

Anatomical Evaluation of Left Ventricular Posterior Wall Thickness by Transthoracic Echocardiography**Mukta Pande¹, Pratima Kulkarni², Vinod Gosavi³, Sudhir Tungikar⁴**¹Assistant Professor, Department of Anatomy, DUPMCH Jalgaon, Maharashtra, India²Professor Department of Anatomy, GMC Latur, Maharashtra, India³Consultant, Kamal Nayan Bajaj Hospital, Aurangabad, Maharashtra, India⁴Professor and HOD Department of Medicine Dr. Balasaheb Vikhe Patil, Rural Medical College, Loni, India

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Conflict of interest: Nil

Abstract

Background: Invention of non-invasive techniques over the past few decades changed the perception of cardiac anatomy and pathophysiology for all of medicine in general and cardiology in particular. The use of ultrasound to study the structure and function of the heart and great vessels defines the field of echocardiography. Echocardiography allows a detailed assessment of the functional anatomy of the heart. Present study was a prospective study in which Echocardiographic examination of patients referred to CVTS Centre Government Medical College Aurangabad were attended and readings were noted for 104 adult individuals above 18 years of age (62 females and 42 males). Patients diagnosed by senior cardiologist for normal Left Ventricular Function (EF > 50%) and normal Right Ventricular function as seen on echocardiography were included in the study.

Objective: 1. To study the dimensions of Left Ventricular Posterior Wall thickness and its relation to physical parameters (height, weight and body surface area (BSA)). 2. To compare & contrast age and sex related differences in morphometry of Left Ventricular Posterior Wall thickness.

Results: Left Ventricular Posterior Wall thickness for total study population was in the range 0.7 cm to 1.2 cm and mean \pm S.D was 0.9231 ± 0.1081 cm.

Conclusion: Study parameter was greater in male population than female population; Age, weight, BSA correlated significantly with study parameter LVPW thickness with their correlation coefficient as $r = 0.459$, $r = 0.326$ and $r = 0.304$ respectively. While weak correlation ($r = 0.123$) was found between height and LVPW thickness. Measurements of Left Ventricular Posterior Wall Thickness of present study corresponded well with those reported by previous studies.

Keywords: Echocardiography, Inter Ventricular Septal Thickness.

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Introduction

With the invention of noninvasive imaging techniques [echocardiography, computed tomography (CT), magnetic resource imaging (MRI) and single-photon-emission computed tomography (SPECT)] over the past two decades, the perception of cardiac anatomy and pathophysiology radically changed for all of medicine in general and cardiology in particular. [1] The use of ultrasound to study the structure and function of the heart and great vessels defines the field of echocardiography. [2]

Echocardiography is a unique noninvasive method for imaging the living heart. It is based on detection of echoes produced by a beam of ultrasound (very high frequency sound) pulses transmitted into the heart. [3] 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.

A more recent development uses electromechanical or electronic techniques to scan the ultrasound beam rapidly across the heart to produce two-dimensional tomographic images of selected cardiac sections. This gives more information than M-mode about the shape of the heart and also shows the spatial relationships of its structures during the cardiac cycle. 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. [3]

Echocardiography allows a detailed assessment of the functional anatomy of the heart.

The gross anatomy of the heart can be evaluated by two dimensional echocardiography in the parasternal, apical, suprasternal and subcostal positions. The standardized planes used are long axis, short axis and four-chamber. [4]

Transthoracic echocardiography is very commonly used diagnostic modality of present time to reveal in vivo anatomy and function of heart; being safest (absence of radiation hazards) painless, and noninvasive method available today.

This work was undertaken with objectives to study Left ventricular posterior wall thickness and its correlation with physical parameters like weight, height and BSA. Age and gender wise comparison in LVPW thickness is also studied.

Study was performed in 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 Ventricular Posterior wall thickness. The data obtained from the echocardiography of the patients was pooled and analysed for the above parameter and for male and female differences, age differences and compared with that given in literature and other studies. In present work range of Left Ventricular Posterior wall thickness for total study population was in the range of 0.7 cm to 1.2 cm and mean \pm S.D was 0.9231 ± 0.1081 .

The mean LVPW was higher among males than that of females. However this difference was not statistically significant.

Pearson's Correlation Coefficient showed moderate correlation of LVPW with age and weight with r and p values ($r=0.459, p=0.000; r=0.326, p=0.213$) respectively.

Material and Methods

Present study was performed in the Department of Anatomy in collaboration with Department of CVTS Centre GMC. Echocardiographic examination of patients referred to CVTS Centre Government Medical College were attended and readings were noted for 104 adult individuals above 18 years of age (62 females and 42 males). Patients diagnosed by senior cardiologist for normal Left Ventricular Function ($EF > 50\%$) and normal Right Ventricular function as seen on

echocardiography were included in the study. The Left ventricular posterior wall thickness parameter was selected for the study. The data obtained from the echocardiography of the patients was pooled and analysed for the study parameter and for male and female differences, age differences and compared with that given in literature and other studies.

Inclusion and Exclusion Criteria for the Study

Inclusion Criteria:

- Patients undergoing TTE at CVTS GMC
- Age >18 years
- Patients with normal LV function ($LVEF >50\%$) and normal RV function as seen on TTE

Exclusion Criteria:

- Patients with Hypertensive Heart disease (Inter Ventricular Septal 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.
- Patients with Structural heart disease.
- Patients in whom high quality TTE is not obtainable.

Methods

Study protocol was submitted to the institutional ethics committee and permission was obtained.

Permission of Head of the Department of Medicine CVTS GMC was obtained.

Echocardiographic examinations of patients who have been advised Trans Thoracic Echocardiography by various clinical departments; were attended.

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

The findings of TTE Echocardiographic procedures of patients were studied.

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.

Following parameters were noted

- Left ventricular posterior wall thickness
- Sex of patient (Male or Female).
- Age of patient
- Height of patient
- Weight of patient

Method of measurement:

All scans were performed in left lateral decubitus with left arm above and behind shoulder of patient.

Echocardiography of these patients was performed on PHILIPS iE33 ECHO machine with transducer S 51 for adult 1.7 to 3.4 HZ.

Left ventricular posterior wall thickness was determined using M mode echocardiography from parasternal long axis view.

2D guided M mode recording of Left ventricular posterior wall thickness was done. (Fig1).

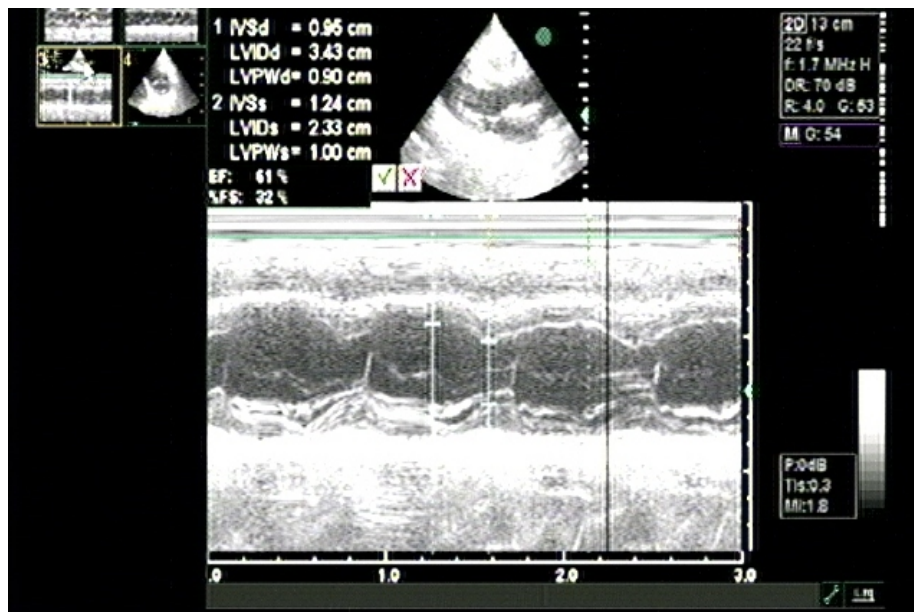


Fig 1: Measurement of Left ventricular posterior wall thickness by 2D guided M mode echocardiography

Reading were recorded in end diastole for Left ventricular posterior wall thickness.

Callipers placed at interface of compacted myocardium of left ventricle at the level just below tips of mitral valve leaflet. Line of measurements extended perpendicular to left ventricular cavity at interface of left ventricle and compacted myocardium to compacted myocardium and pericardial wall. Care taken not to involve the chordae of mitral valve.

The data obtained from the echocardiography of the patients was pooled and analysed for the study parameter and for male and female differences, age differences and compared with that given in literature and other studies.

Statistical analysis: Statistical analysis was performed using Microsoft Excel.

Data was analyzed using minitab + SPSS (Statistical Package for Social Sciences) software for statistical analysis.

For each measured parameter, data was expressed as mean+SD and the relationship with age, weight and height was calculated using the Pearson correlation coefficient. Pearsons correlation

coefficient (r), was used to denote strength of association in three categories. Chi square test was used for Qualitative data comparison and 'T' test and ANOVA was used for quantitative data. Level of significance was $p < 0.05$.

Observations and Results

Present study was performed in Department of Anatomy, Government Medical College in collaboration with Department of Cardiovascular Thoracic Surgery (CVTS) centre Government Medical College during June 2010 to June 2013.

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 were calculated.

Study parameter Left ventricular posterior wall thickness was measured by echocardiography and its correlation with various physical characteristics like height, weight, BSA were obtained.

Study population was grouped and studied gender wise and age wise for any statistical difference Total 104 patients were included in this study, out of which 42 were male and 62 were female.

Table1: Showing age distribution in Female, Male and Total study population

	Number of subjects	Age Range (years)	Mean age (years)	S.D.
Female	62	18-80	43.65	15.21
Male	42	18-75	46.12	16.60
Total	104	18-80	44.64	15.75

yrs –years, S.D.-Standard Deviation.

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 (Body Surface Area) 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.

Table 2: 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

For female population mean height was 152.29 cm with SD 6.16 cm. Mean+/- SD observed in female population for weight and BSA was 54.48 +/- 12.17kg and 1.49+/-0.166 respectively.

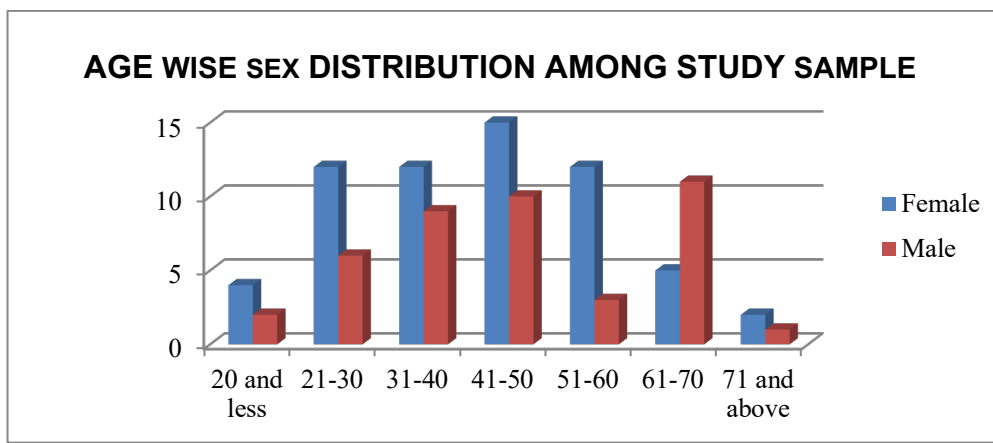
In males mean and SD for height, weight and BSA were 163.50+/-6.19, 61.43+/-9.86, 1.65+/-0.137 respectively. While mean height, weight and BSA

for total study population was 156.82+/-8.26, 57.29+/-11.75, 1.56+/-0.174 respectively. Age and Gender Distribution in groups among the study sample

Subjects were further grouped in the age groups of less than or equal to 20, 21 to 30, 31 to 40, 41 to 50, 51 to 60, 61 to 70 and more than or equal to 71.

Table 3: Age and Gender Distribution in groups among the study sample

Age Group (years)	Number of Female	Number of Male	Total
20 & less	4	2	6
21 – 30	12	6	18
31 – 40	12	9	21
41 – 50	15	10	25
51 – 60	12	3	15
61 – 70	5	11	16
71 & above	2	1	3
Total	62	42	104



Graph 1: Age wise sex distribution among study sample

Since the frequency was very less in age group of 20 and 71 & above they were merged with groups of 21- 30 & 61 – 70 respectively for statistical purpose.

Table 4: Range and mean of the Left Ventricular Posterior Wall thickness (LVPW) dimension for total study population

Parameters	Mean	±S.D.	Minimum	Maximum
LVPW(cm)	0.9231	0.1081	0.7	1.2
Height (mtr)	156.82	8.26	135	175
Weight (Kg)	57.29	11.75	27	87
BSA(kg/cm ²)	1.56	0.174	1.021	1.956

Table 5: Measurements of Left Ventricular Posterior Wall thickness (LVPW) thickness in male study population with mean height, weight and body surface area

Parameters	Mean	±S.D.	Minimum	Maximum
LVPW(cm)	0.948	0.016	0.7	1.2
Height (mtr)	163.50	6.19	151	175
Weight (Kg)	61.43	9.86	37	80
BSA(kg/cm ²)	1.65	0.137	1.339	1.956

Measurements of cardiac dimension LVPW thickness in Male study population: Ranges and the mean values of the cardiac dimensions were Left Ventricular Posterior wall thickness of in the range of 0.7cm to 1.1cm with mean ± S.D of 0.948 ± 0.016 cm.

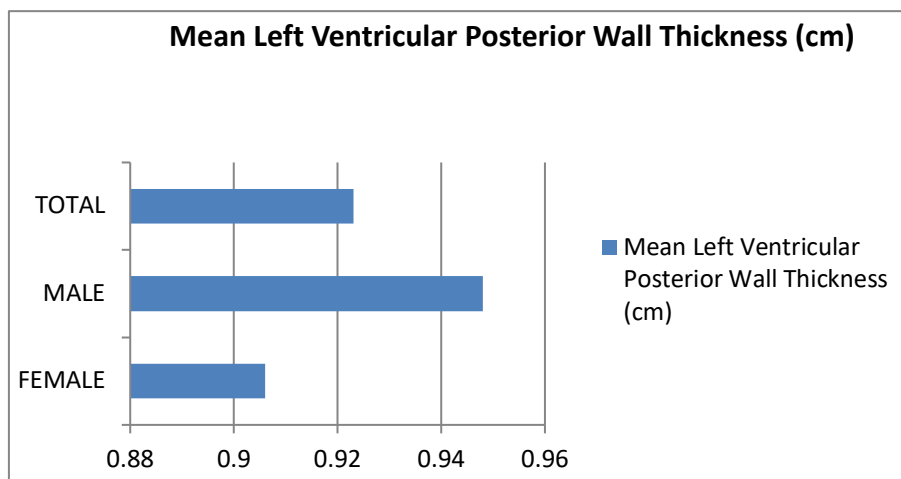
Table 6: Measurements of Left Ventricular Posterior Wall thickness (LVPW) in Female study population with mean height, weight and body surface area

Parameters	Mean	±S.D.	Minimum	Maximum
LVPW(cm)	0.906	0.014	0.7	1.1
Height (mtr)	152.29	6.16	135	163
Weight (Kg)	54.48	12.17	37	80
BSA(kg/cm ²)	1.49	0.166	1.021	1.917

Measurements of cardiac dimension Left Ventricular Posterior Wall (LVPW) thickness in Female study population. Ranges and the mean values of the cardiac dimensions were Left Ventricular Posterior wall thickness was in the range of 0.7cm to 1.1cm and mean ± S.D was 0.906 ± 0.014 cm.

Table 7: Comparison of Left Ventricular Posterior Wall Thickness (LVPW) in male and female population

Sex	N	Mean (mms)	SD
Female	62	0.906	0.014
Male	42	0.948	0.016
Total	104	0.9231	0.1081



Graph 2: showing comparison of mean Left Ventricular Posterior wall thickness in male, female and total population

The mean LVPW was 0.9231cm with SD of 0.1081cm. The mean LVPW was higher among males 0.948 cm with SD of 0.016 cm than that of females 0.906 cms with SD of 0.014cm. However this difference was not statistically significant (T-Value = -1.93 P-Value = 0.057, DF = 88).

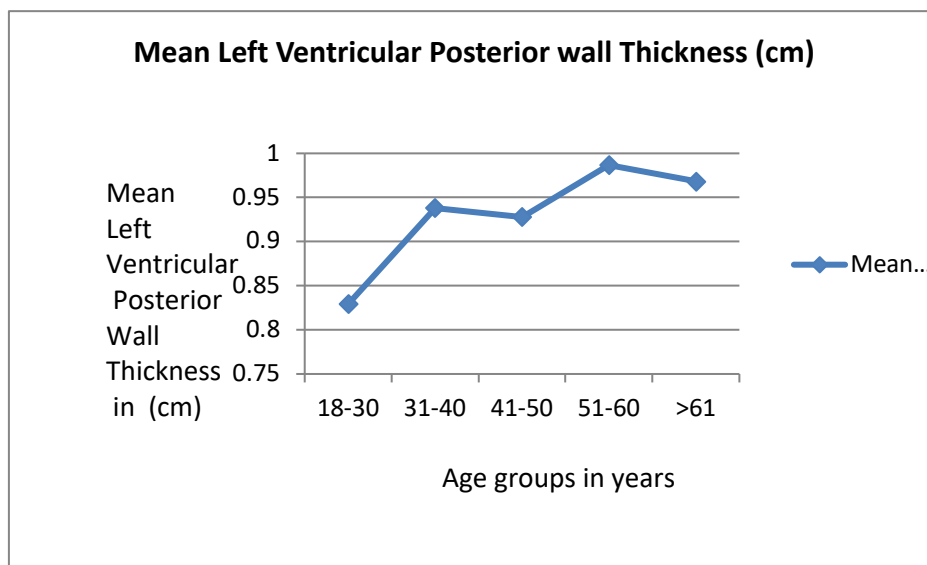
Table 8: Correlation Coefficient for Left Ventricular Posterior Wall thickness (LVPW)

Parameter	R	P	Correlation
Age	0.459	0.000	Moderate
Height	0.123	0.213	Weak
Weight	0.326	0.001	Moderate
BSA	0.304	0.002	Moderate

Pearson’s Correlation Coefficient showed moderate correlation of LVPW with age, weight and BSA with r and p values (r=0.459,p=0.000;r=0.326,p=0.213;r=0.304,p=0.002) respectively. However LVPW and Height had a weak correlation with a r value of 0.123 at p value 0.213.

Table 9: Comparison of Left Ventricular Posterior Wall thickness (LVPW) among various age groups

Age Group(Yrs)	Mean LVPW (mms)	SD	Total
1 (Less than or =30)	0.8292	0.1160	24
2 (31 – 40)	0.9381	0.0086	21
3 (41 – 50)	0.9280	0.0084	25
4 (51 – 60)	0.9867	0.0083	15
5 (61 & above)	0.9684	0.0094	19
Total	0.9231	0.1081	104



Graph 3: Line diagram showing relation of mean Left ventricular posterior wall thickness with age groups

Comparison of mean among the age groups showed statistically significant difference with ANNOVA (Analysis of Variance).

Discussion

Left ventricular posterior wall thickness is one of the parameters commonly assessed during 2D echocardiography examination of patient.

Increased LVPW thickness seen in various cardiac and systemic conditions like cardiomyopathies, hypertension etc. Accurate measurements of this parameter help in diagnosis and may guide to appropriate therapy of individual. Soits important to know normal range of this parameter in healthy

population. 2D Echocardiography is preferred modality of present time to assess structural and functional anatomy of heart.

Indians have different physical characteristics than western population; the present study evaluated study dimension for its relation with height, weight, BSA.

Present study was performed with objective to evaluate Left ventricular posterior wall thickness and its correlation with weight, height and BSA of normal subjects.

Left Ventricular Posterior Wall (LVPW) thickness: In the present study, Left Ventricular

Posterior Wall thickness (LVPW) was in the range of 0.7 to 1.2 cm with a Mean +/- SD of 0.9231 +/- 0.1081cm. Age, weight and BSA correlated significantly with LVPW thickness with their

coefficient correlation values as $r = 0.459$, $r = 0.326$ and $r = 0.304$ respectively. However weak correlation ($r = 0.123$) was found between height and LVPW thickness.

Table 10: Comparison of the range and mean of LVPW thickness of heart with previous studies

Study	n	Age range		LVPW thickness of heart (cm)	
		Range	Mean age	Range	Mean+/-SD
Present study (2012)	104	18-80	44.64 +/- 15.75	0.7-1.2cm	0.9231 +/-0.1081
	62 (M)	18 -75	46.12 +/-16.60 (M)	0.7-1.2 (M)	0.948 +/- 0.016 (M)
	42 (F)	(M) 18 - 80 (F)	43.65 +/- 15.21 (F)	0.7 -1.1 (F)	0.906+/- 0.014 (F)
Gray's Anatomy 40th Edition (2008); [4]	–		–	0.8 -1.2 cm	
Valdez RS et al .(1979); [5]	177		–	–	0.9+/-0.4 cm (0.9+/- 0.4, M; 0.9+/- 0.4, F)
Marcomichelakis J(1983); [6]	–		–	0.75-0.98cm	–
Sanjiv Kaul. et al. (1985); [7]	6				0.92+/-0.17cm
	6				0.97+/-0.08
Harvey Feigenbaum (1994) [8]	137	13-54	26	0.6 -1.1	0.9 cm
Hursts (2001) [9]	50	24+/-6		range 0.7-1.2 cm	0.9+/- 0.1 cm.
Schvartzman PR et al (2000) [10]	100		–	–	0.7+/-0.1(F)
	(52F, 48M)				0.8+/-0.1(M)
MS Gupta. et al. (2004); [11]	100	>64	mean age 69.2+/- 4.18	–	0.94+/-0.15 cm

n- Number of subjects, M – males, F – female

In present study the mean LVPW was higher among males 0.948 cm with SD of 0.016 cm than that of females 0.906 cms with SD of 0.014cm. However this difference was not statistically significant (t-Value = -1.93, p-Value = 0.057, DF = 88).

Thus no statistically significant difference was found in male and female values for LVPW thickness. Comparison of mean among the age groups showed statistically significant difference with ANNOVA (Analysis of Variance).

Post hoc test showed statistically significant difference in means between the age groups 1&2, 1&3, 1&4 1&5. This shows that the age groups above 30 had significantly higher LVPW than those age groups below 30.

Findings of previous studies:

Grays Anatomy 40th Edition (2008) [4]; mentioned about left ventricle that in transverse section, at right angles to the axis, its cavity is oval or nearly circular, with walls about three times thicker (8–12 mm) than those of the right ventricle. Thus the above discussion shows that the findings of the present study correlate with the observations of most of the previous workers

Valdez RS et al. (1979) [5]; found the mean end diastolic left ventricular posterior wall thickness for 177 subjects as 0.9+/-0.4 cm. for females it was 0.9+/-0.4cm and for males 0.9+/-0.4 cm.

Marcomichelakis J et al (1983)6; found that the left ventricular posterior wall thickness increased from 7.5 mm to 9.8 mm. In their study the difference in the medians between the age groups 20-29 and 60-70 was statistically significant for posterior left ventricular wall ($P < 0.02$).

Kaul S et al. (1985) [7]; found mean diastolic Left ventricular posterior wall thickness in 6 normal subjects by 2 Dimensional method to be 9.2+/- 1.7mm and by MRI to be 9.7+/-0.8 mm.

Echocardiography, Fifth Edition, Harvey Feigenbaum (1994) [8]; presented data obtained in 1972 that represented the oldest normal values. In their study 137 individuals of age ranging from 13-54 years (mean 26 year) showed posterior left ventricular wall thickness to be in the range of 0.6cm-1.1cm with a mean of 0.9cm.

Schvartzman PR et al (2000) [10]; In their study on 100 healthy adult inhabitants they found the mean diastolic posterior left ventricular wall thickness in male was 0.8+/-0.1 and female 0.7+/-0.14cm.The

measurements adjusted or not for body surface area or height, were significantly higher in males $p < 0.03$.

MS Gupta. et al. (2004) [11] In their study mean diastolic Left ventricular posterior wall thickness was 9.4 ± 1.5 mm for 100 asymptomatic elderly subjects (age > 65 years) mean age 69.2 ± 4.18 .

Gardin JM et al (1979) [12]; Studied 136 adults (78 men and 58 women) of age ranging from 20 to 97 years without evidence of cardiovascular disease. When patients were subdivided into six age groups, progressive changes were found in mean normal values for various parameters. When they compared oldest group (over 70 years) with the youngest group (21-30 years), significant ($p < 0.01$) increases in left ventricular free wall (18 percent) thicknesses was observed.

Kitzman DW, Scholz DG. et al. (1986) [13]; did a quantitative anatomic study on 765 autopsied normal human hearts with age ranging from 20 to 99 years. They found that although indexed mean values for left and right ventricular wall thicknesses remained relatively constant in all decades, ventricular septal thickness increased significantly between the 3rd and 10th decade of life (P less than 0.001). Grays Anatomy 40th Edition (2008) 4; mentioned about left ventricle that in transverse section, at right angles to the axis, its cavity is oval or nearly circular, with walls about three times thicker (8–12 mm) than those of the right ventricle.

Hee PS et al. (2005); [14] stated that echocardiographic left ventricular (LV) wall thickness increased with age, suggesting LV hypertrophy. Magnetic resonance imaging (MRI) was used in 336 healthy, normotensive adults (mean age 56 ± 18 years; 200 women, 136 men) to measure end-diastolic LV wall thickness, and other left ventricular parameters.

In women, LV wall thickness increased by 14% ($r = 0.19$, $p < 0.02$) with age, In men, LV wall thickness was unrelated to age. Echocardiographic Left Ventricular wall thickness increased in both. Thus, the above discussion shows that the findings of the present study correlate with the observations of most of the previous workers.

Conclusion

Study parameter Left Ventricular Posterior Wall thickness was greater in male population than female population. However, in present study difference between mean of male and female population was not statistically significant.

The parameters Left Ventricular Posterior Wall thickness showed significant correlation with age, weight and BSA. In our study Left Ventricular Posterior Wall thickness do not show significant correlation with height of study population.

The mean and range of Left Ventricular posterior Wall Thickness corresponded well with those previous studies.

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