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Original Article

Normal echocardiographic measurements in Indian adults: How different are we from the western populations? A pilot study

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ABSTRACT

This study sought to gain insights into the magnitude of error resulting in echocardiographic interpretations in Indian subjects by using western data as the reference. Standard transthoracic echocardiographic examination was performed in 100 healthy volunteers (mean age 34.0 ± 8.8 years, 59% males). Compared with the reference values published by the American Society of Echocardiography (ASE), our subjects had much smaller left ventricular (LV) end-diastolic dimension, end-systolic dimension, and end-diastolic volume (only 58%, 61%, and 61% of the subjects were having values within the ASE-defined normal ranges). Indexing to body surface area increased these proportions to 81%, 90%, and 68%, respectively. In contrast, LV ejection fraction and most of the measures of LV diastolic function coincided with the ASE-recommended age- and gender-specific values.

1. Introduction

The interpretation of quantitative data derived from echocardiography is based on comparisons with the predefined age, gender, and ethnic-specific normal reference values.[1,2] Unfortunately, no reference values are currently available for Indian adults and therefore western data only are used as reference for echocardiographic interpretations in Indians. A few previous studies have shown that this may be inappropriate as Indians have smaller cardiac chamber dimensions than the western populations and may also have important differences in ventricular functional parameters.[3–5] However, the clinical impact of this discrepancy is not fully known.

2. Methods

Standard transthoracic echocardiographic examination was performed in 100 apparently healthy volunteers (mean age 34.0 ± 8.8 years, 59% males). Conventional two-dimensional and Doppler measurements were performed as per the recommendations from the American Society of Echocardiography (ASE).[6,7] The cardiac chamber dimensions were compared with

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the references values recently published by the ASE.[1] Both the absolute and body surface area (BSA)-indexed values were compared and the proportions of the subjects having values within the ASE-defined ranges were calculated. The mitral inflow parameters and annular velocities were compared with the reference values provided in the 2009 ASE guidelines for assessment of left ventricular (LV) diastolic function.[8]

3. Results

The echocardiographic measurements in the study subjects and the comparisons with the ASE-recommended reference values are presented in Tables 1 and 2. Our subject had much smaller LV end-diastolic dimension (EDD), end-systolic dimension (ESD), and end-diastolic volume (EDV) with only 58%, 61%, and 61% of them, respectively, having these values within the ASE-defined normal ranges (Table 1). Indexing to BSA increased these proportions to 81%, 90%, and 68%, respectively. Although the pattern was similar for both men and women, slightly greater proportion of women had these values within the ASE-recommended ranges (indexed LVEDD 82.9% vs 79.7%, indexed LVESD 95.1% vs 86.4%, indexed LVEDV 75.6% vs 62.7%, all P values not significant). Unlike LV dimensions, all subjects had LVEF within the normal range described by the ASE (≥52% in men and ≥54% in women).

Among LV diastolic function parameters (Table 2), the ratio of the mitral inflow early diastolic velocity (*E*) to late diastolic velocity (A) was within normal range in the majority of the subjects (86%) but the *E* wave deceleration time was out of range in almost two-thirds of the individuals. In comparison, most of the study subjects had normal mitral *E*/septal annular early diastolic velocity (*E*′) ratio, mitral *E*/lateral *E*′ ratio, and mitral *E*/average *E*′ ratio (65%, 93%, and 90%, respectively), with none having elevated value of any of these three ratios. The LA volume index was normal in all subjects. Using the algorithm recommended for assessment of LV filling pressure in presence of normal LV systolic function,[8] all subjects were diagnosed to have normal LV filling pressure.

4. Discussion

Several studies have demonstrated that ethnicity is an important determinant of cardiac chamber sizes, and therefore, it is strongly recommended to use ethnic-specific reference values for echocardiographic interpretations.[1,2,9,10] Failure to account for these ethnic differences can result in serious consequences as several key therapeutic decisions completely hinge on accurate assessment of cardiac chamber sizes and function.[11,12]

A few previous studies have shown that Indians have smaller cardiac chamber dimensions than the western populations and may also have important difference in ventricular functional parameters. However, no reference values currently exist for various echocardiographic measurements in Indians because the limited previous studies that attempted to provide normative data either had small sample size, were old, employed measurements that are no longer contemporary, obtained only selected measurements, or included only nonresident Indians.[5,13–15] This underscores an urgent need to develop a large, nationally representative database to provide normal reference values for various echocardiographic measurements in Indians.

However, until such time that ethnic-specific normative data become available for Indians, it is pertinent to determine

Table 1 – Comparison between left ventricular dimensions in our subjects and the normal ranges recommended by the American Society of Echocardiography.[1]

Parameter	Males (*n* = 59)			Females (*n* = 41)			Overall population (*n* = 100)
	ASE values (mean, range)	Our data[a]	Within ASE range	ASE values (mean, range)	Our data[a]	Within ASE range	Within ASE range
LVEDD							
Unindexed value (mm)	50, 42.0–58.0	41.1 ± 0.66 (39.8–42.4)	27 (45.8%)	45, 38.0–52.0	39.5 ± 0.53 (38.4–40.6)	31 (75.6%)	58 (58%)
Indexed to BSA (mm/m^2)	26, 22.0–30.0	24.1 ± 0.44 (23.2–25.0)	47 (79.7%)	27, 23.0–31.0	25.8 ± 0.47 (24.9–26.7)	34 (82.9%)	81 (81%)
LVESD							
Unindexed value (mm)	32, 25.0–40.0	25.8 ± 0.51 (24.8–26.8)	33 (55.9%)	28, 22.0–35.0	23.8 ± 0.55 (22.7–24.9)	28 (68.3%)	61 (61%)
Indexed to BSA (mm/m^2)	17, 13.0–21.0	15.1 ± 0.31 (14.5–15.7)	51 (86.4%)	17, 13.0–21.0	15.5 ± 0.34 (14.8–16.2)	39 (95.1%)	90 (90%)
LVEDV[b]							
Unindexed value (ml)	106, 62–150	73 ± 3.3 (66.4–79.6)	32 (54.2%)	76, 46–106	63 ± 2.4 (58.2–67.8)	29 (70.7%)	61 (61.0%)
Indexed to BSA (ml/m^2)	54, 34–74	42 ± 2.0 (38.0–46.0)	37 (62.7%)	45, 29–61	41 ± 1.6 (37.8–44.2)	31 (75.6%)	68 (68.0%)

[a] Values represent mean ± standard error of mean (95% confidence interval for mean).
[b] Age-specific references ranges were used for comparison.
ASE, American Society of Echocardiography; BSA, body surface area; LV, left ventricular; LVEDD, LV end-diastolic dimension; LVEDV, LV end-diastolic volume; LVESD, LV end-systolic dimension.

Table 2 – Left ventricular diastolic function parameters in study subjects in relation to the American Society of Echocardiography-recommended reference values.[8]

Parameter	Males ($n = 59$)	Females ($n = 41$)	Overall population
Mitral *E*/*A*			
Our data	1.74 ± 0.51	1.56 ± 0.39	1.66 ± 0.47
Comparison with ASE-defined ranges[a]			
Normal	50 (84.7%)	36 (87.8%)	86 (86%)
Abnormal	9 (15.3%)	5 (12.2%)	14 (14%)
dtE			
Our data (ms)	234 ± 75	224 ± 85	230 ± 79
Comparison with ASE-defined ranges[a]			
Normal	17 (28.8%)	16 (39.0%)	33 (33%)
Abnormal	42 (71.2%)	25 (61.0%)	67 (67%)
Mitral *E*/septal *E′*			
Our data	7.3 ± 1.6	7.7 ± 2.1	7.5 ± 1.8
Comparison with ASE-defined ranges			
Normal (≤8)	41 (69.5%)	24 (58.5%)	65 (65.0%)
Intermediate (9–14)	18 (30.5%)	17 (41.5%)	35 (35.0%)
Elevated (≥15)	0 (0%)	0 (0%)	0 (0%)
Mitral *E*/lateral *E′*			
Our data	5.5 ± 1.4	5.6 ± 1.4	5.6 ± 1.4
Comparison with ASE-defined ranges			
Normal (≤8)	55 (93.2%)	38 (92.7%)	93 (93.0%)
Intermediate (9–11)	4 (6.8%)	3 (7.3%)	7 (7.0%)
Elevated (≥12)	0 (0%)	0 (0%)	0 (0%)
Mitral *E*/average *E′*			
Our data	6.2 ± 1.3	6.4 ± 1.4	6.3 ± 1.3
Comparison with ASE-defined ranges			
Normal (≤8)	53 (89.8%)	37 (90.2%)	90 (90.0%)
Intermediate (9–12)	6 (10.2%)	4 (9.8%)	10 (10.0%)
Elevated (≥13)	0 (0%)	0 (0%)	0 (0%)
Left atrial volume index			
Our data (ml/m^2)	18.2 ± 1.9	19.5 ± 1.9	18.7 ± 2.0
Comparison with ASE-defined ranges			
Normal (10–34 ml/m^2)	59 (100%)	41 (100%)	100 (100%)
Abnormal (<10 or >34 ml/m^2)	0 (0%)	0 (0%)	0 (0%)

All values are mean ± standard deviation or numbers with percentages in parentheses.
[a] Age-specific reference values, as published in the ASE guideline document, were used for comparison.
A, mitral inflow late diastolic velocity; ASE, American Society of Echocardiography; dtE, deceleration time of mitral E velocity; E, mitral inflow early diastolic velocity; E′, mitral annular early diastolic velocity.

to what extent the values in Indian subjects differ from the currently used reference values derived from other ethnic groups. These issues are very pertinent for day-to-day clinical application of echocardiography as all echo labs in India continue to use ASE data as the reference and very few labs routinely index the measurements to BSA. In this context, our study provides valuable insights. We found that in nearly 40% of the participants, absolute LV size and volume were smaller than the ASE-recommended normal values. These differences were significantly minimized once the values were indexed to BSA. These findings imply that the current practice of using absolute values for defining normality of various cardiac chamber dimensions in Indian subjects should be immediately discontinued and only BSA-indexed values should be used for this purpose.

Ethnic differences have also been reported for ventricular functional parameters. A previous study by Chahal et al. had shown that immigrant Indians had lower mitral *E′* values as compared to European Whites (10.3 ± 2.1 cm/s vs 11 ± 2.1 cm/s, $p < 0.001$) resulting in greater *E*/*E′* ratios in Indians (7.9 ± 2.1 vs 7.0 ± 1.5, $p < 0.001$). However, they did not evaluate whether this difference was clinically relevant. In our study, we measured several parameters of LV diastolic function and categorized them according to the ASE reference values. We found that in all our healthy participants, LV diastolic function was diagnosed to be normal using the integrated algorithm recommended by the ASE. These findings suggest that slightly lower mitral *E′* values in Indians may not have much clinical relevance for day-to-day interpretation of echocardiography. However, it should be noted that medial annular *E′* was found to be less reliable as compared to lateral annular *E′* whereas mitral dtE was not a reliable indicator of LV diastolic function.

4.1. *Study limitations*

The most important limitation of the present study was that it was a small study consisting of a selected population from India. However, as stated above, the objective of this study was to only explore the magnitude of differences between Indian subjects

and their western counterparts and not to establish normative data for Indians. The second major limitation of the study was that only healthy volunteers were included. As a result, we could only confirm the specificity of currently used ASE-recommended values for excluding cardiac dysfunction in Indian subjects. But it could not be determined if the recommended thresholds for LV systolic and diastolic dysfunction also had desirable sensitivity to accurately detect early stages of LV systolic and diastolic dysfunction in Indian subjects.

5. Conclusions

Our study, which included resident Indians, reconfirms previous observations that Indian subjects have much smaller cardiac chamber dimensions as compared to the western populations. However, LV systolic and diastolic functional parameters were not different. The use of BSA-indexed values for cardiac chamber dimensions is strongly recommended to minimize errors in interpretations during routine echocardiography practice.

Conflicts of interest

The authors have none to declare.

REFERENCES

1. Lang RM, Badano LP, Mor-Avi V, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *J Am Soc Echocardiogr*. 2015;28:. 1–39.e14.
2. Ethnic-specific normative reference values for echocardiographic LA and LV size, LV mass, and systolic function: the EchoNoRMAL study. *JACC Cardiovasc Imaging*. 2015;8:656–665.
3. Chahal NS, Lim TK, Jain P, Chambers JC, Kooner JS, Senior R. Ethnicity-related differences in left ventricular function, structure and geometry: a population study of UK Indian Asian and European white subjects. *Heart*. 2010;96:466–471.
4. Chahal NS, Lim TK, Jain P, Chambers JC, Kooner JS, Senior R. Population-based reference values for 3D echocardiographic LV volumes and ejection fraction. *JACC Cardiovasc Imaging*. 2012;5:1191–1197.
5. Trivedi SK, Gupta OP, Jain AP, Jajoo UN, Kamble AN, Bharambe MS. Left ventricular m-mode echocardiographic measurements of Indian population. *J Assoc Physicians India*. 1993;41:14–16.
6. Lang RM, Bierig M, Devereux RB, et al. Recommendations for chamber quantification: a report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. *J Am Soc Echocardiogr*. 2005;18:1440–1463.
7. Quinones MA, Otto CM, Stoddard M, Waggoner A, Zoghbi WA. Recommendations for quantification of Doppler echocardiography: a report from the Doppler quantification task force of the nomenclature and standards committee of the American Society of Echocardiography. *J Am Soc Echocardiogr*. 2002;15:167–184.
8. Nagueh SF, Appleton CP, Gillebert TC, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography. *J Am Soc Echocardiogr*. 2009;22:107–133.
9. Zabalgoitia M, Ur Rahman SN, Haley WE, et al. Impact of ethnicity on left ventricular mass and relative wall thickness in essential hypertension. *Am J Cardiol*. 1998;81:412–417.
10. Badano LP. Ethnicity: a missing variable when defining normative values for reporting echocardiographic studies. *Arch Cardiovasc Imaging*. 2014;2:e16315.
11. Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2014;63:e57–e185.
12. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2013;62:e147–e239.
13. Bahl VK, Dave TH, Sundaram KR, Shrivastava S. Pulsed Doppler echocardiographic indices of left ventricular diastolic function in normal subjects. *Clin Cardiol*. 1992;15:504–512.
14. Chadha DS, Gupta N, Goel K, et al. Impact of obesity on the left ventricular functions and morphology of healthy Asian Indians. *Metab Syndr Relat Disord*. 2009;7:151–158.
15. Ilercil A, O'Grady MJ, Roman MJ, et al. Reference values for echocardiographic measurements in urban and rural populations of differing ethnicity: the Strong Heart Study. *J Am Soc Echocardiogr*. 2001;14:601–611.