

Anatomical evaluation of left atrial antero posterior dimension by trans-thoracic echocardiography in elderly Marathwada population with normal cardiac function

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Abstract

Knowledge of normal range of Left Atrial size is important for physicians and cardiologist to diagnose and manage cardiac diseases with dilated left atrium like Mitral Valve Diseases, dilated cardiomyopathies.

In present work TTE (Trans Thoracic echocardiography) was chosen to measure Left atrial size as it is commonly used diagnostic modality of present time to reveal in vivo anatomy and function of heart. Left Atrial Antero posterior dimension is commonly measured on Trans Thoracic echocardiography (TTE) to assess Left atrial size. The purpose of present study was to find standard range of commonly measured Left Atrial Antero posterior dimension with transthoracic echocardiography in patients with normal left and right ventricular function.

With the permission of ethical committee and consent of patient; total 104 patients (42 male and 62 female) were included in this study. The mean age of present study population was 44.64 years. The range of Left Atrial AP dimension by 2D guided M mode for total study population was (18 to 40)mm with mean \pm S.D was $30.64\text{mm} \pm 4.10\text{mm}$.

Indians have different physical characteristics than western population; the study parameter was evaluated for its relation with height, weight and Body Surface Area. Statistical findings showed significant correlation between study dimension and these physical parameters. The study concludes that these physical parameters should be taken into account while considering normal ranges of LA AP dimension for respective population.

Keywords: Left Atrial Antero Posterior dimension, M mode echocardiography.

Abbreviations: TTE- Trans Thoracic Echocardiography, EF- ejection fractions, LA A-P dimension - Left Atrial Antero posterior dimension, BSA- Body Surface Area.

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Introduction

“The left atrium is roughly cuboidal and extends behind the right atrium, separated from it by the obliquely positioned septum, thus the right atrium is in front and anterolateral to the right part of the left atrium”.⁽¹⁾

Knowledge of normal range of Left Atrial size is important for physicians and cardiologist to diagnose and manage cardiac pathologies with dilated left atrium like Mitral Valve Diseases, dilated cardiomyopathies.

“The gross anatomy of the heart can be evaluated by 2D echocardiography in the para-sternal, apical, suprasternal and subcostal positions. The standardized planes used are long axis, short axis and four-chamber”.⁽¹⁾ Fig. 1 and 2.

“From its introduction in 1954 to the mid 1970’s, most echocardiographic studies employed a technique called M-mode, in which the ultrasound beam is aimed manually at selected cardiac structures to give a graphic recording of their positions and movements. M-mode recordings permit measurement of cardiac dimensions and detailed analysis of complex motion patterns depending on transducer angulation”.⁽²⁾

“A comprehensive echocardiographic examination, utilizing both M-mode and two dimensional recordings, therefore provides a great deal of information about cardiac anatomy and physiology, the clinical value of

which has established echocardiography as a major diagnostic tool.”⁽²⁾

The present study was performed in the Department of Anatomy in collaboration with Department of CVTS centre GMC Aurangabad (2010-2013). Measurements were obtained by 2D guided M MODE on Trans Thoracic Echocardiography for dimensions of Left Atrium. Left Atrial size by M mode on parasternal long axis, sex (Male or Female) and age of patient were noted. The data obtained from the echocardiography of the patients was pooled and analysed for study parameter and for male and female differences, age differences and compared with that given in literature and other studies. The mean age of the study sample and its gender wise distribution was found out. Similarly gender wise distribution of the means and standard differences of the physical characteristics the Height, weight, BSA were calculated. Study population was grouped and studied gender wise and age wise for any statistical difference.

Indians have different physical characteristics than western population; the present study evaluated LA AP dimension for its relation with height, weight and BSA. Statistical findings showed significant correlation between study dimension and these physical parameters.

Needless to mention various cardiac diseases are common in India. The mean age of present study population is 44.64 yrs and heart diseases are more common in this ageing population so our study is useful for this population. Such studies are very few in number.

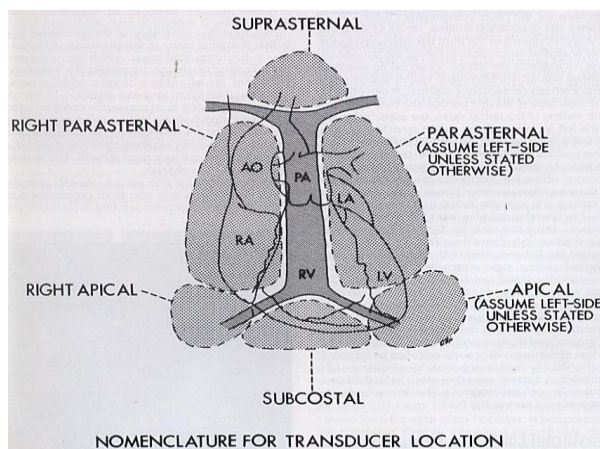


Fig. 1: Courtesy of Feigenbaum 7th edition⁽³⁾

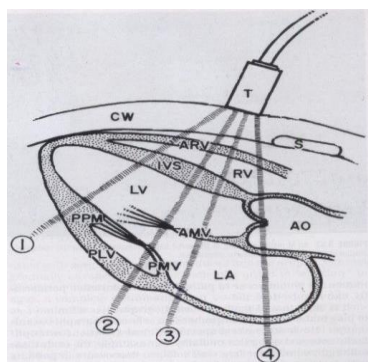


Fig. 2: By courtesy of Feigenbaum Echocardiography 7th edition⁽⁴⁾

Materials and Method

With the permission of the Ethics committee; comprehensive study was performed in the Department of Anatomy in collaboration with Department of CVTS Centre GMC Aurangabad.

Study design: Prospective study: Sample size: 104 (during year 2011 to 2013).

Inclusion Criteria

1. Age >18 years

2. Patients with normal Left Ventricular function (LVEF >50%) and normal Right Ventricular function as seen on TTE

Exclusion Criteria:

- Patients with Hypertensive Heart disease (IVS thickness >12 mm on TTE)
- Patient with Mitral Regurgitation and Mitral Stenosis.
- Age <18 years.
- Patient with Left Ventricular function <50% and poor Right Ventricular function as seen on 2D Echocardiography as recorded by senior cardiologist.
- Patients with Structural heart disease.
- Patients in whom high quality TTE is not obtainable.

Materials and Method

PHILIPS iE33 ECHO machine with transducer S 51 for adult 1.7 to 3.4 HZ

- Weighing machine
 - Sliding wall scale for height measurement
- Study protocol was submitted to the institutional ethics committee and permission was obtained.

Patients were given detailed information about the study and written informed consent was obtained from them for the use of their TTE information for the purpose of this study before enrolling them in to the study.

Height and Weight of the patients were carefully measured and recorded by wall scale and weighing machine respectively. Trans Thoracic Echocardiography of these patients was performed on PHILIPS iE 33 with transducer S 51 for adult 1.7 to 3.4 HZ. Echocardiographic examinations of patients were attended and the findings of TTE procedures of patients were studied.

Methods of Measurements: All Echoes were performed with left lateral decubitus position patient on his/her left side with left hand above and behind the shoulder of the patient. Readings were recorded in diastole for Left atrium at end systole. All readings were recorded by 2 D guided M mode.

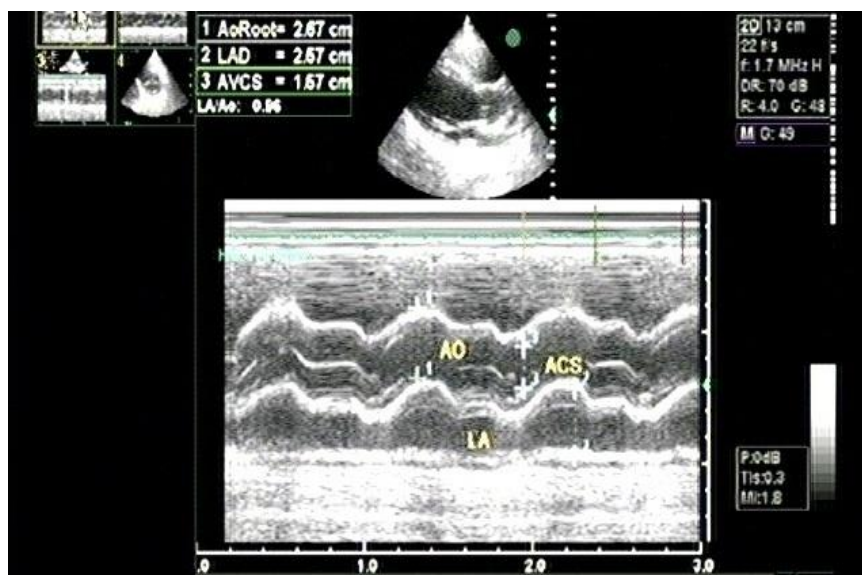


Fig. 3: Measurement of Left Atrial Dimension(LAD) by Trans Thoracic Echocardiography

Left atrial size was determined using M mode echocardiography from the parasternal window. A linear dimension approximating the anteroposterior plane was measured at end systole, just before mitral valve opening (when the left atrial volume was maximal). To standardize this approach plane should pass through the aortic valve.

Statistical analysis was performed using Microsoft Excel. Data was analyzed using minitab + SPSS (Statistical Package for Social Sciences) software for statistical analysis. For study parameter, data was expressed as mean+SD and the relationship with age, weight, height and BSA was calculated using the Pearson correlation coefficient (r) which was used to denote strength of association in three categories. r value <3 weak, r value 3-7 moderate, r value >7 strong.

Chi square test was used for Qualitative data comparison and 'T' test and ANNOVA was used for quantitative data. Level of significance was $p < 0.05$.

Observations and Results

The present study was performed in the Department of Anatomy GMC in collaboration with Department CVTS centre GMCH Aurangabad (2010-2013).

Total 104 patients were included in this study, out of which 42 were male and 62 were female.

Study population was grouped and studied gender wise and age wise for any statistical difference.

Gender wise Age distribution in groups among the study sample: The mean age in years was 46.12 with SD of 16.60 in males and 43.65 with SD of 15.21 in female.

Distribution of Age and physical characteristics among the Total study population Youngest patient of the study sample was 18 years old, and the oldest

patient was of 80 years. The mean age of the sample was 44.64 years with a SD of 15.75.

Minimum and maximum height recorded in subjects was 135cm and 175 cm respectively while mean height of study sample was 156.82cm with SD 8.26 cm.

Minimum and maximum weight recorded was 27 kg and 87 kg respectively while mean weight of the study sample was 57.29 kg with SD 11.75 kg.

Similarly BSA calculated from Height and Weight of a patient using Du bois formula was found to be in the range of 1.021 to 1.956 with mean BSA of population being 1.56 with SD of 0.174.

Age and Gender Distribution in groups among the study sample: Subjects were further grouped in age groups of less than or equal to 30, 31 to 40, 41 to 50, 51 to 60 and above.

Measurements of Left Atrial Antero Posterior dimensions: Ranges and the mean values Left Atrial Antero-posterior dimension by M mode on parasternal long axis for

- Total study population was in the range of 18 mm to 40mm, mean \pm S.D was 30.64mm \pm 4.10mm.
- Male study population was in the range of 22 mm to 40mm with a mean \pm S.D of 31.71mm \pm 4.41mm.
- Female study population was in the range of 18 mm to 37mm with a mean \pm S.D of 29.92 \pm 3.75.

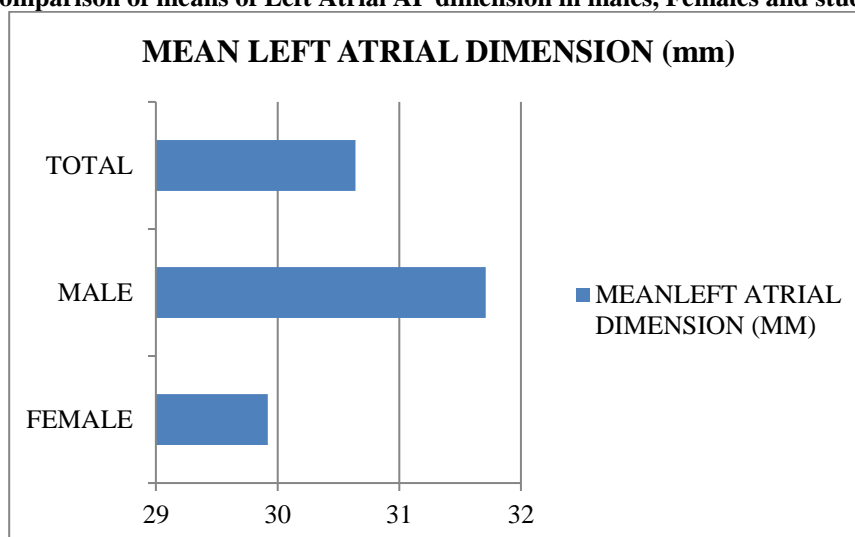
Left Atrial Antero Posterior Dimension: The mean LA AP dimension was 30.64 mm with SD of 4.10 mm. The mean value for Left Atrium was higher among males 31.71(mm) with a SD of 4.41mm than that of females 29.92 mm with a SD of 3.75mm. This difference was statistically significant (T-Value = -2.16, P-Value = 0.034 DF = 78).

Table 1: Table showing comparison of Physical characteristics in males, females and total population

Sex	N	Height mean+/- SD	Weight mean+/- SD	BSA mean+/- SD
Female	62	152.29 +/- 6.16	54.48+/-12.17	1.49+/-0.166
Male	42	163.50+/-6.19	61.43+/-9.86	1.65+/-0.137
Total	104	156.82+/-8.26	57.29+/-11.75	1.56+/-0.174

Table 2: Table showing Comparison of mean Left Atrial Dimension Males, Females and Study Population

Sex	N	Mean (mm)	SD (mm)	Minimum (mm)	Maximum (mm)
Male	42	31.71	4.41	22	40
Female	62	29.92	3.75	18	37
Total	104	30.64	4.10	18	40

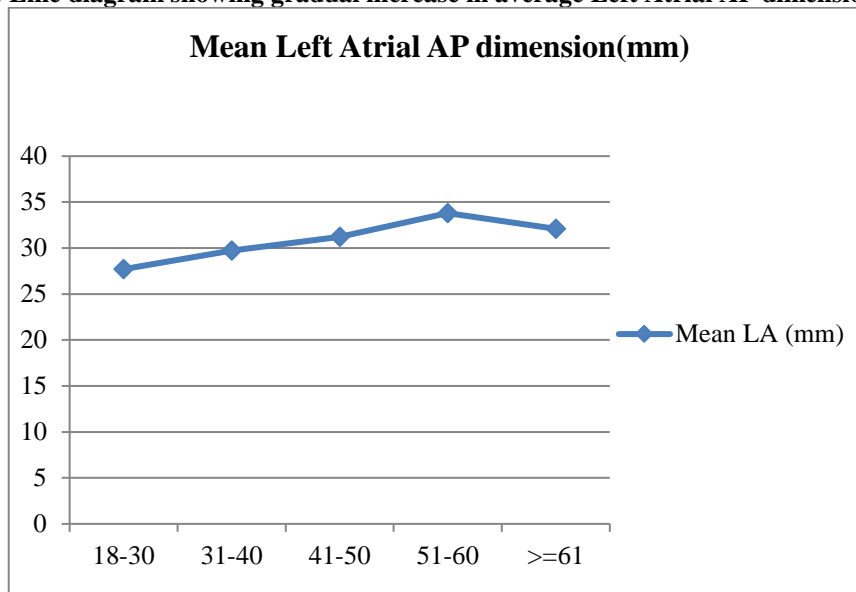
Graph 1: Comparison of means of Left Atrial AP dimension in males, Females and study population

Correlations of Left Atrial Antero Posterior Dimension with Age Height, Weight and Body Surface Area of study population: The Pearson's correlation coefficient (r) was calculated for each study parameter to see any correlation between study parameters and height, weight and BSA.

There was a moderate correlation between Left Atrium AP dimensions and Age, Weight and BSA with 'r' values (0.45, 0.509, 0.514) respectively. On the other hand weak correlation was found between Left Atrial AP dimension and Height with ('r' =0.292, 'p'<0.003)

Table 3: Comparison of Left Atrial AP dimension among various age groups

Age Group(Yrs)	Mean LA (mm)	SD	Total
1 (Less than or =30)	27.71	4.57	24
2 (31 – 40)	29.71	4.39	21
3 (41 – 50)	31.24	2.79	25
4 (51 – 60)	33.80	2.91	15
5 (61 & above)	32.11	2.77	19
Total	30.64	4.10	104

Graph 2: Line diagram showing gradual increase in average Left Atrial AP dimension with age

It was observed from the graph that the mean value of study parameter increased with increasing age group with the exception of age group 51 to 60 where the mean size was more than that of age group 61 & above. The comparison of mean among the age groups showed statistically significant difference when ANOVA (Analysis of Variance) was done.

POST HOC test showed statistically significant difference in means between the age groups 1 & 3, 1 & 4, 1 & 5 and 2 & 4. This shows that the age groups above 40 years had significantly higher value of left atrial dimension than those age groups below 40 years.

Discussion

“The left atrium is roughly cuboidal and extends behind the right atrium, separated from it by the obliquely positioned septum, thus the right atrium is in front and anterolateral to the right part of the left atrium.”⁽¹⁾

“From its introduction in 1954 to the mid 1970’s, most echocardiographic studies employed a technique called M-mode, in which the ultrasound beam is aimed manually at selected cardiac structures to give a graphic recording of their positions and movements. M-mode recordings permit measurement of cardiac dimensions and detailed analysis of complex motion patterns depending on transducer angulation”.⁽²⁾

“A comprehensive echocardiographic examination, utilizing both M-mode and two dimensional recordings, therefore provides a great deal of information about cardiac anatomy and physiology, the clinical value of which has established echocardiography as a major diagnostic tool.”⁽²⁾

The purpose of present study was to find range of commonly measured Left Atrial Antero posterior dimension with transthoracic echocardiography in patients with normal left and right ventricular function.

Mean values for the study dimension was measured by using 2D guided M mode technique.

All measurements were done in left lateral decubitus with left arm above and below the shoulder of the patient. Maximum Left Atrial Antero posterior dimension at end systole was measured. So the data presented here must be taken, therefore, as representing the cardiac dimension for adult with normal left and right ventricular function, measured by above mentioned method and stages of cardiac cycle in left lateral decubitus of subjects.

In present study LA AP dimension by M mode on parasternal long axis for total study population was in the range of 18 mm to 40mm, mean \pm S.D was 30.64mm \pm 4.10mm for the study population.

Age, weight, BSA correlated significantly with LA AP dimension with their pearson coefficient correlation values as $r = 0.45$, $r = 0.509$, $r = 0.514$ respectively. However weak correlation was found between Height and LA AP dimension with $r = 0.292$.

In present study the mean value for Left Atrium was higher among males 31.71mm with SD of 4.41mm than that of females 29.92 mms with SD of 3.75mm. This difference was statistically significant (T-Value = -2.16, P-Value = 0.034 DF = 78).

It was observed that the Mean value of Left Atrium increased with increasing age group with the exception of age group 51 to 60 where the mean LA was more than that of age group 61 & above.

The comparison of mean among the age groups showed statistically significant difference when ANOVA (Analysis of Variance) was done.

Post hoc test showed statistically significant difference in means between the age groups 1 & 3, 1 & 4 1 & 5 and 2 & 4. This shows that the age groups above 40 had significantly higher value of left atrial dimension than those age groups below 40.

Table 4: Showing Comparison of the range and mean of Left Atrial Antero-Posterior Dimension of present study with that of previous studies

Sr No	Author (year)	N	Age in years		Left atrial AP dimension,(mm)	
			Range	mean +/- SD	Range	Mean +/- SD
1	Present study (2012)	104; 42(M) 62(F)	18-80 yrs 18-75 yrs (M) 18-80yrs (F)	(44.64+/-15.75) 46.12+/- 16.60(M) 43.65+/- 15.21(F)	18 to 40 22to 40(M) 18 to 37(F)	30.64+/- 4.10; 31.71+/-4.41 (M) 29.92+/- 3.75(F)
2	Kulkarni DR, Vengaskar AS (1979) ⁽⁵⁾	100	10-50 yrs	–	21.9+/-3.6	21.9 +/- 3.6
3	Valdez RS et al.(1979); ⁽⁶⁾	193	(25-64)yrs	–	33(F) 37(M)	35+/-10
4	F Loperfido. et al. (1983) ⁽⁷⁾	30	(17-59)yrs	–	–	31+/-4(M) 29+/-4(F)
5	Kaul S. et al. (1985); ⁽⁸⁾	7	–	–	–	23.7+/- 3.4(2D) 25+/-4.2 (MRI)
6	Echocardiography, Fifth Edition, Harvey Feigenbaum (1994) ⁽⁹⁾	133	(13-54) yrs	26	19-40	29
7	Hursts The Heart 10 th edition (2001) ⁽¹⁰⁾	50		(25+/-6)	12-35 (M mode); 27-45(2D)	27+/-6 ;36(2D)
8	Gupta MS et al. (2004); ⁽¹¹⁾	100	(>65) yrs	69.2	–	35+/-45

N- number of subjects, M-males, F-females,MRI-Magnetic Resonance imaging,2D- 2D echocardiography method.

After comparison with previous studies (Table 4) it was found that mean and range of LA-AP dimension in present study correlated well with the values obtained by different workers such as Loperfido F. et al.(1983),⁽⁷⁾ and as mentioned by authors of echocardiography, Fifth Edition.⁽⁸⁾ Loperfido F et al.(1983)⁽⁷⁾ assessed left atrial dimensions by M mode in 30 normal subjects (13 F , 17 M) of age 17-59 years with mean age of 39.6+/- 10.1 years. Mean LA AP dimension by M mode in their study was 31+/-4mm.

While Echocardiography, Fifth Edition, Harvey Feigenbaum (1994)⁽⁹⁾ presented data obtained in 1972 that represented the oldest normal values. In their study 133 individuals of age ranging from 13-54 years (mean 26 year) showed left atrial AP dimension ranging from 1.9 to 4.0 cm, with a mean of 2.9cm.

While mean and range of Kulkarni, A S Vengaskar (1979),⁽⁵⁾ Kaul S et al⁽⁸⁾ and those published by Hurst⁽¹⁰⁾ was less than our study. (Table 4)

Study by Kulkarni DR and Vengaskar AS (1979)⁽⁵⁾ on 100 normal Indian subjects (with age range 10 to 50 years), revealed the mean left atrial dimension to be 21.9 ± 3.6 mm. Mean and range of this study was less than our study. Lower mean age and different age distribution of Kulkarni, A S Vengaskar (1979)⁽⁵⁾ and

also for Hurst.⁽¹⁰⁾ The Heart 10th edition could be the most probable cause behind this difference.

Different method (2D Echo, MRI) by Kaul S et al⁽⁸⁾ may be the probable cause behind difference in mean values obtained by their study.

In another study by Kulkarni DR and Vengaskar AS (1979)⁽⁵⁾ on 100 normal Indian subjects (with age range 10 to 50 years), revealed the mean left atrial dimension to be 21.9 ± 3.6 mm. Mean and range of this study was less than our study. Lower mean age and different age distribution of this study could be the most probable cause behind this difference.

Valdez RS et al (1979);⁽⁶⁾ found the mean end systolic dimension to be 3.5+/-1cm in study including 193 subjects with age ranging from 25 to 64 years (for females 3.3+/-1 cm and for males was 3.7+/-1cm). The group found statistically significant effect (p<0.01) of age on Left atrial dimension when population was grouped age wise. Study by Valdez RS et al,⁽⁷⁾ have higher values of mean and range than the present study. Racial difference could be the probable cause behind to this difference.

MS Gupta. et al. (2004)⁽¹¹⁾ did Echocardiographic evaluation of cardiac anatomy and functional capacity out in 100 asymptomatic elderly subjects (age >65

years) and mean age of 69.2 +/- 4.18 . In their study, mean Left atrial dimension was 35+/-4.5 mm for the mean age. Higher mean age (69.2 years) of study population of MS Gupta et al⁽¹¹⁾ could be the most probable cause behind to this difference.

In another study by Schwartzman PR et al. (2000)⁽¹²⁾ in a population based study on 100 healthy adults found the mean Left atrial dimension to be 35+/-4 mm in males and 33+/-5 mm in females. They found that the measurements of left atrium adjusted or not for body surface area or height, were significantly higher in males. The present study gender difference findings were in accordance with the study of Schwartzman PR et al (2000).⁽¹²⁾ Our age analysis also correlate with the study by Valdez RS. et al(1979)⁽⁷⁾ who found statistically significant effect(p<0.01) of age on LA AP dimension when population was grouped age wise.

Age analysis of Left Atrial AP dimensions of present study corresponded well with the studies of Gardin JM⁽¹³⁾ et al (1979),⁽⁵⁾ Kulkarni DR and Vengaskar AS (1979),⁽⁵⁾ Valdez RS et al (1979),⁽⁶⁾ Gardin JM et al (1979)⁽¹³⁾ studied 136 adult (78 men; 58 women) 20 to 97 yrs of age by subdividing them into six age groups; progressive changes were found in mean normal values for various parameters including the Left Atrium. When they compared oldest group (over 70 years) with the youngest group (21-30 years), significant (p<0.01) increases in left atrial dimension (16%) was found. Similarly Kulkarni DR and Vengaskar AS (1979)⁽⁵⁾ grouped study population into 8 five-year subgroups with a minimum of 10 patients in each subgroup. In their study statistically there was no significant difference between the mean values of the first 7 subgroups (19.8 ± 3.6 mm to 22.5 ± 4.7 mm). But the last subgroup (46 years to 50 years) had a mean value (25.2 ± 3.6 mm) which was just significantly higher than 4 of the 7 subgroups. While study by Valdez RS et al (1979)⁽⁶⁾ also found statistically significant effect (p<0.01) of age on Left atrial dimension when population was grouped age wise.

Conclusion

From this study it was concluded that - LA-AP dimension was greater in male population than female population. Study parameter showed moderate correlation with age and with BSA of study population and significant correlation with height of study population.

LA-AP dimension correlated with weight of study population. Also LA-AP dimension showed a significant difference in male and female population. The mean Left Atrial AP dimension corresponded reasonably well to those with those of the previous studies.

Thus the study concludes that gender, BSA, Height and Weight should be taken into account while considering normal ranges of this parameter for respective population.

References

1. Michael GA. Standing S. Thorax. Grays Anatomy. "The anatomical basis of clinical practice" 40th Edition, Philadelphia: Elsevier Churchill Livingstone,(2008), 959-973.
2. Kisslo JA, Adams DB, Leech GJ. Essentials of echocardiography. 1 two dimensional echocardiography in the normal heart. Available from www.echoincontext.com/beginner.pdf. Assessed on(6/1/13)1-15.
3. Armstrong WF, Ryan T. "Feugenbaum's Echocardiography." Seventh Edition. Walters Kluwer, Lippincott Williams and Wilkins, Philadelphia(2010) 9-18.
4. Armstrong WF, Ryan T. "Feugenbaum's Echocardiography." Seventh Edition .Walters Kluwer, Lippincott Williams and Wilkins, Philadelphia.(2010) chapter 5; 91-121.
5. DR Kulkarni, AS Vengaskar. "Normal left atrial dimensions in Indians by echocardiography" JPGM (1979)/Volume:25/ Issue:4/ Page:197-200.
6. Valdez RS, Motta JA, London E, Martin RP, Haskell WL, Farquar JW, Popp RL, Horlick L. "Evaluation of echocardiogram as an epidemiologic tool in an asymptomatic population." Circulation.(1979 Oct);60(4):921-9.
7. Loperfido F, Pennestri F, Digaetano A, Scabbia E, Santarelli P, Mongiardo R, Schiavoni. "Assessment of left atrial dimensions by cross sectional echocardiography in patients with mitral valve disease." British Heart Journal (Dec1983);50,(6):570-8.
8. Kaul S, Wismer GL, Brady TJ, Johnston DL, Weyman AE, Okada RD, Dinsmore RE. "Measurement of normal left heart dimensions using optimally oriented MR images." AJR Am J Roentgenol. (1986 Jan);146(1):75-9.
9. Feigenbaum Harvey. "Echocardiography, Fifth edition"; Lippincott Williams and Wilkins 351 W. Camden Street Baltimore, Maryland 21201-2436 USA Table A-1 Adult Normal Values, (1994) 658.
10. Valentine Fuster, R. Wayne Alexander, Robert A.O' Rourke. Robert Roberts. Spencer B. King III, Hein J.J. Wellens. International edition. "Hurst's The Heart." Volume 1,10th edition.349 Table 13-1 Normal values Source Felner JM, Schlant RC. Echocardiography: A teaching Atlas. New York: Grune and Stratton 1976.
11. Gupta MS, Anand JS, Singh H, Aggarwal R, Verma RP, Gupta G. "Echocardiographic assessment of a healthy geriatric population." JIACM(2004);5(1):47-51.
12. Schwartzman PR, Fuchs FD, Mello AG, Coli M, Schwartzman M, Moreira LB. "Normal values of echocardiographic measurements. A population-based study." Arq Bras Cardiol. (2000 Aug);75(2):107-14.
13. Gardin JM, Henry WL, Savage DD, Ware JH, Burn C, Borer JS. "Echocardiographic measurements in normal subjects: evaluation of an adult population without clinically apparent heart disease." Journal of Clinical Ultrasound.(1979 Dec);7(6):439-47.