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ORIGINAL ARTICLE

Left Ventricular Diastolic Function Assessment Using Time Differences Between Mitral Annular Velocities and Transmitral Inflow Velocities in Patients with Heart Failure

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Background Evaluation of left ventricular (LV) diastolic function is important in clinical echocardiography. The relationship between mitral annular velocities and transmitral inflow velocities provide additional information about LV filling and diastolic function. This study evaluates the relationships of time intervals between peaks E of mitral inflow velocities and E′ of mitral annular velocities, and peaks A and A′ in patients with heart failure (HF).

Methods Eighty patients with HF and 50 age- and gender-matched normal healthy subjects were prospectively recruited and underwent full echocardiograms. The following time intervals were measured: (1) from the onset of R-wave on the ECG to the peak of E-wave on the transmitral flow (TMF) (R-pE); (2) from R to peak of E′-wave on the LV lateral wall of tissue Doppler imaging (TDI) (R-pE′); (3) from onset of P-wave to peak of A-wave on the TMF (P-pA); and (4) from onset of P-wave to peak of A′-wave (P-pA′) of TDI. Early-diastolic temporal discordance (EDTD) and late-diastolic temporal discordance (LDTD) were calculated as the difference between the time intervals (R-E) and (R-E′), (P-pA) and (P-p A′).

Results EDTD significantly decreased in patients with HF compared with normal subjects (18.0 ± 54.1 ms vs. 28.0 ± 33.5 ms, $P < 0.05$). There was also a significant decrease in LDTD in HF patients compared with normal subjects (19.6 ± 23.5 ms vs. 34.8 ± 20.6; $P < 0.05$).

Conclusions EDTD and LDTD decreased in patients with heart failure, and they may be useful tools in identifying abnormal LV relaxation and left atrial contraction for LV diastolic function.

Keywords LV relaxation • Heart failure • Pulsed tissue Doppler imaging • Time interval • Temporal discordance

Introduction

Evaluation of left ventricular (LV) diastolic function plays an important role in clinical echocardiography, especially in diagnosis of heart failure (HF). Non-invasive echocardiography has been the modality for the assessment of LV relaxation and filling pressure [1]. Trans-mitral flow (TMF) velocities (early (E) and late (A) diastolic velocities as well

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as its E/A ratio), pulmonary venous reversal flow velocity (Ar), isovolumic relaxation time (IVRT), flow propagation velocity (Vp) and myocardial velocities from tissue Doppler imaging (TDI) (early (E′) and late (A′) diastolic myocardial velocities) are commonly used to assess LV diastolic function. The resultant E/E′ ratio and E/Vp ratio have been used to estimate left atrium (LA), and hence LV-filling pressure [1]. Furthermore, some studies found that E′ was a potential marker of LV recoil [2–4]. Recently, some investigators proposed a new method for assessment LV diastolic function in terms of the time difference between mitral annulus motion via TDI and TMF velocities [2,5,6]. Early-diastolic temporal discordance (EDTD) was defined as the time difference between peaks E and E′. Likewise, late-diastolic temporal discordance (LDTD) was defined as the time difference between peaks A and A′.

Peak Ar has previously been shown to coincide with the peaks of longitudinal motion of the mitral annulus A′ in late diastole [7], so A′ can be used instead of Ar if Ar cannot be traced clearly. This study aims to evaluate the time intervals between mitral inflow velocity E and mitral annulus velocity E′, and mitral inflow velocity A and mitral annulus velocity A′ in patients with heart failure.

Methods

Subjects

A total of 80 patients with heart failure (both left ventricular ejection fraction <50% and preserved left ventricular ejection fraction) (mean age: 60.7 ± 9.7 years) and 50 age- and gender-matched healthy volunteers (mean age 59.1 ± 10.2 years) were prospectively recruited in this study. Patients with more than mildly aortic and/or mitral valve stenosis and/or regurgitation, with atrial fibrillation and received cardiac device (ICD, CRT or pacemaker implantation) treatment were excluded. The hospital ethics committee approved the study. All subjects gave informed written consent.

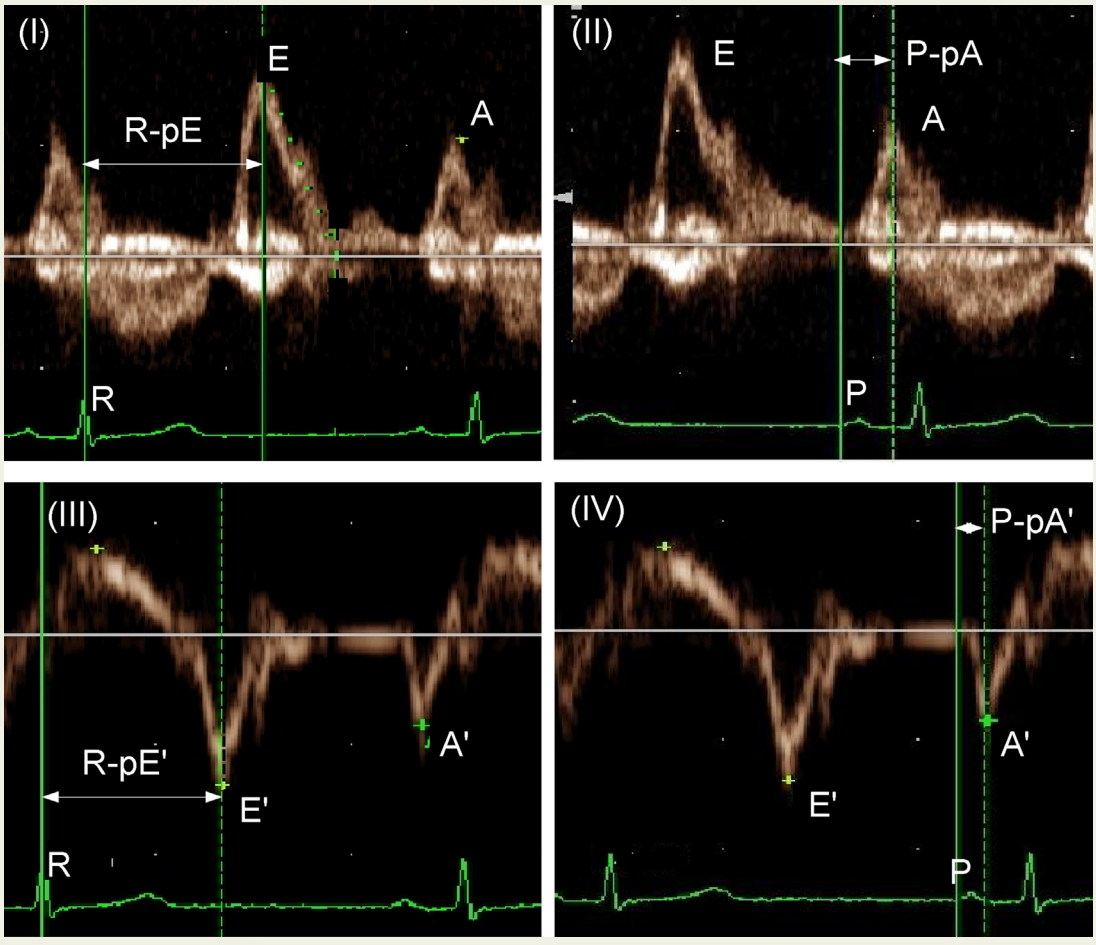

Figure 1 Transmitral pulsed wave echo-Doppler tracings and tissue Doppler imaging at the left ventricular septal wall in a normal case. (I) R-wave on ECG to the peak E for transmitral flow velocity (R-pE: 505 ms); (II) onset of P-wave on ECG to the peak A for transmitral flow velocity (P-pA: 132 ms); (III) R-wave on ECG to the peak E′ for mitral annulus velocity (R-pE′: 463 ms); (IV) onset of P-wave on ECG to the peak A′ for mitral annulus velocity (P-pA′: 72 ms). The resultant EDTD and LDTD are 49.80 ms and 60.24 ms, after adjusting RR interval.