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Cardiac resynchronization therapy guided by tissue Doppler.

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Abstract

The aim of this study was to observe the effect of tissue Doppler on cardiac resynchronization therapy (CRT) in patients with chronic congestive heart failure (CHF). CRT was guided by tissue Doppler. Patients with CHF were studied by using tissue Doppler before and after resynchronization. The target vein was determined according to the latest systolic area identified via pre-implant tissue Doppler. After implantation, atrioventricular and interventricular intervals were optimized with the aid of tissue Doppler. Six months after CRT, a significant reduction in left ventricular end-diastolic dimension (6.89 ± 0.38 cm versus 6.45 ± 0.79 cm) and a significant increase in left ventricular ejection fraction (29% ± 2.19% versus 44.8% ± 8.47%) were observed. Simultaneously, intra-ventricular and inter-ventricular asynchrony indexes were significantly reduced. CRT guided by tissue Doppler can result in beneficial therapeutic effects.

Keywords: Cardiac resynchronization therapy, Tissue Doppler, Heart failure.

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Introduction

Nowadays, chronic congestive heart failure (CHF) remains a challenge despite significant progress in drug therapy. Cardiac resynchronization therapy (CRT) has revolutionized CHF treatment as a result of improved cardiac function based on optimal drug therapy [1, 2]. However, approximately 18% to 32% of patients who have undergone CRT do not experience positive curative effects [3, 4]. Recent studies have suggested that ventricular mechanical resynchronization is the key point to positive curative effects [4-6], although several controversies exist [7, 8]. We conducted the present study to observe the effects of CRT guided by tissue Doppler.

Subjects and Methods

Subjects

Twelve patients with definite ventricular asynchrony were selected to receive CRT between October 2004 and June 2006. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Nanjing Drum Tower Hospital. Written informed consent was obtained from all participants. The sample was composed of 10 males and 2 females. Four patients had ischemic cardiomyopathy as background disease, whereas the others had non-ischemic cardiomyopathy. The heart rhythms of all patients were characterized as sinus rhythm. Follow-ups continued for 6 months to 12 months.

Echocardiography Examination

All patients underwent routine echocardiography and tissue Doppler examinations before and after CRT. Left ventricular end-diastolic dimension (LVED), left ventricular ejection fraction (LVEF), mitral regurgitation, and systolic asynchrony indexes were measured. Systolic asynchrony indexes included inter-ventricular mechanical delay, standard deviation of time-to-peak velocities in 12 segments (Ts-SD), and septal-to-posterior wall motion delay (SPWMD). Inter-ventricular mechanical delay was defined as the difference between the time from the beginning of QRS to pulmonary blood flow and the time from the beginning of QRS to aortic blood flow.

Biventricular Pacemaker Implantation

The left subclavian vein was punctured. The right atrial lead was positioned at the anterior wall of the right atrium and the right ventricular lead was positioned at the right ventricular apex. The target vein of the left ventricular lead was determined according to the latest systolic area identified via pre-implant tissue Doppler and intra-implant coronary vein radiography. After implantation, atrioventricular (AV) and interventricular (VV) intervals were optimized under tissue Doppler guidance.

Statistical Analysis

Data was expressed by mean and standard deviation. The paired *t* test was used to compare the parameters before and

Table 1: *Comparison of parameters before and after 6 months of CRT implantation*

	LVED (cm)	EF (%)	Ts-SD (ms)	IVMD (ms)	SPWMD (ms)	QRS (ms)
Pre-CRT	6.89 ± 0.38	29 ± 2.19	50.86 ± 4.1	61.67 ± 28.6	78.3 ± 32.5	160.6 ± 10.1
6 months Post-CRT	6.45 ± 0.79	44.8 ± 8.4	28 ± 16.7	26.67 ± 10.3	36.6 ± 21.6	147.5 ± 8.8
P	0.03	0.01	0.04	0.01	0.03	0.01

after pacemaker implantation. $P<0.05$ indicated statistical significance.

Results

Biventricular pacemakers were successfully implanted in all 12 patients. Nine patients were New York Heart Association cardiac function Class III, whereas three patients were Class IV. All patients exhibited definite ventricular electrical asynchrony and mechanical asynchrony at baseline, as shown in Table 1.

Pre-implant tissue Doppler showed that the latest left ventricular systolic region was the lateral wall or the latero-posterior wall in each patient. All patients had their left ventricular leads positioned at the latero-posterior vein of the left ventricle.

Six months after CRT, a significant reduction in LVED (6.89 ± 0.38 cm versus 6.45 ± 0.79 cm) was observed, as well as a significant increase in LVEF (29% ± 2.19% versus 44.8% ± 8.47%). Simultaneously, the intra-ventricular and inter-ventricular asynchrony indexes were significantly reduced, as shown in Table 1.

Discussion

In this study, we found that CRT guided by tissue Doppler results in positive therapeutic effects, thus indicating that tissue Doppler is a useful tool for improving CRT. Our findings are consistent with the literature.

Two studies have shown that only indicators of ventricular mechanical asynchrony at baseline exhibit obvious differences between CRT response and CRT non-response groups, whereas QRS duration, LVEF, LVED, and severity of mitral regurgitation exhibit no distinct differences [5, 6]. Baseline SPWMD was found to predict left ventricular reverse remodeling, and SPWMD >130 ms was found to predict CRT response [4].

Several published studies have reported pre-implant Ts-SD as a sound predictor of CRT response [9-12]. Yu et al. [10] even found Ts-SD to be the most powerful predictor of left ventricular reverse remodeling compared with other asynchrony indicators.

In addition, the left ventricular pacing site is considered as a crucial factor for successful CRT [13-15]. Ansalone et al. [14] demonstrated that left ventricular lead placement at the most delayed segment using tissue Doppler resulted in the greatest immediate improvement from CRT. Murphy et al. [15] demonstrated that patients on CRT whose left ventricular lead was concordant with the latest activation site by tissue strain imaging exhibited greater improvement in left ventricular function and reverse remodeling than those with discordant positioning. The latest results of "Stroke: A Randomized Trial of Exercise or Relaxation" (STARTER, for short) [16] further demonstrated that the strategy of echocardiography-guided left ventricular lead placement for CRT improves patient outcomes by reducing the combined risk of death or heart failure hospitalization.

Post-implant optimization of CRT is also important. At present, no gold standard method exists for AV and VV optimization. Enhancing ventricular mechanical synchronicity with the aid of tissue Doppler is feasible and effective. Sogaard et al. [17] showed for the first time that VV optimization performed with tissue tracking imaging yields additional benefits in left ventricular systolic function. Novak et al. [18] reported that inter-ventricular synchrony optimization via strain rate imaging is associated with increased cardiac output.

In conclusion, tissue Doppler-assisted CRT can yield satisfying therapeutic effects. The underlying mechanism is minimization of ventricular mechanical asynchrony. This result is supported by most published studies. The disappointing results of the Predictors of Response to CRT (PROSPECT, for short) trial may be attributed primarily to excessively large inter-operator variations.

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