ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 68 . 16
PubMed - National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 5, Issue – 1, February - 2020, Page No. : 214 - 222

Study of 2D-Echocardiographic Dimensions of Heart in Normal Indian Population

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Citation this Article: Dr. Basheeruddin Ansari, Dr. Gopalsing Solanke, Sumaira Siddiqui, "Study of 2D-Echocardiographic Dimensions of Heart in Normal Indian Population", IJMSIR- February - 2020, Vol – 5, Issue -1, P. No. 214 – 222.

Type of Publication: Original Research Paper

Conflicts of Interest: Nil

Abstract

Background: All the echocardiographic reference parameters that we use to compare during echocardiographic studies are derived from those defined in the western world. The present research was undertaken to study the echocardiographic dimensions of heart in normal healthy Indian adults and find out whether there is any significant difference between the dimensions of heart of Indian adult and available reference values of Western population.

Method: The cardiac chamber dimensions of 940 normal healthy subjects (male - 553, female - 387) in the age group of 21 to 88 years were measured echocardiographically. Correlations of these dimensions with age were studied and estimated dimensions were compared between Indian males and females and between Indian and Western population.

Results: There was age wise progressive increase in interventricular septum in diastole (IVSd), posterior wall thickness in diastole (PWTd), left atrial internal diameter and aortic root diameter in both males and females, while there was no significant change in left ventricular internal diameter in systole and diastole (LVIDs and LVIDd). Overall echocardiographic dimensions were higher in men than women in all age groups. The measurements were found to differ significantly from the western data i.e. dimensions of Indian population being lower than their Western counterparts.

Conclusion: There should be separate reference values for echocardiographic dimensions of heart of normal healthy Indian population that could be useful in routine clinical practice as well as in clinical trials. Western data is not helpful for defining the normal limits of cardiac dimensions for the Indian subjects.

Key words: Echocardiography; Dimensions; Indian population; Heart, Western population, Systole, Diastole

Introduction

Echocardiography is the most widely used imaging technique in clinical cardiology practice since it provides comprehensive evaluation of cardiac and vascular structures and functions. The technique can immediately affect the diagnostic and management work-up of the patient, dictate therapeutic decisions, determine response to therapy and predict patient outcome. The real-time nature, portability and low cost of echocardiography, with the amount and quality of the provided information render it the technique of choice for the diagnosis and follow-up of most heart disease [1-3]. Even with advances in other cardiovascular imaging modalities, such as cardiac magnetic resonance imaging (CMR) and computed tomography (CT), echocardiography remains the most frequently used and usually the initial imaging test to evaluate all cardiovascular diseases related to structural, functional, or hemodynamic abnormality of the heart or great vessels [4].

Moreover, various primary echocardiographic parameters e.g. the left ventricular posterior wall thickness, the interventricular septal thickness, the internal dimension in end systole and end diastole are used to derive secondary parameters such as the mean muscle thickness, relative wall thickness, ejection fraction, the fractional shortening and the left ventricular mass. The interpretation of quantitative data derived from echocardiography is based on comparisons with the predefined age, gender, and ethnic-specific normal reference values [5, 6]. Unfortunately, no reference values currently exist for various echocardiographic dimensions of heart for normal Indian population as the limited previous studies had small sample size. Therefore in order to define the normal heart dimensions we continue to use the data from the western studies for the Indian population, without questioning their credibility in the Indian context. We report for the first time the normal values of echocardiographic measurements and the relationship of these parameters with age in a large Indian population.

Materials and Methods

After obtaining Institutional Ethical Committee approval and written informed consent from all the participants and/or his/her relatives, this observational cross sectional study was conducted at Tertiary Care Hospital in the urban setting during the study period of one and half year. Total 940 apparently healthy volunteers of normal BMI, age between 21 to 88 years, not having any history of heart disease or any other diseases or conditions that tend to affect the cardiac size and/or function were enrolled in the study. And these study population consisted of relatives accompanying the patients attending OPD and IPD, and other healthy volunteers willing to participate in the study. The subjects having history of heart disease, hypertension, diabetes mellitus, other systemic diseases or conditions tends to affecting cardiac size and function (e.g. anaemia, thyroid disorder, renal diseases, connective tissue diseases etc), those having significant fever at the time of echocardiographic examination, any congenital or acquired heart disease found during echocardiography and abnormal electrocardiographic findings in asymptomatic subjects, subject with poor echo window, BMI more than 25 or less than 18.5. 9), age <20 years, pregnant women and subject not willing to participate in the study were excluded from the study.

A detailed history and physical examination findings were noted using predesigned and pretested proforma. Electrocardiogram was performed in all subjects. The

demographic parameters (age, sex, height, weight, BMI and body surface area) were used while collecting information and taking the measurements. The standard transthoracic echocardiographic examination was done using Philips Image Point Hx (Harmonic) machine with S4 probe phased array (Harmonic) transducer in supine and left lateral position and following dimensions were estimated.

1. Left ventrical (LV) - Interventricular septum in diastole (IVSd), Left ventricular internal diameter in systole and diastole (LVIDs and LVIDd), Left ventricular posterior wall in diastole (LVPWd)
2. Left atrial internal diameter
3. Aortic root diameter

Correlations of these echocardiographic dimensions with age were studied and estimated dimensions were compared between Indian males and females and between Indian and Western population. Measurements were taken as per the recommendations of American Society of Echocardiography (ASE), developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology [1].

Statistical analysis

The statistical analysis was done by using statistical package for the social sciences-SPSS version 17 and Graph Pad Prism version 5 software. All data were analyzed by unpaired t test and bivariate correlation. A p value < 0.05 was considered significant.

Results

In current study a total of 940 healthy Indian subjects, aged from 21-88 years were studied echocardiographically. Out of which 553 were men and 387 were women. Majority of subjects were in the age group of 41-50 years (22.98%) followed by 31-40 years (20.32%) as shown in table 1.

Table 1: Distribution of study subjects according to age and sex

Age group (years)	Males	Females	Total
21-30	109 (19.71%)	72 (18.61%)	181 (19.26%)
31-40	103 (18.62%)	88 (22.74%)	191 (20.32%)
41-50	141 (25.50%)	75 (19.38%)	216 (22.98%)
51-60	117 (21.16%)	70 (18.09%)	187 (19.89%)
>60	83 (15.01%)	82 (21.19%)	165 (17.55%)
Total	553 (100%)	387 (100%)	940 (100%)

Table 2 shows age wise means of all echocardiographic dimensions studied in Indian male and female subjects screened.

Table 2: Mean echocardiographic dimensions according to age in males and females

Dimensions in males	**Age Groups (years)**				
	21 to 30	**31 to 40**	**41 to 50**	**51 to 60**	**> 60**
IVSd (cm)	0.87 ± 0.09	0.89 ± 0.09	0.90 ± 0.07	0.93 ± 0.09	0.96 ± 0.08
LVIDd (cm)	4.33 ± 0.30	4.34 ± 0.25	4.33 ± 0.16	4.33 ± 0.18	4.35 ± 0.13
LVIDs (cm)	3.06 ± 0.32	3.05 ± 0.30	3.04 ± 0.16	3.03 ± 0.18	3.04 ± 0.16
PWTd (cm)	0.75 ± 0.09	0.77 ± 0.10	0.80 ± 0.08	0.82 ± 0.09	0.86 ± 0.07

LA internal diameter(cm)	2.66 ± 0.2	2.66 ± 0.19	2.68 ± 0.13	2.80 ± 0.13	2.86 ± 0.13
Aortic root diameter(cm)	2.80 ± 0.2	2.87 ± 0.24	2.98 ± 0.12	3.09 ± 0.12	3.16 ± 0.13
Dimensions in females	**Age Groups (years)**				
	21 to 30	**31 to 40**	**41 to 50**	**51 to 60**	**> 60**
IVSd (cm)	0.77 ± 0.03	0.79 ± 0.04	0.81 ± 0.04	0.84 ± 0.03	0.86 ± 0.03
LVIDd (cm)	3.94 ± 0.19	3.97 ± 0.22	3.96 ± 0.17	3.95 ± 0.13	3.96 ± 0.14
LVIDs (cm)	2.66 ± 0.23	2.64 ± 0.21	2.58 ± 0.17	2.64 ± 0.12	2.57 ± 0.16
PWTd (cm)	0.70 ± 0.03	0.71 ± 0.05	0.73 ± 0.05	0.75 ± 0.04	0.78 ± 0.02
LA internal diameter(cm)	2.33 ± 0.12	2.43 ± 0.18	2.46 ± 0.12	2.55 ± 0.14	2.59 ± 0.15
Aortic root diameter(cm)	2.45 ± 0.11	2.64 ± 0.16	2.78 ± 0.15	2.88 ± 0.13	2.99 ± 0.11

Table 3 shows with increasing age there was significant increase in IVSd, PWTd, LA internal diameter and Aortic root diameter in both males and females, however there was no significant change in LVIDd and LVIDs.

Table 3: Correlation of echocardiographic dimensions with age in males and females

Dimensions	**Males**		**Females**	
	'r' Coefficient	**'p' value**	**'r' Coefficient**	**'p' value**
IVSd (cm)	0.3	0.01	0.66	0.01
LVIDd (cm)	-0.02	0.61	0.05	0.35
LVIDs (cm)	-0.08	0.08	- 0.07	0.2
PWTd (cm)	0.39	0.01	0.61	0.01
LA internal diameter (cm)	0.39	0.01	0.56	0.01
Aortic root diameter (cm)	0.60	0.01	0.81	0.01

Mean values of all studied echocardiographic dimensions (IVSd, LVIDd, LVIDs, PWTd, LA internal diameter, Aortic root diameter) were higher in males than in females and the difference between two was statistically significant ($p<0.05$). Also anthropometric measurements (Weight, Height, BMI and BSA) of males were significantly higher than females ($p<0.05$) while there was no significant difference ($p=0.76$) in age of males and females as shown in table 4.

Table 4: Gender wise comparison of echocardiographic dimensions and anthropometric parameters in the Indian subjects screened

Dimensions		Males (n=553)	Females (n=387)	't' value	'p' value
Echocardiographic dimensions	IVSd (cm)	0.91±0.09	0.81±0.05	18.35	0.001
	LVIDd (cm)	4.34±0.21	3.96±0.17	29.34	0.001
	LVIDs (cm)	3.05±0.23	2.62±0.19	29.90	0.001
	PWTd (cms)	0.80±0.09	0.73±0.05	12.82	0.001
	LA internal diameter (cm)	2.73±0.18	2.47±0.17	21.84	0.001
	Aortic root diameter (cm)	2.98±0.21	2.75±0.23	15.60	0.001
Anthropometric measurements	Age (yrs)	45.27±14.23	45.57±15.18	0.31	0.76
	Weight (Kg)	58.84±6.70	47.80±4.64	28.06	0.001
	Height (cm)	162.27±6.04	150.70±4.77	31.44	0.001
	BMI (Kg/m^2)	22.30±1.55	21.01±1.32	13.31	0.001
	BSA (m2)	1.62±0.12	1.41±0.09	30.77	0.001

The mean values of all studied echocardiographic dimensions were lower in Indian males and females than their Western counterparts and the difference between two was statistically significant ($p<0.05$), (Figure 1 and 2).

Figure 1: Comparison of Echocardiographic dimensions in the Indian and Western males

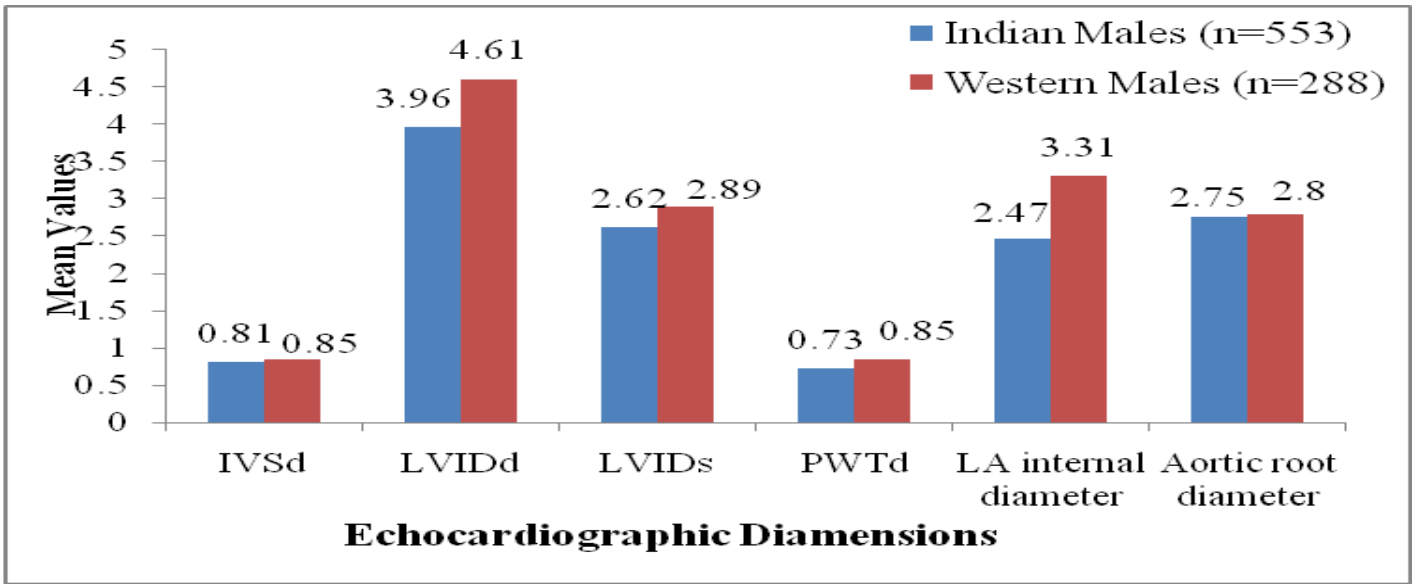
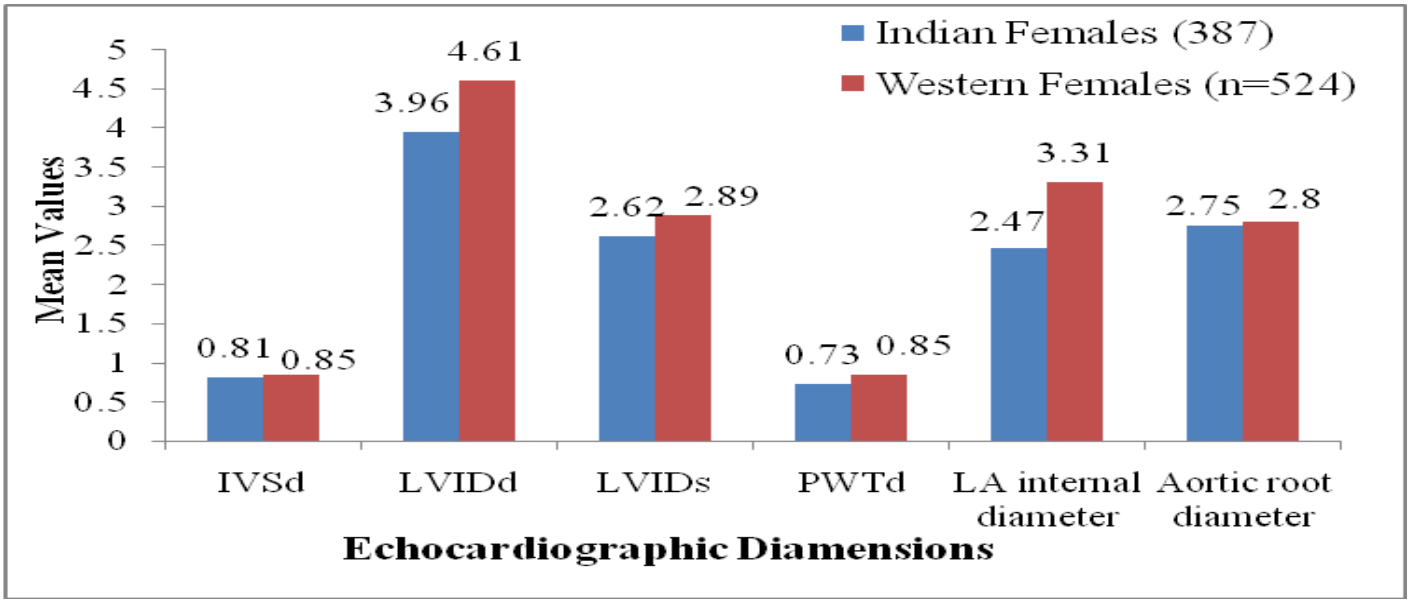


Figure 2: Comparison of Echocardiographic dimensions in the Indian and Western females



Discussion

Studies with the purpose of defining normal parameters must describe the origin of the population and the sampling criteria. The absolute majority of the reference studies of normal values for echocardiographic measurements do not present this information. Reference values for the echocardiogram must originate from a representative population sample of the inhabitants free of cardiovascular disease or other illnesses clinically relevant to the parameter of interest [7]. Many studies do not specify the origin of the studied population or use relatives of patients, employees, or individuals whose echocardiogram was interpreted as normal [8, 9]. In present study, the sampling criteria was relatives of patients attending OPD and IPD, and other healthy volunteers willing to participate in the study after meeting inclusion and exclusion criteria.

A total of 940 healthy subjects were enrolled in this study and divided into five age groups 1) 21-30, 2) 31-40, 3) 41-50, 4) 51-60, 5) >60. We assessed the relationships between age and echocardiographic dimensions by using univariate regression analysis. There was age wise progressive increase in the thickness of IVSd, PWTd in male and female. This could be due to increase in size of myocytes with aging and increased rate of degenerative changes leading to deposition of lipid, collagen, elastin, and lipofuscin in myocardium [7]. There was also significant increase in LA internal diameter and aortic root diameter in both men and women. This result is consistent with the study done by Daimon et al [10] who found that LA diameter in the parasternal long axis acoustic view increased significantly with age. This could be due to pathophysiologic perturbations that often accompany advancing age rather than a consequence of chronologic aging [11]. However, Vasan et al [12] concluded that age is the principle determinant of Aortic root size. This could be due to age related thinning and fracturing of the elastic laminae, presumably related to the effects of cyclic stress. It has been postulated that because aortic distensibility declines with age, the aortic diameter increases, so that the volume buffering capacity is constant [12]. Thus IVSd, PWTd, LA internal diameter and aortic root diameter had positive correlation ($r > 0$) with age,

which was statistically significant ($p<0.05$) in both men and women. While there were no significant age wise changes in the measurements of LVIDd and LVIDs in both men and women. LVIDd and LVIDs in males and LVIDs in females had weak negative correlation ($r < 0$) with age and LVIDd in females had weak positive correlation ($r > 0$) with age which were statistically not significant ($p>0.05$). These results are similar to study done by Daimon et al [39], Gerstenblith et al [13], Gupta et al [14] and Gardin et al [15].

There was significant difference between the echocardiographic dimensions of male and female population screened, all studied echocardiographic dimensions were higher in males than in females and the difference between two was statistically significant ($p<0.05$). This result is consistent with the previous studies [7, 16-20] which could be due to significantly higher height, weight and body surface area of males as compare to females. All studied echocardiographic dimensions were lower in Indian population as compare to their Western counterparts and the difference was statistically significant ($p<0.05$). This result is correlated with the study done by Trivedi et al [8] and Bansal et al [21]. These studies found that left ventricular echocardiographic measurements of Indian population were significantly lower than their western counterparts. These differences could well be due to the difference in the body habitus parameter, lean body mass and racial variation.

Limitations of the Study

In the present study we could not compare the echocardiographic dimensions indexed by various body habitus parameters. Now a day's echocardiography is being used as a screening tool, where it will not be feasible to index the various echocardiographic parameters by various body habitus indices. It would rather be more preferable to use our own standards, where such time consuming methodology, such as estimation of lean body mass and body surface area will not be required.

Conclusion

All studied echocardiographic dimensions were higher in men as compare to women. This observation does not allow us to use a single set of standards for both men and women in Indian population. The current study reconfirms previous observations that Indian subjects have much smaller cardiac chamber dimensions as compared to the western populations. This observation does not permit us the use of western data in the Indian context. There should be separate reference values for echocardiographic dimensions of heart of normal healthy Indian population that could be useful in routine clinical practice as well as in clinical trials. Western data is not helpful for defining the normal limits of cardiac dimensions for the Indian subjects. It is also desirable that a few more multicentric studies in the Indian population ought to be carried out to establish the normal reference values.

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