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ORIGINAL ARTICLE

An effect of left ventricular hypertrophy on mild-to-moderate left ventricular diastolic dysfunction

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Abstract *Objectives:* Left ventricular diastolic dysfunction (LVDD) is associated with a variety of medical conditions. Left ventricular hypertrophy (LVH) is one of the most common abnormalities that induce LVDD. However, it is unclear whether LVH is a predictor of future LVDD deterioration that leads to diastolic heart failure in patients who already have mild-to-moderate LVDD. In this study, we investigated the effect of LVH on LV diastolic function in mild-to-moderate LVDD patients.

Methods: Of the patients with mild-to-moderate LVDD (Grade I and II) with preserved left ventricular ejection fraction (EF), 225 with LVH (LVH group) and 225 without LVH (non-LVH group) were consecutively selected. LVDD was defined by the abnormal patterns of Doppler mitral inflow and tissue Doppler. Left ventricular filling pressure (FP) was estimated by the following formula: $1.9 + 1.24\times$ [early mitral inflow velocity (E)/early mitral annular velocity (e')]. The Tei index was implemented to assess global (both systolic and diastolic) left ventricular function. Echocardiographic parameters for LVDD, such as isovolumic relaxation time (IVRT), were compared between the two groups.

Results: FP and Tei index were significantly higher in the LVH group compared to the non-LVH group [15.68 mmHg vs. 14.07 mmHg, $P < 0.0001$, and 0.58 vs. 0.53, $P < 0.003$, respectively]. IVRT was significantly longer in the LVH group than in the non-LVH group [103.93 $\pm$ 23.93 vs.

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95.94 ± 20.16, P < 0.0001].
Conclusions: In mild-to-moderate LVDD patients, both FP and the Tei index were significantly higher when LVH was present. This may suggest LVH as a possible predictor for the future development of severe LVDD and diastolic heart failure.

1. Introduction

Diastolic heart failure, also known as heart failure with preserved EF, is a clinical syndrome that accounts for approximately half of all heart failure patients.[1,2] Diastolic heart failure is diagnosed when there are clinical symptoms of heart failure, the presence of normal or near normal left ventricular systolic function and evidence of left ventricle diastolic dysfunction (LVDD).[2,3] LVDD is known to have strong associations with advanced age, female gender, obesity, hypertension, diabetes mellitus, and left ventricular hypertrophy (LVH).[4–7] However, it is still unclear whether all cases of LVDD are characteristically the same among different aetiologies. Because the prevalence of heart failure is increasing by approximately 1% annually,[1,8] understanding the pathophysiology of LVDD is important for identifying the high-risk group.

LVH is known to be the most common pathological condition that induces LVDD, and it is associated with worsened cardiovascular prognosis.[6,8,9] However, to date, there has been no direct comparison of the LVDD characteristics between patients with LVH and those without. We hypothesized that mild-to-moderate LVDD with LVH carries a higher risk of developing severe LVDD and diastolic heart failure than LVDD without LVH. In this context, we studied two LVDD groups, a mild-to-moderate LVDD with LVH group (the LVH group) and a mild-to-moderate LVDD without LVH group (the non-LVH group), to determine the echocardiographic differences between the groups. We compared the patient demographics and the echocardiographic characteristics, including left ventricular filling pressure (FP) and the Tei index (also known as myocardial performance index) between the two groups.

2. Methods

2.1. Data collection

The study was reviewed and approved by the Internal Review Board. A total of 450 patients with an echocardiographic diagnosis of LVDD (225 patients with LVH and 225 patients without LVH) were consecutively selected from our echocardiography database.

2.2. Patient demographic profiles

Demographic profiles, laboratory values, medications, and medical histories were obtained from the electronic health records. Hypertension is defined as a history of hypertension requiring the current use of anti-hypertensive medications. The blood pressure values in the study were obtained from the echocardiogram. Coronary artery disease (CAD) was defined as a history of a stress test that was positive for ischemia, the presence of coronary flow-limiting stenosis by coronary angiogram, and/or a history of coronary revascularization. Chronic obstructive pulmonary disease (COPD) was a clinical diagnosis with/without pulmonary function testing. Diabetes mellitus was defined according to the American Diabetes Association guidelines.[10] Valvular heart disease was defined as the presence of moderate to severe mitral, aortic, or tricuspid valvular disease, or a history of valve repair/replacement.[11]

2.3. Exclusion criteria

Patients with atrial fibrillation, tachycardia, or myocardial infarction within the last six months, hypertrophic cardiomyopathy, and valvular heart diseases were excluded because the conventional echocardiographic parameters are known to have weak to no correlation with FP.[12–14] Patients with EF less than 50% were excluded to eliminate the effect of LV systolic dysfunction on FP.

2.4. 2D and Doppler echocardiography

All echocardiograms were performed by certified technicians, and the results were stored digitally in the echocardiogram database. EF was measured by the quantitative 2-dimensional biplane volumetric Simpson method from the 4- and the 2-chamber views[15] by the following equation: 100 X (end diastolic volume − end systolic volume)/end diastolic volume. The parameters for left ventricle mass, left atrial volume and left ventricle internal diameter in diastole obtained from the chamber quantification was indexed for the body surface area. To assess the diastolic parameters, the mitral inflow and the mitral annular motion velocity were measured by the Doppler studies. The following were also assessed: peak early diastolic velocity (E); the deceleration time from the peak of the early diastolic wave to baseline (DT); the peak atrial systolic velocity (A); the E/A ratio; the isovolumic contraction time (IVCT) from the mitral valve closure to the aortic valve opening; the ejection time (ET) from the aortic valve opening to closure; and the isovolumic relaxation time (IVRT) from the aortic valve closure to the mitral valve opening. The mitral annular motion velocity was recorded at the medial mitral annulus site in the apical 4-chamber view by the pulsed tissue Doppler echocardiography (the tissue Doppler). The peak early diastolic motion velocity (e'), the peak motion velocity during atrial systole (a′), and