SHORT COMMUNICATION

Normal values of left atrial size and strain analyzed by dedicated speckle-tracking echocardiography in the Chinese population

Lei Li[1–3], Chunyuan You[1, 2], Jun Yang[1, 2], Junfei Shen[1, 2], Pingyang Zhang[3]

[1]Department of Cardiology, Wuxi No. 2 People's Hospital, Wuxi, China
[2]Department of Cardiology, Jiangnan University Medical Center, Wuxi, China
[3]Department of Echocardiography, Nanjing First Hospital, Nanjing Medical University, Nanjing, China

Correspondence to:
Pingyang Zhang, MD, PhD, Department of Echocardiography, Nanjing First Hospital, Nanjing Medical University, Changle Road 68, Nanjing, Jiangsu Province, China, phone: +86 510 68 561 134, e-mail: junxiao2010@126.com

DOI: 10.33963/v.kp.97479

Received:
July 2, 2023

Accepted:
September 15, 2023

Early publication date:
October 2, 2023

INTRODUCTION

Left atrial (LA) size is a simple measurement in evaluating left ventricular (LV) diastolic function and has a well-known prognostic value in adults with atrial fibrillation and heart failure [1]. Recently, LA strain has been evaluated using commercial speckle-tracking software methods. LA strain, an alternative measure of LA function, has proven useful for classification of LV diastolic dysfunction [2] and has additive value in the prognostication of patients with atrial fibrillation, heart failure, and chronic kidney disease [3]. As we know, the LA strain exhibits greater diagnostic sensitivity than traditional characteristics and is crucial in a number of disorders [4]. Unfortunately, the reference values for LA strain have not been established yet. Before the widespread use of LA-specific software, when that software was employed only in clinical research, LA strain was measured using LV-dedicated software [5]. Therefore, the LA strain values could vary greatly depending on the software algorithm provided by each manufacturer [6].

Our goal was to identify normal reference values to quantify LA size and strain in healthy subjects using the most recent LA-specific speckle-tracking software offered by GE medical systems. We also tried to establish links between LA strain and other clinical indicators.

METHODS

Participants were retrospectively reviewed and included in this cross-sectional analysis from January 2021 to December 2022. We enrolled apparently healthy subjects ≥18 years of age from Wuxi No. 2 People's Hospital, China. Apparently healthy subjects were defined as individuals without any disease or cardiovascular risk factors such as obesity, diabetes, or hypertension, who did not take any medications. The institutional ethics review board approved the study.

Using GE Medical Systems (Vivid E95), we performed transthoracic echocardiography. According to recent recommendations, left ventricular dimensions and other standard echocardiographic parameters were assessed. The biplane disk summation technique was used to measure LA volume. Using LV-specific analytic software from Echo-PAC version 204, the global longitudinal strain (GLS), peak systolic dispersion (PSD) of the left ventricle, and LA reservoir strain were assessed. The GLS of the LV was calculated from the 2-chamber, 3-chamber, and 4-chamber apical views. Absolute values were used to express LV GLS parameters and reservoir LA strain. LA volume and strain were assessed using LA-dedicated software (AFI-LA). The ventricular end-diastole was used as the time reference to define the zero baseline for LA strain curves. Left atrial volume (LAV) versus time curves were created, with the maximum LAV, the minimum LAV, and LAV before atrial contraction (Figure 1A). All volume measurements were indexed to body surface area (BSA). Additionally, the reservoir, conduit, and contractile phases of LA longitudinal strains were measured and expressed as absolute measures (Figure 1B). Biplane LA parameters were calculated as the averaged values from the 2- and 4-chamber apical views.

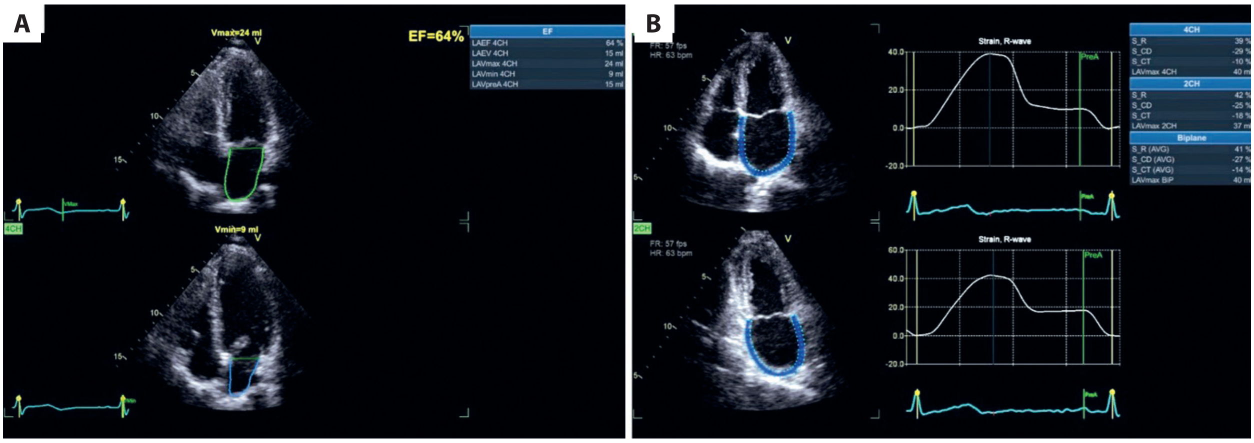

Figure 1. Left atrial strain and volume derived from left atrium (LA) dedicated software (Automated function imaging LA). (**A**) Left atrial volume. (**B**) Left atrial strain

Statistical analysis

While continuous data were presented as means (standard deviations), categorical parameters were expressed as numbers and percentages. The Shapiro-Wilk W test was used to assess normality. Unpaired, two-tailed Student's t-test was used to analyze differences between the two groups. Comparisons between three or more groups were analyzed using one-way analysis of variance (ANOVA). Statistical significance was defined as $P < 0.05$. The normal range for each parameter was defined as the range that would include 95% of the normal population. Correlations between LA strain and continuous variables were tested by simple linear correlation analysis (Pearson's correlation). In addition, to identify the variables with the association with LA strain, we performed simple and multivariable stepwise forward linear regression analysis. We evaluated intra- and inter-observer measurement variabilities based on intraclass correlation coefficients (ICCs). Statistical analysis was performed using IBM SPSS Statistics version 20 (IBM corporation, Armonk, NY) and SAS version 9.2 (SAS Institute, Cary, NC, US).

RESULTS AND DISCUSSION

Clinical characteristics and conventional LV measurements of 111 healthy individuals are shown in Supplementary material, *Table S1*. The mean (SD) and normal ranges for LA size are presented separately in Supplementary material, *Table S2* and *S3*. We found that the maximum, minimum, and pre-A LAV adjusted for BSA were similar for men and women. In addition, the mean (SD) and normal ranges for the LA strain values and other functional indices are shown separately in Supplementary material, *Table S4* and *S5*. The LA ejection volume adjusted for BSA, LA ejection fraction (EF), LA reservoir, conduit, and booster strains were identical for both sexes.

We conducted age quartile comparisons in the healthy individuals (Supplementary material, *Table S6* and *S7*).

The indexed minimum LAV and LA pre-A volume in the quartile 1(Q1) group were considerably lower than those in the quartile 4(Q4) group, whereas the LA reservoir strain, conduit strain, and LA EF were significantly higher.

In 2-chamber, 4-chamber, and biplane views, the LA reservoir and conduit strains were both inversely correlated with age (Supplementary material, *Table S8*), which shows that the strains on the LA reservoir and conduit deteriorate with aging. However, there was no statistically significant correlation between the LA booster strain and age, a finding that is consistent with some, but not all, studies suggesting that additional research is required to fully understand the relationship [5].

The association of PSD and GLS with LA reservoir and conduit strains, while statically significant, was weak with an r-value of <0.35 (Supplementary material, *Table S8*). There was no correlation between LA booster strain and LV functional parameters (GLS and PSD). As a result, we think that the LA strain should be understood in relation to the LV.

The LA reservoir and booster strains were inversely related to LA remodeling (determined by maximum LAV index) in 2-chamber and biplane views, though the r-value was weak ($r = -0.2$; $P = 0.01$). Except for the booster strain in the 4-chamber view, other LA strains were positively related to LA EF, which showed a moderate correlation ($r > 0.6$; $P < 0.0001$). Although left atrial volume index max and LA EF were both connected to the LA strain parameters, LA EF influence was more pronounced. Lastly, in the simple and stepwise multivariable regression analysis, factors showing significant associations with LA reservoir and conduit strains were age, LV GLS, and LA EF (Supplementary material, *Table S9* and *S10*). In addition, LA booster strain had a significant association with LA EF in the 2-chamber view (Supplementary material, *Table S11*). The reproducibility of the LA size and strain was adequate (Supplementary material, *Table S12*).

As shown in Supplementary material, *Table S13*, the LA size and strain were measured using dedicated software (AFI-LA analyses) and the traditional methods (the biplane disk summation technique and LV-dedicated software). Compared with the traditional method that can only measure maximum and minimum LAV, the AFI-LA analyses additionally assessed LA pre-A volume and LA ejection volume. The AFI-LA software can also automatically measure the reservoir, conduit, and contractile phases of LA longitudinal strains, while the LV-dedicated software can merely automatically assess LA reservoir strain, and other strains need to be measured manually, which is both time-consuming and less accurate. Therefore, by using the AFI-LA method, the measurement accuracy could be improved and plenty of time could be saved (112 seconds vs. 337 seconds; P <0.0001). Using the AFI-LA analyses, the mean reservoir LA strain (32.7%) was significantly smaller than that obtained using the LV-dedicated software (37.8%). LA strain values substantially differed according to the different software used (LA-dedicated software vs. LV-dedicated software), which is consistent with previous studies [5]. Thus, it is important to establish the normal values of left atrial strain assessed by the AFI-LA analyses and promote its use in clinical practice [5].

We assessed LA size and strain in the healthy Chinese population, the LA reservoir, conduit, and booster strains were 32.7% (6.3%), 18.1% (6.0%), and 14.5% (3.6%), respectively. We also provided age- and sex-stratified reference values of LA strain, which may serve as reliable parameters for LA mechanical functional assessment. Our findings suggest LA reservoir and conduit strains decay with advanced age in the healthy Chinese population.

Further study will need to expand the sample size and include more cities to ensure that the results are more representative.

Supplementary material

Supplementary material is available at https://journals.viamedica.pl/kardiologia_polska.

Article information

Conflict of interest: None declared.

Funding: None.

REFERENCES

1. Njoku A, Kannabhiran M, Arora R, et al. Left atrial volume predicts atrial fibrillation recurrence after radiofrequency ablation: a meta-analysis. Europace. 2018; 20(1): 33–42, doi: 10.1093/europace/eux013, indexed in Pubmed: 28444307.
2. Morris DA, Belyavskiy E, Aravind-Kumar R, et al. Lower limit of normality and clinical relevance of left ventricular early diastolic strain rate for the detection of left ventricular diastolic dysfunction. Eur Heart J Cardiovasc Imaging. 2018; 19(8): 905–915, doi: 10.1093/ehjci/jex185, indexed in Pubmed: 28977386.
3. Wieczorek J, Mizia-Stec K, Cichoń M, et al. Positive left atrial remodeling in patients with paroxysmal atrial fibrillation after a successful radiofrequency pulmonary vein isolation. Kardiol Pol. 2023; 81(7-8): 737–745, doi: 10.33963/KP.a2023.0095, indexed in Pubmed: 37096949.
4. Kupczyńska K, Mandoli GE, Cameli M, et al. Left atrial strain — a current clinical perspective. Kardiol Pol. 2021; 79(9): 955–964, doi: 10.33963/KP.a2021.0105, indexed in Pubmed: 34599503.
5. Morris DA, Takeuchi M, Krisper M, et al. Normal values and clinical relevance of left atrial myocardial function analysed by speckle-tracking echocardiography: multicentre study. Eur Heart J Cardiovasc Imaging. 2015; 16(4): 364–372, doi: 10.1093/ehjci/jeu219, indexed in Pubmed: 25368210.
6. Sun BJ, Park JH. Echocardiographic Measurement of left atrial strain — a key requirement in clinical practice. Circ J. 2021; 86(1): 6–13, doi: 10.1253/circj.CJ-21-0373, indexed in Pubmed: 34092759.