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

Short title: The normal range for left atrial size and strain in Chinese population

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INTRODUCTION

Left atrial (LA) size is a simple measurement in evaluating left ventricular diastolic function and has well-known prognostic value in adults with atrial fibrillation and heart failure [1]. Lately, the LA strain was evaluated using commercial speckle tracking software methods. LA strain, an alternative measure of LA function, had proven useful for the classification of LV diastolic dysfunction [2], and shown to provide 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 LA strain's reference value has not yet been established.

Because LA strain was measured using LV-dedicated software before the advent of LA-specific software [5], and the LA strain values could greatly vary depending on the software algorithm provided by each vendor, even if LA-specific software was employed in clinical research [6]. To quantify LA size and strain in healthy subjects using the most recent LA-specific speckle tracking software offered by GE medical systems, our goal was to create normal reference values. We also tried to establish links between LA strain and other clinical indicators.

METHODS

Participants from January 2021 to December 2022 were retrospectively reviewed and comprised this cross-sectional analysis. We enrolled apparently healthy subjects≥18 years of age from Wuxi No. 2 People's Hospital, China. Apparently healthy subjects were defined as all those individuals with the absence of any disease and cardiovascular risk factors such as obesity, diabetes and hypertension; no medication. The institutional review board gave their approval to the study.

Using a GE Medical Systems (Vivid E95), transthoracic echocardiography was done. According to recent recommendations, the 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-Ch, 3-Ch and 4-Ch 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. 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 respectively and expressed as absolute measures (Figure 1B). Biplane LA parameters were calculated as the averaged values from the 2-Ch and 4-Ch apical views.

Statistical analysis

While continuous data were presented as mean (standard deviation), 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 two groups. Comparisons between three or more groups were analyzed using a one-way analysis of variance (ANOVA). Statistical significance was defined as P <0.05. The 95% values from the normal population were used to define the normal range for each parameter. 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 a 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 were shown in Supplementary material, *Table S1*. The mean (SD) and the normal ranges for LA size were presented in Supplementary material, *Table S2* and *S3*, separately. We found that the maximum, minimum and pre-A LA volumes(LAV) adjusted for BSA were similar for men and women. In addition, the mean (SD) and the normal ranges for the LA strain values and other functional indices were showed in Supplementary material, *Table S4* and *S5*, separately. The LA EV adjusted for BSA, LA EF, LA reservoir, conduit and booster strains were identical for both sexes.

We conducted age quartile comparisons among 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-Ch, 4-Ch, and biplane views, the LA reservoir and conduit strains were both inversely correlated with age (Supplementary material, *Table S8*), which showing that the strains on the LA reservoir and conduit were deteriorated with aging. However, there was no statistically significant correlation between the LA booster strain and age, a finding that is consistent with some studies but not others, 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 was statically significant, was mild with an r-value of <0.35 (Supplementary material, *Table S8*). There is 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 LV.

The LA reservoir and booster strains were inversely related to LA remodeling (determined by maximum LAV index) in 2Ch and biplane views, though the r-value is weak (r = -0.2; *P* = 0.01). Except for the booster strain in 4-Ch view, other LA strains were positively related to LA EF, which showed a moderate correlation (r ＞0.6; *P* <0.0001). Although LAVI max and LAEF were both connected to LA strain parameters, LAEF's 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 2-Ch 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 the dedicated software (AFI-LA analyses) and the traditional methods (the biplane disk summation technique and LV-dedicated software). Compared with the traditional method which can only measure maximum and minimum LAV, the AFI-LA analyses additionally assessed LA pre-A volume and LA EV. 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 the 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 while a 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 differ 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 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 a healthy Chinese population.

Further study may need to expand the sample size and include more cities to ensure that the result is more representative.

Supplementary material

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

Article information

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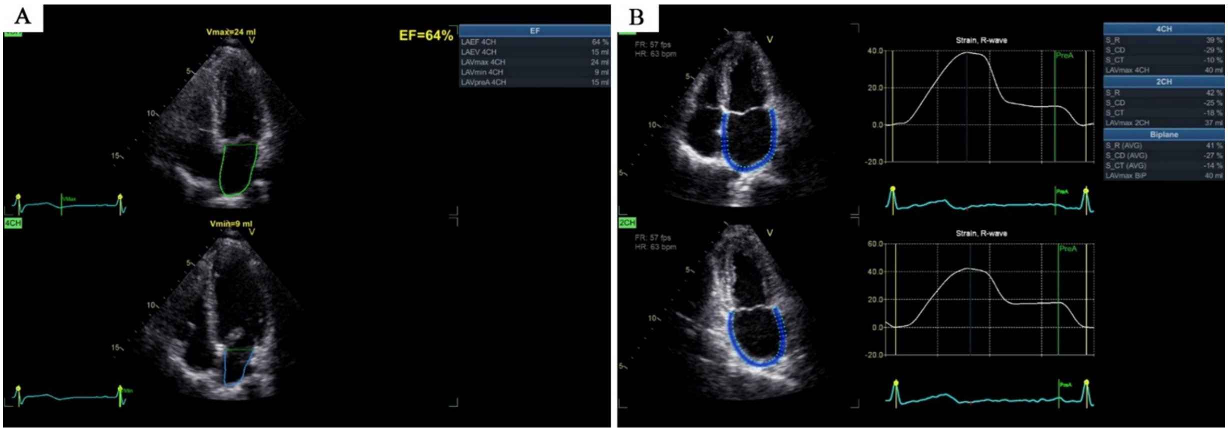

Figure 1. Left atrial strain and volume derived Left atrium (LA) dedicated software (Automated function imaging LA). (**A**) Left atrial volume. (**B**) Left atrial strain