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A study on normal reference values of the left ventricular strain parameters in young adults

Malyaban Das[1], Madhumita Kuila[2], Swapan Kumar Halder[3]

[1]Senior Resident, [2]Assistant Professor, [3]Associate Professor, Department of Cardiology, Nil Ratan Sircar Medical College, Kolkata, West Bengal, India

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ABSTRACT

Background: The left ventricular (LV) function is an important prognostic determinant of cardiopulmonary pathologies in adult. Clinical application of cardiac strain by two-dimensional speckle tracking echocardiography to measure LV function requires knowledge of the range of normal values. Reference values and associated variations of the deformation measures need to be "firmly established before routine clinical adoption" of LV strain measurements can be implemented in Indian population. **Aims and Objectives:** This study aims to establish normal values of LV strain parameters in normal Indian population. **Materials and Methods:** An observational, cross-sectional, single-center, hospital-based study. The study period October 2021–October 2022 in Nil Ratan Sircir Medical College, Kolkata. Cardiologically healthy adult subjects (sample size 250) both male and female, aged 18–45 years who were health-care professionals of this medical college and hospital were included in the study. Routine history taking and investigations were done. Echodoppler was done with special emphasis on LV strain parameters. **Results:** Distribution of mean LV circumferential strain (LVCS) with age in years was statistically not significant (P=0.8068). The mean value in male and female were −18.9574(±0.9049) and −19.0257(±0.8908) respectively. In the current study, LVCS did not vary in statistically significant a way among different age groups too. The mean values in male and female were −22.5887(±1.8065) and −22.3312(±1.9007) respectively. **Conclusion:** This current study failed to show significant differences in LV strain parameters between age groups or male and female in Eastern India Population.

Key words: Left ventricular strain; Echocardiography; Cardiology

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INTRODUCTION

Left ventricular (LV) function is an important prognostic determinant of cardiopulmonary pathologies in adult. The LV myocardium has a complex architecture and consists of circumferential fibers in the mid-wall layer and longitudinal fibers in the endocardial and epicardial layers. LV deformation comprises radial thickening, circumferential shortening, and longitudinal shortening, and myocardial strain describes this deformation under an applied force.[1] Specifically, two-dimensional speckle-tracking echocardiography (2DSTE) is an angle-independent method for myocardial strain measurement that has been used to estimate deformation measures and quantitatively characterize LV function. Clinical application of cardiac strain by 2DSTE to measure LV function requires knowledge of the range of normal values. The use of strain imaging to assess LV systolic and diastolic function in healthy young adults has recently produced measures of normal global and segmental longitudinal strain, circumferential strain (CS), and radial strain and strain rate. Measurements of myocardial strain imaging are subject to "physiologic variation" depending on patient demographics (age, gender, race), clinical factors (heart rate [HR], blood pressure, weight or body surface area [BSA]), and equipment and image technique variables (ultrasound and vendor-customized software, probe size, tissue-tracking methodology, location of reported strain value along the strain curve, frame rate [FR], and FR/HR ratio). Reference values and associated variations of the

Address for Correspondence:
Dr. Madhumita Kuila, Assistant Professor, Department of Cardiology, Nil Ratan Sircar Medical College, Kolkata, West Bengal, India.
Mobile: +91-9875616968. **E-mail:** drmadhumita_k@rediffmail.com

deformation measures need to be "firmly established before routine clinical adoption" of LV strain measurements can be implemented in Indian population.[2-4]

Aims and objectives

This study aiims to establish normal values of LV strain parameters in normal Indian population.

MATERIALS AND METHODS

Study design

This was an observational, cross-sectional, single-center, and hospital-based study.

Study setting and timeline

i. Review of literature, protocol preparation: 1 month
ii. Collection of data: 1 year
iii. Analysis of data and report writing -2 months

Place of study

The study was conducted by N.R.S Medical College and Hospital.

Period of study

The duration of the study was October 2021–October 2022.

Study population

Cardiologically healthy adult subjects, both male and female, aged 18–45 years were health-care professionals of this medical college and hospital.

Sample size

Considering the study sample of the existing studies, approximately 250 subjects were assessed over the period of 1 year.

Inclusion criteria

Cardiologically healthy adult subjects, both male and female, aged 18–45 years, were included in the study.

Exclusion criteria

The following criteria were excluded from the study:

1. Systemic hypertension
2. Pulmonary hypertension
3. Chronic renal disease
4. Diabetes mellitus (DM)
5. Hypo and hyperthyroidism
6. Chronic corticosteroid treatment
7. Alcohol use disorder
8. Known coronary artery disease or other cardiovascular disease
9. Pregnancy
10. Obesity.

Data collections method

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later revisions. Informed consent was obtained from all patients for being included in the study.

i. Detailed Clinical History with emphasis on the risk factors like DM, Hypertension, Family history of premature coronary artery disease, smoking, tobacco chewing, physical inactivity, exertional angina, Known cardiovascular disease, medicine intake, and physical training was taken.
ii. Systematic clinical examinations were performed. Parameters which were assessed include blood pressure, peripheral pulse, height, weight, body mass index (BMI), waist circumference, and vital parameters.
iii. Bodyweight was measured in kilograms to the nearest 0.1 kg using a digital scale, which was calibrated regularly. Height was measured to the nearest 5 mm using a height gauge. BMI was calculated using Quetlet's formula as weight in kg/square of the height in meters. Obesity was defined as BMI >25 kg/mm^2.
iv. Blood pressure was recorded in the left arm in supine position with an appropriately sized cuff using a sphygmomanometer. Hypertension was defined as systolic blood pressure ≥140 and/or diastolic ≥90 mmHg and/or on anti-hypertensive treatment.
v. DM was defined as patients having fasting plasma glucose ≥126 mg/dL and/or random plasma glucose ≥200 mg/dL with features suggestive of DM or a history of DM and/or taking medication for diabetes.
vi. Laboratory investigations such as fasting blood glucose, random blood glucose, cardiac enzymes, serum urea and creatinine, creatinine clearance, estimated glomerular filtration rate (by chronic kidney disease-EPI formula), spot urine albumin creatinine ratio, lipid profile, and complete hemogram were done.
vii. Free T3, Free T4, and thyroid stimulating hormone (TSH) were measured. Subjects with TSH level ≤5 mIU/mL and normal free T3, Free T4 was included in the study.
viii. Electrocardiogram, chest radiograph, and echocardiography were done.
ix. DSM-5 criteria for alcohol use disorder are as follows:

A maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by 2 or more of the following, occurring at any time in the same 12-month period:

1. Alcohol is often taken in larger amounts or over a longer period than was intended

2. There is a persistent desire or unsuccessful efforts to cut down or control alcohol use
3. A great deal of time is spent in activities necessary to obtain alcohol, use alcohol, or recover from its effects
4. Craving or a strong desire or urge to use alcohol
5. Recurrent alcohol use failing to fulfill major role obligations at work, school, or home
6. Continued alcohol use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of alcohol
7. Important social, occupational, or recreational activities are given up or reduced because of alcohol use
8. Recurrent alcohol use in situations in which it is physically hazardous
9. Alcohol use is continued despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by alcohol
10. Tolerance, as defined by either of the following:
    a. A need for markedly increased amounts of alcohol to achieve intoxication or desired effect.
    b. A markedly diminished effect with continued use of the same amount of alcohol.

Withdrawal, as manifested by either of the following:
  a. The characteristic withdrawal syndrome for alcohol
  b. Alcohol (or a closely related substance, such as a benzodiazepine) is taken to relieve or avoid withdrawal symptoms.

Statistical plan

The mean±2 standard deviation (SD) rule was used to propose normal echocardiographic reference values from the results acquired in this study. This is based on the assumption that this range contains 95% of values of a reference group, and the sample value can be greater than upper limit or lesser than lower limit in 2.5% of the time respectively, whatever might be the distribution of these values. For statistical analysis, data were analyzed by Statistical Package for the Social Sciences (SPSS) (version 24.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Summarization of data was done as mean and SD for numerical variables and count and percentages for categorical variables. Two-sample t-test for a difference in mean was used for independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. A Chi-squared test (χ^2 test) was a statistical hypothesis test wherein the sampling distribution of the test statistic is a Chi-squared distribution when the null hypothesis is true. Chi-square test or Fischer's exact test was used to compare unpaired proportions as appropriate. Wilcoxon-Mann-Whitney test was used to compare the normal mean echocardiographic measurements of the results of this study with ASE/ASCVI guideline. P≤0.05 was considered for statistically significant.

RESULTS

In ≤20, the mean LV global longitudinal strain (LVGLS) (mean±SD) of patients was −19.5000±1.7847.

In 21–30, the mean LVGLS (mean±SD) of patients was −21.8271±20.9763.

In 31–40, the mean LVGLS (mean±SD) of patients was −19.0419±9557.

In 41–50, the mean LVGLS (mean±SD) of patients was −19.0326±6267.

Table 1: Distribution of mean LVGLS: Age in years

Age in years	Number	Mean	SD	Minimum	Maximum	Median	P-value
LVGLS							
≤20	5	−19.5000	1.7847	−22.5000	−17.9000	−18.9000	0.4140
21–30	85	−21.8271	20.9763	−198.0000	−17.2000	−18.7000	
31–40	117	−19.0419	0.9557	−22.4000	−17.2000	−19.1000	
41–50	43	−19.0326	0.6267	−20.8000	−17.8000	−19.1000	

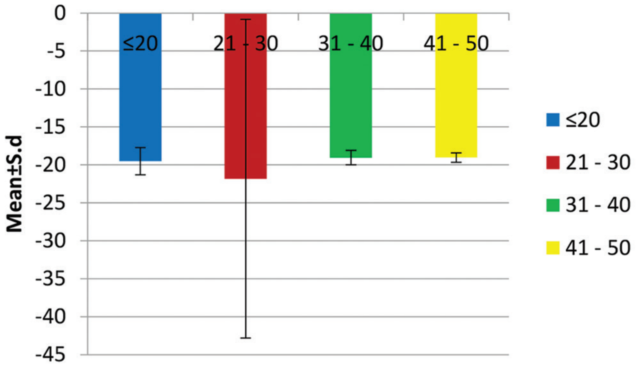
LVGLS: Left ventricular global longitudinal strain, SD: Standard deviation

Table 2: Distribution of mean LVCS: Age in years

Age in years	Number	Mean	SD	Minimum	Maximum	Median	P-value
LVCS							
≤20	5	−22.1400	2.2898	−25.4000	−19.8000	−22.5000	0.8068
21–30	85	−22.3859	1.7412	−25.6000	−19.2000	−21.9000	
31–40	117	−22.4752	1.9699	−29.3000	−17.9000	−22.1000	
41–50	43	−22.6977	1.7045	−25.4000	−18.9000	−22.5000	

LVCS: Left ventricular circumferential strain

Distribution of mean LVGLS with Age in years was statistically not significant (P=0.4140).



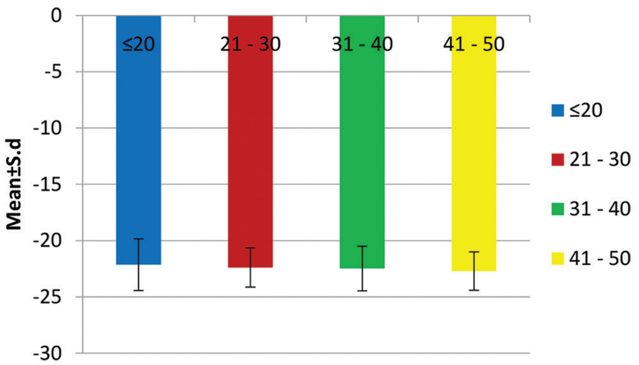
In ≤20, the mean LV circumferential strain (LVCS) (mean±SD) of patients was −22.1400±2.2898.

In 21–30, the mean LVCS (mean±SD) of patients was −22.3859±1.7412.

In 31–40, the mean LVCS (mean±SD) of patients was −22.4752±1.9699.

In 41–50, the mean LVCS (mean±SD) of patients was −22.6977±1.7045.

Distribution of mean LVCS with Age in years was statistically not significant (P=0.8068).



DISCUSSION

The present study was an observational, cross-sectional, single-center, hospital-based study. This study was conducted from October 2021–October 2022 at N.R.S Medical College and Hospital. A total of 250 patients were included in this study.

In the current study, LVGLS did not vary in statistically significant a way among different age groups (Table 1). The mean values in male and female were −18.9574 (±0.9049) and −19.0257 (±0.8908), respectively. In the current study, LVCS did not vary in statistically significant a way among different age groups too (Table 2). The mean values in male and female were −22.5887 (±1.8065) and −22.3312 (±1.9007), respectively. In one of the largest studies on global and segmental strain of healthy individuals by Dalen et al.,[5] strain parameters were significantly lower in higher age groups at all walls and at all levels, though this difference was so small that it had hardly any clinical implication. This current study failed to show such differences between age groups probably because relatively small study population and younger healthy individuals were included in this study. In the above-mentioned study, strain parameters were different among male and female too, though in the current study, there were no such difference.

Signal noise and acoustic artifacts pose a challenge in measuring strain. Dropouts and reverberations lead to low or zero values in the area of artifacts. As strain based on the velocity measurements in reality are equivalent to a subtraction of the more apical velocity from the more basal, all measurements below the artifact may result in overestimation. Thus, including only basal segments may induce a systematic error. Hence, we rejected those imaged with poor tracking. Commercial software more often accept segments even though they should be discarded for the same reasons.[6] Nevertheless use of a customized software was in fact the only way to achieve full information about segmental borders and the process used to calculate myocardial deformation. The use of customized software was also the only practical solution for using such methods to assess strain parameters in such a large population after doing proper adjustments to the software-acquired tracking.

Ethnicity is an important factor on which cardiac chamber dimensions differ.[7,8] Several therapeutic decisions depend on the proper assessment of cardiac chamber measurements and function and normal reference values are important to avoid putting patients with normal measurements to abnormal category and vice versa.[9-11] Therefore it is strongly recommended that ethnicity specific reference values are used for interpretation of echocardiography results. In this study mean±2 SD rule was implemented in producing the reference which ensured inclusion of approximately 95% of the subjects. Studies have already shown there is disparity of echocardiographic parameters in Indians and western population. Thus, the need of Indian normal reference values is paramount but no such guideline exists because the previous studies were either old with non-contemporary ways of measurements or included only non-resident Indians or had small sample size.[12-15] Choi et al., and Yao et al., have already presented the normal echocardiographic measurements of Korean and Chinese population, respectively, in three separate studies.[16-18] Prajapati et al., have presented the normal echocardiographic parameters of a small Nepalese population.[19] Variations in LV size and function among race and nationalities were studied in the WASE study but in it Indian population was represented by only 126 subjects from south India and 101 subjects from north India.[20] Moreover, only LV parameters were studied in the WASE study. Sullere et al., presented the data of 707 subjects from a single center from central India.[21] This is the first study reporting normative echocardiographic values from eastern India and the largest Indian sample studied till date for the same. The wide spectrum of data among these contemporary studies involving Indian subjects re-asserts the influence of race, ethnicity, heredity, lifestyle, and BSA on echocardiographic parameters even within a single country. Thus, there remains a requirement of a nationally representative sizeable database from which the normal reference values for Indian population can be achieved.

Limitations of the study

In spite of every sincere effort, my study has lacunae.

The notable short comings of this study are:

- The sample size was small. 250 cases are not sufficient for this kind of study
- The study has been done in a single Centre
- The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

CONCLUSION

This current study failed to show significant difference in left ventricular strain parameters between age groups or male and female in Eastern Indian population.

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Authors' Contributions:
MD- Definition of present work, literature survey, data collection, data analysis, preparation of manuscript draft; **MK-** Concept, design, supervision of work, preparation of final manuscript, submission of manuscript; **SKH**- Concept, design of study, manuscript editing and revision.

Work attributed to:
Nir Ratan Sircar Medical College and Hospital, Kolkata - 700015, West Bengal, India.

Orcid ID:
Dr. Malyaban Das - https://orcid.org/0009-0009-5763-9693
Dr. Madhumita Kuila - https://orcid.org/0000-0002-2048-8352
Dr. Swapan Kumar Halder - https://orcid.org/0000-0003-3560-3883

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