to severe grade and help for therapeutic purpose, prevent complications. So, echo was found to be more specific in detection of LAE than ECG.

**Acknowledgement:** None

**Conflict of Interest:** None

**Source of Funding:** None

**Ethical Approval:** Approved

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How to cite this article: Abbas Naqvi, A. K. Shadani, Shubhangi Gupta et.al. Study of detection of left atrial enlargement by echocardiography and ECG correlation in cardiac and non cardiac diseases. *International Journal of Science & Healthcare Research*. 2022; 7(2): 173-182. DOI: <https://doi.org/10.52403/ijshr.20220426>

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