



LEFT ATRIAL SIZE IN NON-VALVULAR ATRIAL FIBRILLATION: PERCENTAGE INCREASE IN DIAGNOSIS OF LEFT ATRIAL SIZE BY M-MODE VERSUS PROLATE ELLIPSE VOLUME METHOD.

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ABSTRACT

BACKGROUND: Atrial fibrillation (AF) is the most common cardiac arrhythmia with overall prevalence of 5.5%. AF is associated with left atrial (LA) enlargement. LA enlargement is considered both a cause and effect of the arrhythmia. The aim of the study was to determine the influence of AF on changes in LA size determined by Echocardiography in a population without rheumatic heart disease or any valvular pathology i.e NVAf.

OBJECTIVE: 1. To determine the frequency of LA enlargement by M-mode diameter method and LA volume by Prolate Ellipse method in nonvalvular atrial fibrillation patients.

2. To determine percentage increase in the diagnosis of LA enlargement when measured by Prolate Ellipse volume as compared to M-mode diameter method.

MATERIAL AND METHODS: This cross sectional study was conducted at Department of Cardiology, Punjab Institute of Cardiology, Lahore for six months from October 2012 to April 2013.

210 patients fulfilling inclusion and exclusion criteria were recruited after obtaining informed consent from Cardiology department of Punjab institute of cardiology Lahore. Each patient was explained about the procedure of the study. Demographic details like age, sex, and address were noted. 12-lead ECG were recorded before echo to document atrial fibrillation. Echocardiographic measurements were averaged for three readings, performed and interpreted by experienced echocardiographer according to standard protocol. LA size was assessed as: One plane indexed LA diameter measurement in left parasternal long axis view (PSLAV). Prolate Ellipse volume measurement calculated by following formula.

$LA\ volume = (D1 \times D2 \times D3) \times (0.523).$

Both values were indexed to body surface area, calculated as follow

$BSA\ (m^2) = ([Height\ (cm) \times Weight\ (kg)] / 3600)^{1/2}$

RESULTS: A total of 210 patients were enrolled in current study. Among these 120 patients (57.35%) were male and 90 (42.65%) were female patients. Mean age was 57.59 ± 14.2 years. Echocardiography of patients showed that 66(31.5%) patients were having normal LADI measured by M-mode diameter method and 54(25.7%) patients were having normal LAVI measured by Prolate Ellipse volume method. While 144(68.5%) and 156(74.2%) patients were having enlarged LA by M-mode diameter and Prolate Ellipse volume method respectively. Percentage accuracy of Prolate Ellipse volume method was 6%.

CONCLUSION: In conclusion, LAVI by Prolate Ellipse method gives more accurate measure of LA size than LADI on M-mode echocardiography.

KEY WORDS: Non valvular atrial fibrillation (NVAf), Atrial fibrillation (AF), Left atrial diameter index (LADI), Left atrial volume index (LAVI).

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INTRODUCTION:

Atrial fibrillation is the most common cardiac arrhythmia associated with high morbidity, mortality and increased socioeconomic

burden. Its prevalence is 5.5% and increases with age as 0.7% in 55–59 years of age and 17.8% in patients of 85 years and above. The incidence is 9.9/1000 person-years. Prevalence and incidence are higher in males than in females. The lifetime risk to develop AF at the age of 55 years is 23.8% in males and 22.2% in females.¹

Although major causes of nonvalvular atrial fibrillation (NVAf) are hypertension and coronary artery disease, enlarged left atrium is now identified as a source of production and maintenance of atrial fibrillation. Majority of paroxysmal atrial

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fibrillation patients have enlarged left atrium on echocardiography.²

Atrial arrhythmia causes electroanatomical remodeling and dilation of atria.³ This remodeling of atria determines the recurrence rate of atrial fibrillation especially in paroxysmal atrial fibrillation.⁴

Dilated left atrium in non valvular atrial fibrillation is a major source of cardiovascular and cerebrovascular events as it predicts increased stretch on atrial myocytes secondary to left ventricular diastolic dysfunction and provide a site for blood stasis and thrombus formation leading to thromboembolic phenomenon and stroke. There is five to seven fold increased risk of ischemic stroke in patients of atrial fibrillation as compared to control.^{5, 6, 7}

Atrial fibrillation leads to asymmetrical remodeling or reverse remodeling in different clinical scenarios so only measuring one dimension will lead to either underestimation or overestimation of left atrium. In such conditions left atrial volume taken on 2D echocardiography gives a better estimate of LA size.

It is well known that left atrial size is predictive of different clinical outcomes as atrial fibrillation, stroke, cardiac failure etc so it can be used as a marker to treat them e.g. anticoagulation, before cardioversion and before catheter ablation for atrial fibrillation. Measurement of LA volume in patients with atrial fibrillation has not been studied in Pakistani population so far.

Percentage accuracy was obtained by subtracting frequency of the cases of enlarged LA on indexed diameter method from those positive on indexed volume method.

MATERIALS AND METHODS:

This cross sectional study was conducted at Department of Cardiology, Punjab Institute of Cardiology, Lahore for six months from October 2012 to April 2013.

Patients with atrial fibrillation of either sex 30-90 years of age were included in the study

Patients with valvular heart disease assessed on clinical examination or echocardiography, Congenital heart disease assessed on history, clinical examination and echo and patients with H/O cardiac surgery were excluded from the study.

Sample size: Sample size of 210 cases was calculated with 95% confidence interval, 6% margin of error .

CLINICAL DATA:

Age, gender, height, weight, cardiac rhythm,

and history of co morbid conditions were recorded at enrollment. Baseline cardiac rhythm was considered as sinus or AF at the time of echocardiography. Paroxysmal AF was defined as episodes of AF that terminated spontaneously or with intervention within seven days; may recur with variable frequency.

Permanent AF was defined as a condition in which a normal heart rhythm could not be restored with treatment.

ECHOCARDIOGRAPHIC DATA:

Echocardiographic data was collected prospectively to see LA size via two methods, M-mode diameter and Prolate Ellipse volume method. Measurements were obtained once in sinus rhythm and three times in AF.

M-mode LA dimension was taken according to the American Society of Echocardiography method in parasternal long axis view at end systole from leading edge of aorta to leading edge of left atrium. For volume measurement, three dimensions were taken at end systole:

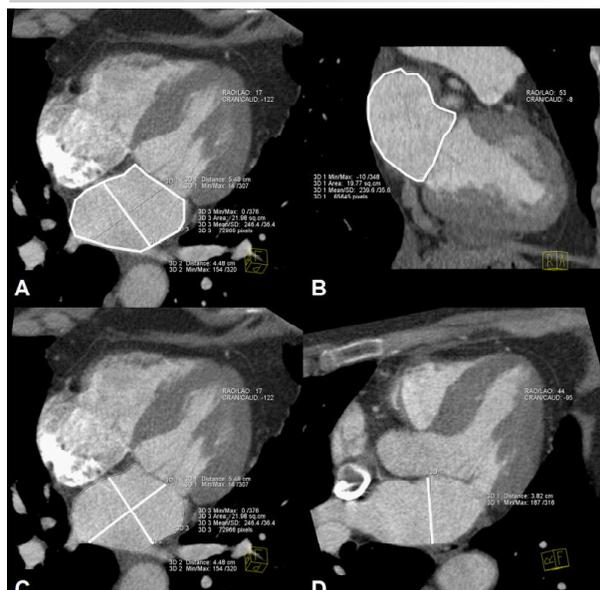
For Prolate Ellipse, the anterior-posterior (D1) and the medial-lateral diameter(D2) of the left atrium in four-chamber view and the anterior-posterior diameter (D3) in three-chamber view were measured.(fig 1)

Volume was calculated by following formula.

$$LA \text{ volume} = (D1 \times D2 \times D3) \times (0.523).$$

Both values were indexed to body surface area which was calculated as follow

Fig 1 showing measurement by Prolate Ellipse method





$$BSA (m^2) = ([Height (cm) \times Weight (kg)] / 3600)^{1/2}$$

Severity of LA Inlargement measured by LAVI (ml/m²) is graded as mildly abnormal 16-28, moderately abnormal 34-39 and severely abnormal ≥ 40 . Reference range is 16-28 ml/m².

Frequency of LA enlargement was recorded by both M-mode diameter and Prolate Ellipse volume method and then % increase in diagnosis was calculated as per operational definition.

STATISTICAL ANALYSIS:

Continuous variables like age, LA volume and heart rate were reported as mean \pm SD. Categorical variables like sex were reported as percentages. Results of LA volume and the LA volume index as assessed by the M-mode diameter and Prolate Ellipse volume methods were compared. The paired t test was used to test for mean differences among LA volumes by each method. Difference was obtained by subtracting frequency of the cases of enlarged LA on indexed diameter method from those positive on indexed volume method.

RESULTS:

A total of 210 patients with mean age of 57.59 \pm 14.2 years, 57.35 % male, 42.65% females(fig2,3) fulfilled inclusion criteria and informed consent was taken before participation. Presenting symptoms were: dyspnea, chest pain, presyncope, syncope and palpitations. Out of these 96 (44.5 %) had a history of paroxysmal AF, and 114 (55.4 %) had permanent AF. Mean BSA was 1.6 \pm 0.4m² (table 1) .

The mean LADI was 2.9 \pm 0.9 and mean LAVI was 45.1 \pm 30.5. The reference range for LADI and LAVI was 1.5- 2.3 cm³/m² and 22 \pm 6 cm³/m² respectively as recommended by European society

Figure-2: Graphical distribution according to the sex.

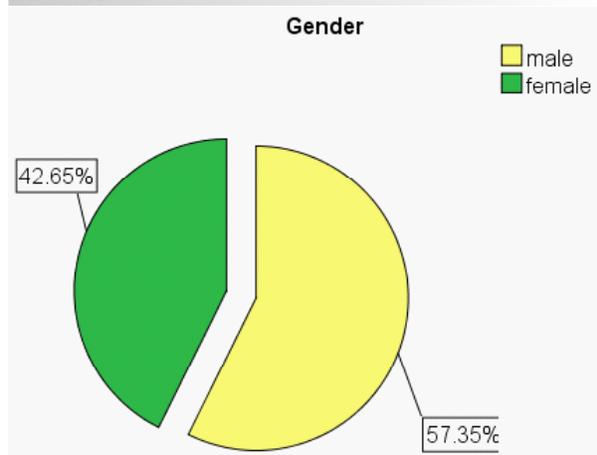


Figure-3: Graphical distribution according to the age.

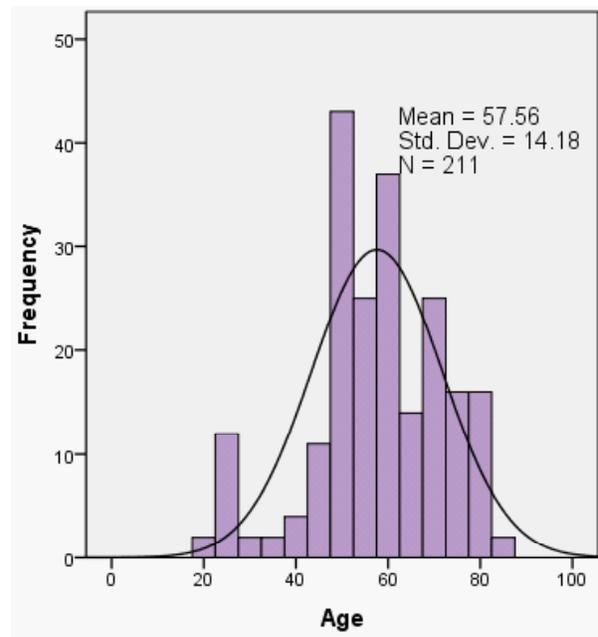


Table-1: Descriptive statistics according to BSA, age, LADI and LAVI.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
BSA	209	.82	2.79	1.6099	.46764
Age	210	20	83	57.59	14.211
LADI	210	1.39	5.70	2.9365	.92196
LAVI	210	8.90	211.90	45.1962	30.51491

Table-2: Frequency distribution according to LADI and LAVI.

	LADI	LAVI	P-value
SUBNORMAL	1(0.4%)	6(2.8%)	0.065
NORMAL	65(30.95%)	48(22.85%)	
ENLARGED	MILDLY	15(7.14%)	0.0153
	MODERATELY	22(10.47%)	
	SEVERLY	88(41.9%)	

Total no. of patients having enlarged LADI = 144(68.5%)

Total no. of patients having enlarged LAVI = 156(74.28%)

The percentage increase in diagnosis of LA enlargement by Prolate Ellipse method is around 6%.

of cardiology, 66 (31.5%) patients were having normal LADI measured by M-mode diameter method and 54(25.7%) patients were having normal LAVI measured by Prolate Ellipse volume method. While 144(68.5%) and 156(74.2%) patients were having enlarged LA by M-mode diameter and Prolate Ellipse volume method respectively. Out of 144 pts with enlarged LADI on M-mode 26(12.58%), 30(14.28%) and 88(41.9%) were having mild,



moderate and severely enlarged LA respectively. While out of 156 patients who had enlarged LAVI 15 (7.41%), 22 (10.47%) and 119 (56.6%) patients were having mild, moderate and severely enlarged LA respectively (table 2). Percentage accuracy of Prolate Ellipse volume method was around 6%.

DISCUSSION:

Atrial fibrillation (AF) is a dangerous cardiac arrhythmia causing increased morbidity and mortality. This study was done on 210 patients of nonvalvular AF selected randomly from out-patient department who were referred for echocardiography for cardiac assessment. Their LA size was measured by applying two methods to check the accuracy of each. Data of this study showed that indexed LA dimensions are superior to simple LA dimensions as these values are highly correlated to BSA and in comparison of both LADI and LAVI, volume measurements were better predictor of LA size as its diagnostic accuracy was 6%. Indexed left atrial volume (iLAV) is the most accurate measure of left atrial size, and is predictor of recurrence of atrial fibrillation as shown by Marchese et al⁸. In one study by Tsang et al⁹ done on patients of normal sinus rhythm and with atrial fibrillation to compare left atrial (LA) volume to LA area and diameter to predict poor cardiovascular outcomes by using biplane area length method. All values were indexed to BSA. Out of 106 patients with AF the normal LA was found in 31 and 6 patients by LADI and LAVI respectively while enlarged LA was present in 69 and 94 patients by same methods respectively with overall accuracy of 25%. The overall sensitivity and specificity of different methods of LA size quantitation using receiver operator characteristic curves were compared, the area under the curve for indexed LA volume was greater than that of the other two methods, and its sensitivity was superior throughout the range of LA size.⁹

The difference in results in this study are due to the method used for LAVI i.e. Biplane area length method which is more accurate than Prolate Ellipse method. LA dimension by M-mode method is easy to measure, but its validity has recently been questioned.¹⁰ LA size is more precisely measured by volume index method rather than linear dimension as the left atrium is an asymmetrical cavity. Moreover, LA dilatation might not be evenly distributed in all planes, and measurement of anteroposterior dimension is likely to be insensitive to changes in LA size.

Dilatation of the left atrium, in the absence of organic mitral valve disease or history of AF,

is a common cause of cardiovascular disease morbidity.¹⁰⁻¹² LA usually dilates in presence of diastolic dysfunction in which LA pressure rises as ventricular stiffness increases and LA dilates to produce adequate pressure to maintain LV filling.

LA enlargement should be carefully interpreted in the presence of Atrial Fibrillation. LA enlargement is not always strictly spherical, it may be asymmetrical. There are more chances of measurement error of LA size when it is taken in single dimension. The two or three-dimensional measurements of LA size are better predictive of LA size and prognosis. LA dimension by M-mode echocardiography and LA volume using two-dimensional techniques among a random population sample is assessed and compared in a recent study. LA volume is a better method of measurement over LA diameter for predicting outcomes inclusive of AF.^{10,13}

Body size is an important determinant of LA size. To adjust for this influence, LA size should be indexed to a measure of body surface area. LA single dimension is not accurate for LA size measurement. Different methods of LA size measurement should be used. The biplane, which is readily applicable with current echocardiographic equipment, should be routinely applied in clinical practice.¹⁴ It needs to be clarified that LA volume indexed with body surface area, reduced body size related variations in LA volume and it may be prognostically important¹³. Gender differences in LA size¹⁵ are almost completely determined by variation in body surface area. In population without cardiovascular disease, indexed LA volume is independent of age from childhood onward¹⁵. Age-related LA enlargement is a reflection of the pathophysiologic factors that often accompany advancing age rather than a result of chronologic aging.¹⁵

LA volume is closely related to LV mass/hypertrophy, systolic and diastolic dysfunction¹³. The incremental value of each parameter for the prediction of death is expected to diminish when considering others. LA volume index is important in providing incremental value in predicting mortality.¹⁶

STUDY LIMITATIONS:

The study patients were referral-based, and the extent to which the data can be generalized to other population groups is not known. Other factors such as change in LA size were not considered. The small sample size, the various etiologies for which the patients were seen and the differences in dosage and duration of various therapies were other limiting factors.



CONCLUSION:

Enlargement of left atrial size has important clinical and prognostic effects. Indexed left atrial

volume is superior to LA diameter as a measure of LA size, and should be included into the routine echocardiographic evaluation.

Author's Contribution

MAR: Reviewed and analyzed the data and has written the article AV: has done data collection and conducted the study AH: table and figure TN,AN,SH: Were consultant incharge and gave frequent advice , correction and did proof reading.

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