Left Atrial Reservoir Function: Prevalence of Dysfunction in the General Population

The left atrium (LA) has three major roles: contractile pump that delivers 15% to 30% of the left ventricular filling; deposit or reservoir that collects pulmonary venous return during ventricular systole; and conduit for the passage of stored blood from the LA to the left ventricle (LV) during early ventricular diastole. Echocardiographic recommendations for chamber quantification stress the relevance of LA dimensions and its implications in clinical events, but do not mention the routine use of atrial function parameters. (1) The altered reservoir function (RF) can be an early marker of left ventricular diastolic dysfunction prior to ventricular hypertrophy or atrial dilatation, and it can even predict cardiovascular events. (2) No information is available about the normal RF value measured by two-dimensional echocardiography or how often it occurs in the general population. The purpose of our study was to determine the frequency of abnormal RF.

This was a retrospective, cross-sectional study conducted between May and October, 2016. Inclusion criteria was an echocardiography with adequate acoustic window to perform volumetric measures of the LA in 4 and 2 chamber apical views. In addition, patients had to be in sinus rhythm, with no significant valve diseases, and with left ventricular ejection fraction > 50% (Figure 1). Medical history and clinical background were reviewed.

The echocardiography was performed with a GE Vivid S5 or E9 ultrasound machine, and recorded in RAW format for offline analysis. Standard echocardiographic measurements were performed under existing regulations. (1) Maximum left atrial volume was obtained just before the opening of the mitral valve, and minimum left atrial volume just before its closure; both measurements were in 4- and 2- apical chamber views. The reservoir function was calculated with the following formula: Maximum left atrial volume - Minimum left atrial volume / Maximum left atrial volume × 100. (3)

Taking into account an abnormal RF prevalence of 4%, a sample of 59 patients was estimated for a 95% reliability level and 5% error margin. Categorical variables were expressed as percentage, and continuous variables as mean and standard deviation. Mean left atrial RF was obtained from all the study population. Kolmogorov-Smirnov goodness-of-fit test was performed to determine RF normal distribution. The RF limit value was considered as the mean minus two standard deviations. SPSS 17™ statistical package was used to perform the analyses.

A total of 64 patients were included in the study. Mean age was 55.7 years (±15.2 years), 57.8% were women, and 56.2% had hypertension. All the patients had preserved left ventricular ejection fraction, with normal ventricular diameters and left atrial indexed volume (Table 1). The RF was 55.7 ± 9.7% with normal distribution (p=0.94); therefore, the limit RF was determined as ≥36.3%, and with this normal limit, 3 patients had abnormal RF (4.69% p5% CI 95 0.98%-13.09%).

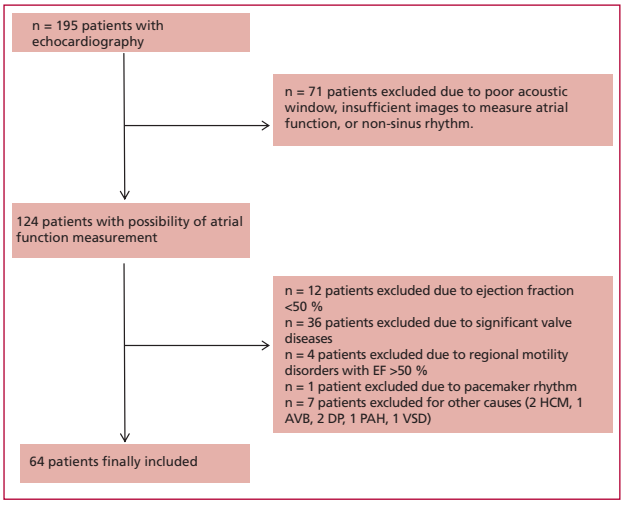

Fig. 1. HCM: Hypertrophic cardiomyopathy. AVB: Atrio-ventricular block. DP: Dual pacemaker. PAH: Pulmonary artery hypertension. VSD: Ventricular septal defect.

The LA plays an important role in the physiology of the cardiovascular system, acting as a reservoir during ventricular systole, receiving blood from the pulmonary veins. During early diastole, when the mitral valve is open, the LA acts as a conduit allowing the passage of blood volume from the LA to the LV due to pressure and aspiration differences of the LV; then atrial contraction determines the third function of the LA, that is, as a booster pump during late diastole. Left atrial function has a prognostic value in different clinical scenarios, even adding prognostic value to the measurement of atrial volume. (3) These functions can be determined by echocardiography, measuring atrial volumes in different phases of the cardiac cycle, and they can also be assessed with new technologies (for example, strain). (4)

Echocardiographic recommendations do not determine the normal values of atrial functions. The limit value we found is similar to that reported by other researchers in Argentina, measured with atrial strain. (5) A recent meta-analysis of 40 articles published normal atrial function reference values and revealed a normal reference range for reservoir strain of 39% (95% CI, 38%-41%). (6)

In our work, we did not use atrial strain to measure RF; however, since we used two-dimensional echocardiography, it broadens its use to any echocardiography laboratory that does not have the technology to measure longitudinal atrial strain.

Therefore, we conclude that the limit value of RF is >36.3%, and that this value is altered in 1-13% of the general population, despite normal atrial volumes.

Table 1. Population characteristics

History	
Age (years±SD)	55.7±15.2
Hypertension (%)	56.2
Diabetes (%)	10.9
Hypercholesterolemia (%)	50.7
Previous atrial fibrillation (%)	4.7
Coronary heart disease (%)	7.8
Glomerular filtration (ml/min±SD)	86.5±18.7
ECG criteria of LVH (%)	6.3
Echocardiography	
LV diastolic diameter (cm±SD)	4.62±0.42
LV systolic diameter (cm±SD)	2.92 ± 0.42
LV ejection fraction (%±SD)	66.2 ± 6.6
LV mass index (g/m2±SD)	62.6 ± 12.8
LA volume index (ml/m2)	25.5 ± 6
LA reservoir function (%±SD)	55.7 ± 9.7
E wave (m/sec±SD)	0.76 ± 0.15
A wave (m/sec±SD)	0.74 ± 0.15
E-wave deceleration	204 ± 37.9
E´ wave (cm/sec±SD)	0.12 ± 0.04
E/E´ ratio	6.87 ± 2.47

LV: Left ventricular. LA: Left atrial. LVH: Left ventricular hypertrophy according to Cornell's and/or Sokolov's criteria.

Conflicts of interest

None declared.

(See authors' conflicts of interest forms on the web/Supplementary material).

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