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Diagnosis of constrictive pericarditis by quantitative tissue Doppler imaging

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Abstract

Objectives: To observe the motion of pericardium and myocardium in patients with constrictive pericarditis (CP) and normal subjects using two-dimensional (2D) echocardiography and quantitative tissue Doppler imaging (QTDI), and to investigate the value of this echocardiographic approach in the diagnosis of pericardial adhesion in CP.
Background: The relationship of the motion of pericardium and myocardium in CP has not been investigated by QTDI.
Methods: The motions of pericardium and myocardium and the difference between them were investigated using 2D echocardiography combined with QTDI technique in 20 patients with CP and 20 age- and sex-matched normal subjects. Systolic peak displacements of pericardium (D_1), outer-layer myocardium (D_2) and inner-layer myocardium (D_3) were measured from quantitative tissue displacement curves. The ratios of $(D_3–D_2)/(D_2–D_1)$ were then calculated.
Results: In normal subjects, the motion of myocardium was found to be stronger than that of pericardium, but the motions of outer-layer and inner-layer myocardium were virtually identical. However, in patients with CP, the motion of outer-layer myocardium was significantly reduced approaching that of pericardium, while the motion of inner-layer myocardium was stronger than that of outer-layer myocardium. The ratios of $(D_3–D_2)/(D_2–D_1)$ were significantly higher in patients with CP than those in normal subjects (5.0 ± 4.7 vs 0.6 ± 0.7, $P<0.05$).
Conclusions: Obvious differences exist in the motion of pericardium and myocardium between normal subjects and patients with CP; observations of these differences using 2D echocardiography and QTDI provide a new and sensitive method in the diagnosis of pericardial adhesion in CP.

Keywords: Constrictive pericarditis; Myocardium; Pericardial adhesion; Pericardium; Quantitative tissue Doppler imaging, Restrictive cardiomyopathy

Diagnosis of constrictive pericarditis (CP) is clinically important but often challenging. Adhesion of visceral and parietal pericardium, which is the most important pathological finding in patients with CP, will lead to diminution of relative motion between pericardium and myocardium. In our study, we observed the motion of pericardium and myocardium using two-dimensional (2D) echocardiography in patients with CP, and systolic displacement of pericardium and myocardium were analyzed quantitatively using quantitative tissue Doppler imaging (QTDI). Our findings provide a new and sensitive in vivo method of diagnosing pericardial adhesion in CP.

1. Methods

1.1. Study group

Between April 2006 and February 2008, 20 patients (11 males, 9 females, with a mean age of 35 years) with

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Table 1
Echocardiographic features of normal subjects and patients with CP.

Variable	Normal subjects (n=20)	Patients with CP (n=20)
LA (mm)	32.0±2.3	43.2±4.8*
LVEDD (mm)	45.1±3.1	37.8±4.0*
IVSD (mm)	8.7±5.4	8.1±7.5
PWD (mm)	8.4±4.2	8.3±9.5
LVEF	65.2±4.2%	61.3±4.9%
Respiratory variation E	7.3±2.1%	30.6±10.2%*
Ea (cm/s)	9.7±2.2	13.2±4.5*

LA: left atrium; LVEDD: left ventricular end-diastolic diameter; IVSD: interventricular septal diameter; PWD: posterior wall diameter; LVEF: left ventricular ejection fraction.
Ea: E peak of mitral annulus.
*P<0.05.

typical clinical and echocardiographic features of, and surgically confirmed, CP and 20 age- and sex-matched normal subjects (11 males, 9 females, with a mean age of 33 years) were included in this study. The underlying causes of CP were tuberculosis in 10 patients, post-operative in 2, and unknown in the remaining 8. All patients were in sinus rhythm. The study protocol conformed to the Declaration of Helsinki and was approved by our institution's ethics committee. The objective of the examination was explained to, and informed consent was obtained from, all these patients and healthy volunteers.

1.2. Echocardiographic examination

All the subjects underwent comprehensive echocardiographic examination including M-mode, 2D, pulse wave Doppler echocardiography, tissue Doppler imaging (TDI) and QTDI analysis using a GE Vivid 7 or GE Vivid Dimension Ultrasound System, equipped with QTDI capabilities, and a 2–4 MHz transducer. The patients were studied at rest in the left lateral decubitus position. After routine M-mode and 2D measurements, pulsed wave Doppler study of mitral inflow velocity was performed simultaneously with the respiratory cycle. The first cardiac cycle in which filling and ejection occurred in their entirety during a particular respiratory phase (either inspiration or expiration) was analyzed. Then a 4- to 6-mm sampling gate was placed at the lateral margin of the mitral anulus, and the peak velocities of systolic (Sa) and early diastolic (Ea) were measured.

After routine echocardiography was completed, the motions of pericardium and myocardium of posterior and inferior walls were observed from apical left heart 2-chamber and 3-chamber views, with longitudinal axis of posterior and inferior wall parallel with the ultrasonic beam. Raw data of 2D and tissue Doppler images of 3 continuous cardiac cycles were stored in magneto-optical disk for post processing.

Using QTDI analysis software on above 2-chamber and 3-chamber views, we placed a sample gate in the parietal pericardium (henceforth called pericardium in this study), outer-layer myocardium (adjacent to visceral pericardium, that is, epicardium) and inner-layer myocardium (adjacent to endocardium), respectively, at basal segment of posterior and inferior wall (1~2 cm distal to the mitral anulus), the size of the sample at each; three sampling gates were at the same level, and were adjusted semi-automatically in accordance with the cardiac cycle. Tissue displacement curves were then acquired, and peak systolic displacements of pericardium (D_1), outer-layer myocardium (D_2) and inner-layer myocardium (D_3) were measured; the data from the two views above were averaged. To assess interobserver variability of displacement measurements, echocardiographic data from a randomly selected

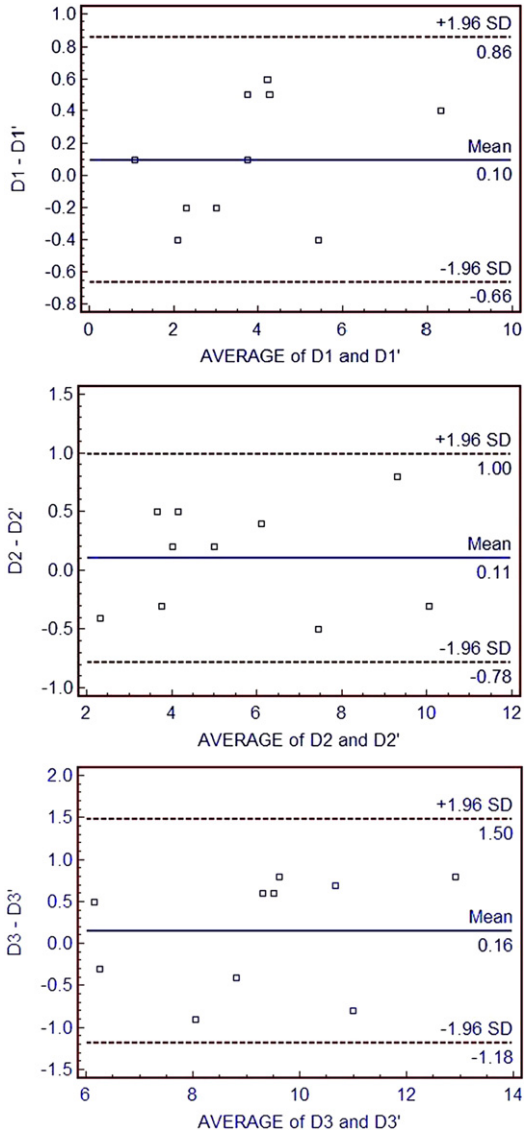

Fig. 1. Bland–Altman graph comparing interobserver measurements of D_1, D_2 and D_3.