Longitudinal, Radial, and Circumferential Myocardial Velocities in Patients with Ventricular Dyssynchrony

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Introduction: Tissue Doppler imaging (TDI) has been proposed as a tool to detect ventricular dyssynchrony and to predict which patients will respond to Cardiac Resynchronization Therapy (CRT). However, several characteristics of TDI limit its ability to evaluate dyssynchrony, including difficulty evaluating radial velocities, inability to obtain adequate windows in some patients, and low reproducibility. Measurement of myocardial tissue velocity by magnetic resonance (MR) phase velocity mapping could potentially overcome some of these limitations.

Purpose: The purpose of this study was to examine three-dimensional myocardial tissue velocity in both normal volunteers and patients with ventricular dyssynchrony scheduled for CRT.

Methods: 28 patients with ventricular dyssynchrony (age= 64 +/-15) scheduled for CRT and 17 normal volunteers (age= 28 +/-7) participated in this study. MRI scans were performed on a Philips Medical Systems 1.5T Intera CV MRI scanner. A segmented, navigator-echo and ECG-gated sequence was used to acquire three-directional myocardial velocity from a mid-basal short axis slice. Navigator-echo gating allowed velocity data to be acquired at high spatial (1.36 x 1.36 x 8mm) and temporal resolution (35msec). Interleaved acquisition ensured that all velocity directions (x,y,z) were properly registered for postprocessing. Regions of interest (8 x 8 mm) were selected in the septal, lateral, anterior and inferior walls of the left ventricle. Values of velocity vs. time in these regions were exported to a spreadsheet for analysis.

The acquired velocities were converted into radial velocity (positive toward the center of the LV blood pool), longitudinal velocity (positive toward the apex), and circumferential velocity (positive for clockwise rotation when viewed from the apex). Peak systolic and diastolic velocities, as well as the *time to peak* systolic and diastolic velocities were computed for all subjects. Normal and patient values were compared using a two-tailed t-test, with p-values < 0.005 considered statistically significant (denoted as *).

Results: Both peak radial and longitudinal velocities were greater in the normal volunteers than the dyssynchrony patients, both during systole and diastole. No significant differences were observed in the magnitude of peak circumferential velocity between the normal volunteers and the dsysynchrony patients, either during systole or diastole, Table 1.

A significant delay in *time to peak* systolic velocity was observed in the ***lateral*** wall of dyssynchrony patients, Figure 1. This delay was seen in both the longitudinal and radial directions, but not in the circumferential direction. No significant differences in time to peak systolic velocity were observed in any of the other walls. Since the majority of the dyssynchrony patients had left bundle branch block, a delay in peak velocity is expected in the lateral wall.

The reason for the lack of significance in circumferential velocity may due to the location of the velocity measurement slice, as circumferential velocity varies greatly along the long axis of the LV.

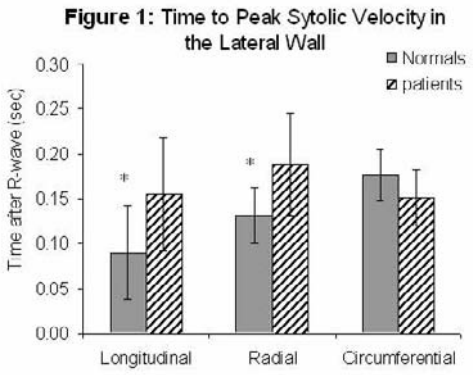

Table 1: Peak Systolic and Diastolic Velocities

	Longitudinal Velocity (cm/s)		***Radial Velocity (cm/s)***		***Circumferential Velocity (cm/s)***	
	Systole	**Diastole**	**Systole**	**Diastole**	**Systole**	**Diastole**
Normals	8.7+/-2.8	-15.9+/-4.1	5.4+/-1.9	-8.2+/-3.0	4.3+/- 1.6	-4.8+/-2.3
Patients	5.1+/-1.9	-5.8+/-3.1	4.1+/-1.7	-5.8+/-3.0	4.2+/-1.8	-4.9+/-2.1
	p<0.001	p<0.001	p<0.001	P<0.001	p=NS	p=NS

Conclusions: Peak radial and longitudinal myocardial velocities were greater in magnitude in the normal volunteers than the dyssynchrony patients. No significant difference was observed in the magnitude of peak circumferential velocity. A significant delay in *time to peak* systolic contraction velocity was observed in the ***lateral*** wall of dsyssynchrony patients. This preliminary study indicates that 3-directional MR PVM may provide a new method to detect regional ventricular dyssynchrony.