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KEY WORDS:

STUDY OF LEFT ATRIAL ENLARGEMENT AND ITS CORRELATION WITH LEFT VENTRICULAR HYPERTROPHY IN PATIENTS WITH SYSTEMIC HYPERTENSION

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ABSTRACT

Left ventricular hypertrophy has been suggested to mediate the relation between hypertension and left atrial enlargement. However, less is known about correlates of left atrial size in hypertensive patients with left ventricular hypertrophy. We assessed left atrial enlargement by echocardiography and electrocardiography in 500 hypertensive patients, age 25 years and above (mean, 58.65) and compared it with electrocardiographic and echocardiographic left ventricular hypertrophy at baseline. Enlarged left atrial diameter (women, 3.8 cm; men, 4.2 cm) was present in 46.4% of women and 53.5% of men (P <0.01) with mean left atrial volume index 33.84 (ml/m^2) and 32.32(ml/m^2) respectively. Compared with the 388 patients with normal left atrial size, the 112 patients with enlarged left atrium more often had echocardiographic left ventricular hypertrophy. They also had higher age, systolic blood pressure, pulse pressure, weight, body mass index and interventricular septal thickness (all, P <0.01). In logistic regression analysis, left atrial enlargement was related to left ventricular hypertrophy and eccentric geometry; greater body mass index, systolic blood pressure, and age and female gender (all, P<0.01). Thus, left atrial size in hypertensive patients with electrocardiographic left ventricular hypertrophy is influenced by gender, age, obesity, systolic blood pressure, and left ventricular geometry. Also ECG showed very low sensitivity but high specificity in detecting LAE as compared to ECHO which is the gold standard. Sensitivity and specificity of ECG for detecting LAE depends upon the number of diagnostic criteria taken into account. Sensitivity of ECG in detecting LAE can be increased by using more criteria.

Introduction

Hypertension is the major risk factor for adverse cardiovascular (CV) and cerebrovascular events in both developed and developing countries. Long-term high blood pressure can cause coronary artery disease, stroke, heart failure, peripheral vascular disease, vision loss, and chronic kidney disease. Left ventricular hypertrophy considered to be one of the part of target organ damage, has been used as one of the marker of long term hypertension. Left atrial enlargement (LAE) is a marker of left-ventricular pressure and volume overload.[1] The size of the left atrium (LA) is increased in numerous CV disorders and is characterized by alterations in LV structure and function, such as mitral valve or myocardial disease and arterial hypertension. In hypertensive heart disease, LAE is a reliable marker of a chronically elevated LV filling pressure and diastolic dysfunction even in the absence of MV disease.[1,2]

There have been reports of an independent association between LA size and incident CV death or congestive HF. Previously, The Losartan Intervention for Endpoint Reduction in Hypertension (LIFE) study has stated that left atrial size in hypertensive patients with electrocardiographic left ventricular hypertrophy is influenced by gender, age, obesity, systolic BP and left ventricular geometry independent of left ventricular mass and presence of mitral regurgitation or atrial fibrillation (AF).[3]

LAE and LVH can be detected both by electrocardiography (ECG) and echocardiography (ECHO). ECHO has been clinically employed for more than 30 years, making it one of the most important non-invasive imaging methods in the evaluation of cardiac morphology and dynamics. Though ECHO is superior to ECG, it is economically expensive and not widely available, especially in rural parts and in a developing country like ours. The purpose of this study, hence, is to explore the correlation of diagnosing LAE and LVH on ECG in patients with systemic hypertension as compared to ECHO which is the gold standard in this study.

Method

In this cross sectional study, a total of 500 hypertensive patients newly diagnosed or on treatment attending Acharya Vinoba Bhave Rural Hospital were included in the study. The patients who were above 25 years, were selected randomly irrespective of sex and age. Patients with chronic kidney disease, valvular heart disease, dilated cardiomyopathy, cor pulmonale, congenital heart disease, ischemic heart disease, atrial fibrillation / atrial flutter, hyper dynamic states (Chronic anaemia, thyrotoxicosis), pregnancy and poor quality ECHO window were excluded. Written informed consent in English and Marathi language was taken from the subjects after explaining the nature of the evaluation to them.

BP was measured with standard mercury sphygmomanometer and cuff, after the subject had rested in supine position for 15 minutes. The systolic and diastolic BP levels were taken at the points of appearance and disappearance of korotkoff sounds, respectively.

Patients BMI according to Asian criteria[4] and waist hip ratio were recorded. Electrocardiographic LA enlargement was diagnosed by P wave duration ≥ 0.12s in lead II and Notched P wave in limb leads with the inter-peak duration ≥ 0.04s. LVH on ECG was diagnosed by Sokolow-lyon index criteria (S in VI, + R in V 5 or V 6 > 35 mm) and Cornell voltage criteria for LVH (>2440 mV X ms).

On echocardiography, LVH was detected by measuring interventricular septal thickness on M mode. Thickness exceeding 11 mm was taken as hypertrophied LV[5,6]. LAE was diagnosed by measuring left atrial dimension, left atrial volume and left atrial volume index. Left atrial dimension was measured by M mode in parasternal long or short axis view at end-systole as per the recommendations of the American Society of Echocardiography. All measurements were made from leading edge to leading edge i.e. the uppermost line of a structure. Left atrial volume was measured by biplane method of disks (modified Simpson's rule) at ventricular end systole. Left atrial volume index was calculated by indexing left atrial volume to body surface area. Values for left atrial volume index are same for both men and women.[6]

Statistical analysis was done by using descriptive and inferential statistics using the Chi square test, z-test for difference between two means, Pearson's Correlation coefficient and Multiple Regression Analysis. Software used in the analysis was the SPSS

22.0 version. A P<0.01 is considered as level of significance (p<0.01). Univariate correlation analysis was used to confirm the significance of various risk factors associated with LAE.

Results

The mean age of the study population was 58.65 years (SD ± 10.48) with 54.2% of them male and 45.8% females. Mean systolic BP of the study population was 154.49 mmHg (SD ± 20.48) and the mean diastolic BP was 95.48 mmHg (SD ± 15.62). The mean BMI of the study patients was 25.79 kg/m^2 (SD ± 2.82). In the study, 207 (41.4%) patients were newly diagnosed as hypertensive and 293 (58.6%) were already on previous antihypertensive treatment (Table 1).

On 2D Echo, mean left atrial dimension was found out to be 31.122 mm (SD ± 9.45), left atrial volume 38.02 ml (SD ± 15.22), left atrial volume index 20.48 ml/m^2 (SD ± 7.62), interventricular septum thickness 12.25 mm (SD ± 2.42), and posterior wall thickness 11.49 mm (SD ± 2.17). (Table 2)

Table 1: Baseline Characteristics of the study population

TOTAL NO OF PATIENTS	n=500
Mean Age (years)	58.65± 10.48
Gender: Male	271 (54.2%)
Female	229 (45.8%)
BMI (kg/m^2)	25.79 ± 2.82
Waist Hip Ratio	0.8609 ± 0.47
Alcoholic	87 (17.4%)
Smoker	180 (36%)
Systolic Blood Pressure (mmHg)	154.49 ± 20.48
Diastolic Blood Pressure (mmHg)	95.48 ± 15.62
Previous Treatment	
Continuous	293 (58.6%)
Newly Diagnosed	207 (41.4%)

Table 2: 2D ECHO findings in patients with systemic hypertension

ECHO Findings	Mean ± SD
La Dimension (mm)	31.122 ± 9.45
Interventricular Septal Thickness (IVST) (mm)	12.25 ± 2.42
Posterior Wall Thickness (PWT) (mm)	11.49 ± 2.17
Left Atrial Volume (ml)	38.02 ± 15.22
Left Atrial Volume Index (Volume/ BSA) (ml/m^2)	20.48 ± 7.62

Table 3: Comparison of LAE on ECG with 2D ECHO

LAE	LAE		Total	X^2-value
	ECHO Positive	ECHO Negative		110.60
LAE ECG +	30	0	30	p=0.0001,S
LAE ECG -	82	388	470	
TOTAL	112	388	500	

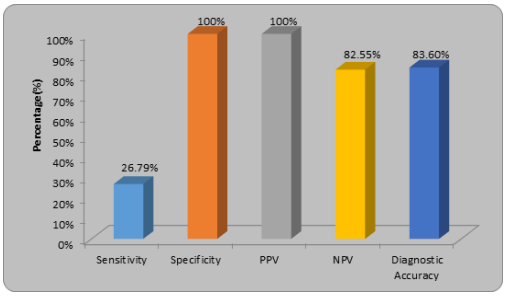


Table 3 shows the comparison of LAE on ECG as compared to gold standard ECHO. On comparing ECG with ECHO for the diagnosing LAE, the sensitivity of ECG was found to be 26.79%, specificity 100%, PPV of 100% and NPV of 82.55%

Table 4: Comparison of patient groups with and without Left Ventricular hypertrophy

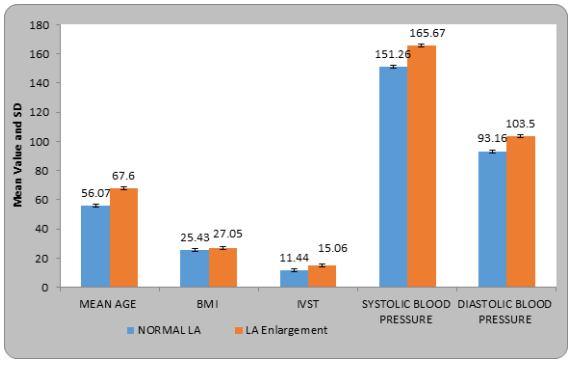
	NO LVH	LVH	t-value	p-value
LA Dimension	26.20±6.78	33.72±9.64	9.12	0.0001,S
Left Atrial Volume	27.93±5.41	43.35±16.02	12.28	0.0001,S
LAVI (VOLUME/BSA)	15.50±2.89	23.12±8.03	12.06	0.0001,S

Comparison was done on the basis of LVH on ECHO in which it was seen that LA dimension in patients with normal LV was 26.20 mm (SD ± 6.78) whereas patients with LVH had 33.72 mm (SD ± 9.64). Similarly, there was a significant difference in left atrial volume in patients having normal and hypertrophic LV (27.93 ± 5.41 vs 43.34 ± 16.02). Left atrial volume index in patients with normal LV was found to be 15.50 ml/m^2 (SD ± 2.89) whereas it was 23.12 ml/m^2 (SD ± 8.03) in patients with LVH.

Table 5: Comparison of total patients with and without la enlargement on basis of LAVI (VOLUME/BSA)

	NORMAL LA	LA Enlargement	t-value	p-value
No Of Patients	388 (77.6%)	112 (22.4%)		
Gender (M/F)	211/177	60/52	0.02	0.88,NS
Mean Age (years)	56.07±10.02	67.60±6.46	11.49	0.0001,S
BMI (kg/m^2)	25.43±2.54	27.05±3.335	5.52	0.0001,S
IVST(mm)	11.44±2.07	15.06±1.03	17.78	0.0001,S
Systolic BP (mmHg)	151.26±18.03	165.67±24.30	6.85	0.0001,S
Diastolic BP (mmHg)	93.16±13.85	103.50±18.58	6.40	0.0001,S

Graph : Comparison of Total Patients with and Without La Enlargement on Basis of LAI (VOLUME/BSA)



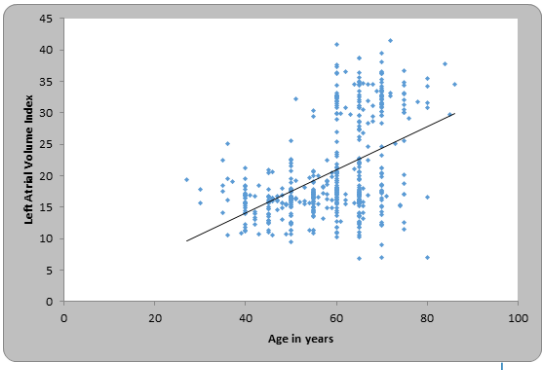
Out of the total 500 patients, 388 (77.6%) had normal LA size whereas 112 (22.4%) had enlarged LA. We compared various parameters like mean age, BMI, IVST, systolic and diastolic BP between patients having normal LA size and enlarged LA. All the observations shown in table 5 show significant positive correlation.

Table 6: Risk factor for LA enlargement

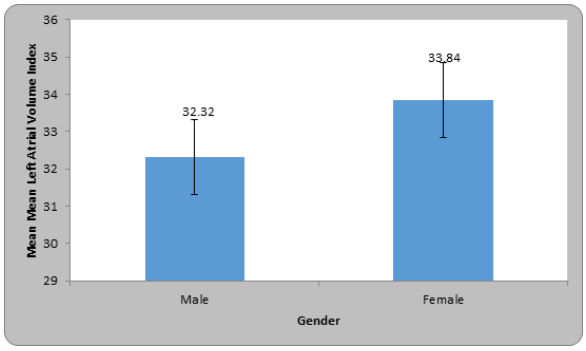
Risk factor	r- value	P value
Age> 60 years	0.475	< 0.01, S
Gender (female)	0.288	< 0.01, S
BMI	0.217	< 0.01, S
Duration of hypertension	0.651	< 0.01, S

Table 6 shows the correlation coefficient of various risk factors with the LA size. LA size as a continuous variable showed positive correlation with age ® = 0.475, p<0.01), body mass index (r= 0.217, p< 0.01), female sex (r= 0.288, p<0.01) and duration of hypertension (r= 0.651, p<0.01)

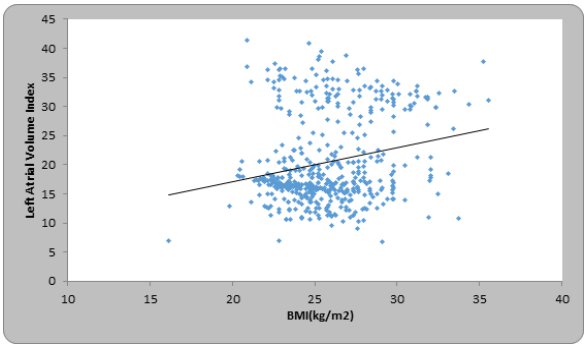
Graph: Correlation between age in years and Left Atrial Enlargement



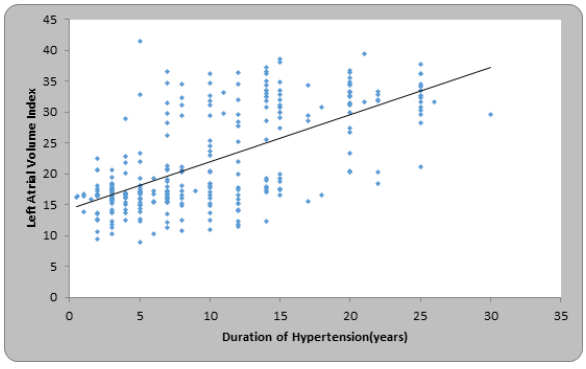
Graph : Correlation between gender and Left Atrial Enlargement



Graph: Correlation between BMI (kg/m^2) and Left Atrial Enlargement



Graph : Correlation between duration of hypertension and Left Atrial Enlargement



Discussion

Although LA enlargement is a common finding in hypertensive patients that indicates hypertensive heart disease, few echocardiographic studies have assessed LA size in hypertension. The present study describe covariates of LA size in a large hypertensive population with ECG LV hypertrophy. The study adds to previous knowledge by identifying several independent covariates of LA size in middle-aged and older hypertensives like old age, female sex, higher BMI and duration of hypertension.

Comparison of patients with normal and enlarged LA showed that patients with LAE were older, more obese, had larger intraventricular septal thickness and higher systolic blood pressure. These results were similar to those conducted by Eva Gerdts et al[7] and QiaoyunOu et al[8].

Present study showed a sensitivity of just 26.79% but specificity of 100% of ECG in diagnosing LAH as compare to gold standard of ECHO. A similar study conducted by Hameed et al[9] showed sensitivity of 22.50% and specificity of 100%. The small difference in sensitivity between their study and the present data (22.50% vs 26.79%) may be due to the fact that they had used only 'P' mitrale criteria for the diagnosis of LAE on ECG whereas in the present study data, two criteria for the diagnosis of LAE on ECG are included. Mishra et al[10] conducted a similar study and found that on combining all the six criteria for detecting LAE on ECG, the sensitivity can be increased to 89% but specificity dropped to 77%. The huge difference in sensitivity and specificity between ours and the above study might be due to the fact that they have included all the six criteria for detecting LAE on ECG whereas in the present study we have taken only two criteria for detecting LAE on ECG. On comparing patients having normal and hypertrophied LV on ECHO, it was seen that patients with LVH had greater probability of having LAE than those with normal LV.

A positive correlation was found in our study between LAE and age i.e. as the age increases the chances of LAE also increases. Moreover, in our study it was found that females had a greater prevalence of developing LAE than males. Patients who were obese had a greater chance of developing LAE than those with normal BMI. Similar correlations were stated by Eva Gerdts et al[7], QiaoyunOu et al[8], Marco Proietti et al[11], Kumar et al[12] and Jan Stritzke et al[13] in their studies. A positive correlation was seen in our study between duration of hypertension and chances of developing LAE. As the duration of hypertension is increased, the chances of developing LAE are also increased. Studies conducted by Xu et al[14] and Su et al[15] also proved similar results.

In conclusion, echocardiographic LA enlargement is commonly found in hypertensive patients with LV hypertrophy. In such patients, LA enlargement is particularly prevalent in older and more obese patients, as well as in women with longer duration of hypertension. In our study ECG showed very low sensitivity but high specificity in detecting LAE as compared to ECHO which is the gold standard. Sensitivity and specificity of ECG for detecting LAE depends upon the number of diagnostic criteria taken into account. Sensitivity of ECG in detecting LAE can be increased by using more criteria.

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