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Left atrial geometry and pump function in ischemic cardiomyopathy

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ABSTRACT

Background: Many of the factors that are known to alter left atrial (LA) contractility are present in patients with ischemic cardiomyopathy (ICM). Nevertheless, preservation of LA contractile function in this group of patients was reported in previous studies. The aim of this study was to assess the changes in LA size, geometry and contractile function in ICM.

Methods and results: 60 subjects (age: 49 ± 12 years, 53% males) in sinus rhythm undergoing coronary angiography (CA), were enrolled in this study; 15 subjects as a control group, 30 patients with reduced ejection fraction (EF) and significant coronary artery disease; as the ICM group, and 15 with reduced EF and normal CA; as the dilated cardiomyopathy (DCM) group.

LA dimensions, volume, active emptying fraction (ACTEF) and eccentricity index (LAEi) as well as late diastolic velocities of the mitral annulus (a′) and LA free wall (A_3) were measured.

Compared with the control group, ICM patients had larger LA volume and reduced ACTEF, a′ and A_3, with no significant difference between patients with ICM and DCM in any of these parameters. LA eccentricity was, non-significantly, higher in both cardiomyopathy groups than in the control group.

Conclusions: Patients with ICM have increased LA volume and reduced LA contractile function in comparison with normal controls. LA enlargement, LA contractile dysfunction and LA geometric changes in ICM are similar to that occurring in DCM. LA size, contractile function and eccentricity may not be reliable in differentiating ischemic from idiopathic dilated cardiomyopathy.

1. Introduction

Left atrial (LA) size and function are powerful predictors of outcome in heart failure (HF) patients with predominantly impaired systolic function, adding important clinical information, independent of any of its determinants [1–3]. In addition to its prognostic value, LA size and function have been linked to exercise capacity and hospitalizations in patients with HF [3,4]. These findings have drawn attention to the importance of LA size and function in patients with systolic heart failure.

Histological evidence of a high degree of fibrosis in the LA was found in patients with idiopathic dilated cardiomyopathy (DCM) but not in patients with old myocardial infarction despite similar degrees of left ventricular (LV) dysfunction. These findings suggested that atrial fibrosis in these patients may not have been related to mechanical overload of the left atrium but rather to LA involvement in the myopathic process [5]. These findings were further emphasized in a number of observational studies that reported LA contractile dysfunction in DCM and preservation in ischemic cardiomyopathy (ICM) [4,6,7].

LA contractile dysfunction was, however, demonstrable in patients with coronary artery disease (CAD) even when the LV systolic function was preserved and LA was not enlarged [8].

With the progression of myocardial ischemia, and as the LV systolic and diastolic functions deteriorate, poor LV-ejection fraction (EF) and the presence of severe diastolic dysfunction causing a restrictive LV-filling pattern (RFP) become the most important determinants of LA contractile function in CAD patients [9]. LA contractile function is, thus, expected to be altered in patients with ICM (where LV systolic function is impaired and severe diastolic dysfunction {RFP} is common). We conducted this study primarily to assess LA size, geometry and contractile function in patients with ICM.

2. Methods

The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the institutional review board. Sixty patients referred to Bab El-Sha'rya University Hospital for diagnostic coronary angiography (CA) and transthoracic echocardiography between May 2011 and June 2012, were enrolled. All patients provided written informed consent.

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There were 30 patients with ICM and 15 patients with DCM. ICM was defined as a reduced EF (<45%) and CA showing significant CAD proportionate with the degree of LV dysfunction (multivessel, left main or proximal left anterior descending artery stenosis), previous myocardial infarction or coronary revascularization [10]. DCM patients had an EF < 45% and normal CA.

In addition, 15 control subjects with normal EF, normal diastolic function and normal CA were included.

The exclusion criteria were: 1) atrial fibrillation; 2) conduction defects; 3) significant organic mitral or aortic valve disease and 4) a recent myocardial infarction (<1 month).

2.1. Echocardiography

All patients were imaged in the left lateral position using an Esaote My Lab 5 Gold ultrasound system. Left atrial maximum volume (LA V_{max}) was measured at LV end systole, LA minimal volume (LA V_{min}) at LV end diastole and LA volume at the onset of atrial contraction (V_p) at the onset of electrocardiographic P wave from the apical four-chamber and apical two-chamber views using the biplane area–length method (Fig. 1) [11]. LA active emptying fraction ACTEF equals the difference between Vp and Vmin, divided by Vp i.e. ACTEF = (Vp-Vmin)/Vp [12,13].

LA antero-posterior dimension (D1) was measured at end systole in the parasternal long axis view from the trailing edge of the posterior aortic wall to the leading edge of the posterior LA [11]. The superior–inferior (D2) and medio-lateral dimensions (D3) were measured in the apical four chamber view at end systole (Fig. 1). We used left atrial eccentricity index (LAEi = {2 × D2} / {D1 + D3}) to assess the changes in the LA shape [14].

Tissue Doppler velocities were measured in the apical four-chamber view at the septal side of the mitral annulus and mid-segment of LA free wall, using pulsed wave tissue Doppler. Peak velocity of septal mitral annulus at late diastole (a′) [15–17] and atrial contraction peak velocity at the mid segment of the LA lateral wall (A_3) [18,19] were measured and used as markers of LA contractility.

To measure septal a′, the sample volume was placed on the atrial side of the mitral annulus at the basal inter-atrial septum from the apical four-chamber view [12]. To measure A_3, sample volume of 4 mm was put at the mid segment of the LA lateral wall in apical four-chamber view. Special care was taken to place the sample volume away from the pulmonary vein entrance [18].

Left ventricular end-diastolic and end-systolic dimensions were measured and fractional shortening was calculated from the parasternal long axis view. Left ventricular end-diastolic and end-systolic volumes were measured and EF was calculated from the apical four-chamber and two-chamber views using modified biplane Simpson's method [11].

Mitral E-wave and A-wave velocities, E/A ratio, and E-wave deceleration time (DT) were also measured using pulsed wave Doppler with the sample volume put at the tips of the mitral valve leaflets. E-wave DT was measured as the interval in milliseconds (ms), from the peak of E-wave to an extrapolation of the deceleration to 0 m/s. Severe diastolic dysfunction/restrictive LV-filling was defined by the presence of the following criteria: E/A ratio > 2, DT < 160 ms and E/e′ > 15 [20].

Mitral regurgitation (MR) was semi-quantitatively assessed by color flow Doppler echocardiography. Four grades of regurgitant jet area were determined (1 = regurgitant jet area < 1.5 cm^2; 2 = regurgitant jet area 1.5–3 cm^2, 3 = regurgitant jet area 3–8 cm^2 and 4 = regurgitant jet area > 8 cm^2) [21].

2.2. Statistical analysis

Data are presented as the mean value ± standard deviation (SD) for continuous variables and as numbers and frequency percentages for categorical variables. Comparisons of continuous variables between groups were made using the unpaired *t* test, whereas categorical variables were compared by the Chi-square and Fisher's exact tests.

Correlation between the LA volume and ACTEF was tested by Pearson's correlation coefficient.

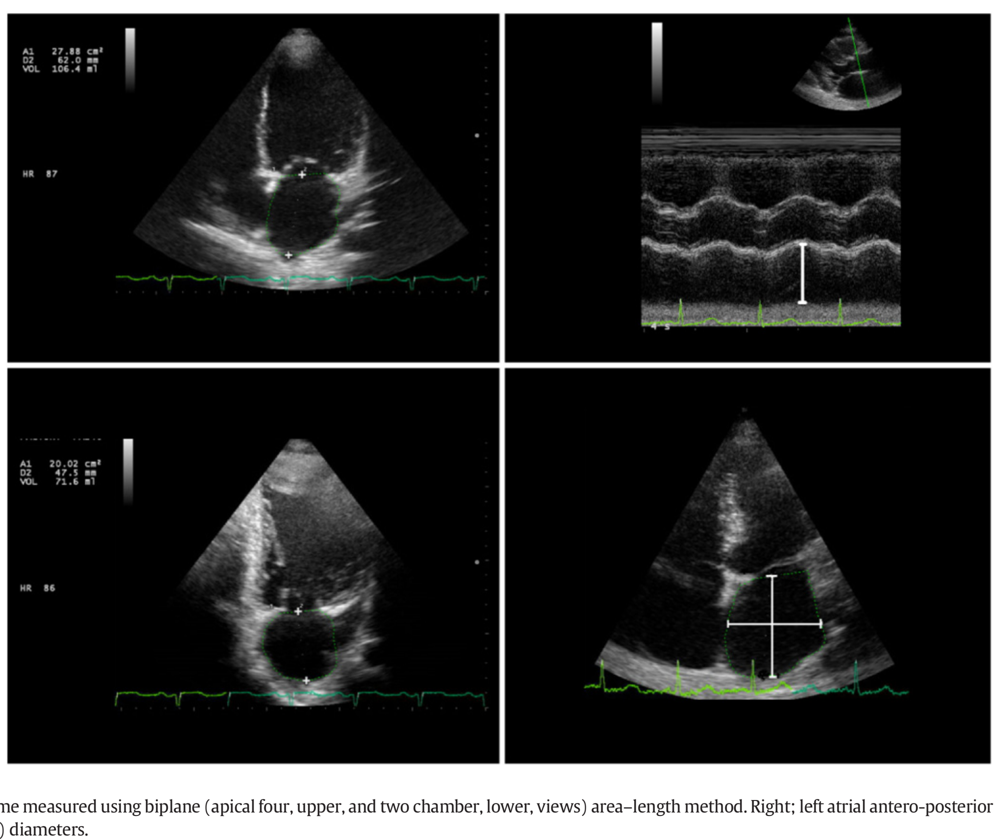

Fig. 1. Left; left atrial volume measured using biplane (apical four, upper, and two chamber, lower, views) area–length method. Right; left atrial antero-posterior (upper), superior–inferior and medio-lateral (lower) diameters.