Myocardial Tissue Velocity Measured by MR Phase Velocity Mapping and Tissue Doppler Imaging (TDI)

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Introduction: Ventricular dyssynchrony is a condition where sections of the ventricular myocardial wall contract in a uncoordinated manner. This dyssychronous contraction reduces ejection fraction, increases mitral regurgitation, and accelerates heart failure. Patients are diagnosed with dyssynchrony based on a prolonged QRS duration on a surface electrocardiogram or by velocity and timing parameters obtained from Tissue Doppler imaging (TDI). TDI is an echocardiographic method that can measure longitudinal (apex-to-base) velocity of the myocardial wall. We hypothesized that MR phase velocity mapping could measure myocardial wall velocities and that MR velocity values would be similar to those obtained with TDI.

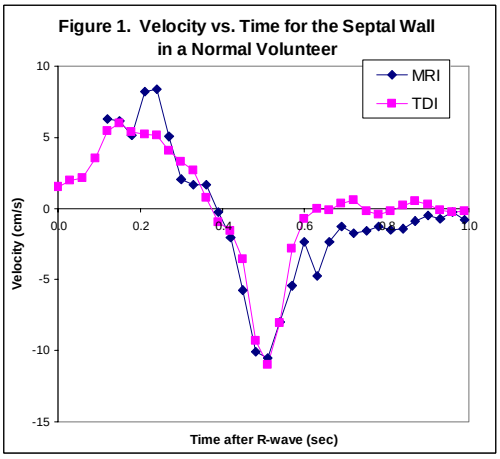
Purpose: The purpose of this study is to compare longitudinal myocardial tissue velocity measured by TDI and MR phase velocity mapping in normal volunteers and patients diagnosed with ventricular dyssynchrony.

Methods: Ten normal volunteers (ages 28.6+/-7.72) and ten patients (ages 61.8+/-15.63) diagnosed with asynchrony (QRS >120 msec and LVEF < 35%) participated in the study. Longitudinal (apex-to-base) velocities in the septal and lateral myocardial walls were examined in the 4-chamber view by digital color-coded TDI using a General Electric Vivid 7 system. Regions of interest (8 x 8 mm) were placed in the myocardial wall at 70% of the distance from apex to base. TDI velocities were corrected for the angle between longitudinal movement and the Doppler beam. Values for longitudinal velocity versus time were digitized and exported to a spreadsheet.

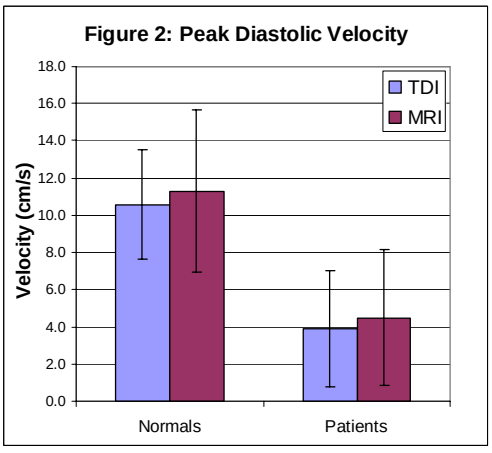
MRI scans were done the same day as the TDI in both normal volunteers and patients. Scans were performed on a Philips Medical Systems Intera CV MRI scanner. MR phase velocity maps were acquired in the short axis orientation with the slice positioned at 70% of the distance from the apex to base. A segmented, navigator-echo and ECG-gated sequence was used to acquire velocity in the thru-plane (apex-to-base) direction. In-plane resolution was 1.1 to 1.4 mm, slice thickness was 8 mm, and the VENC value was 20cm/sec. Presaturation slabs were used on each slide of the slice to eliminate signal from fast flowing blood, which has a large phase shift.

Background phase offset in the MR phase velocity maps was corrected off-line using an in-house MATLAB program. Regions of interest (8 x 8 mm) corresponding to the locations measured by TDI were selected in the septal and lateral walls. Values of longitudinal velocity vs. time were exported to a spreadsheet. Longitudinal velocity vs. time was plotted for the septal and lateral walls for both TDI and MRI, and the velocity values were compared at 30 msec intervals for each subject using a linear regression analysis. In addition, peak diastolic relaxation velocity (a potential marker for dyssynchrony) measured by TDI and MRI was compared using a two-tailed t-test.

Results: There was excellent agreement between the TDI and MRI. Figure 1 shows an example of a longitudinal velocity versus time curve for the septal wall of one of the volunteers. In normal volunteers, longitudinal velocities in the septal and lateral walls measured by TDI correlated well with MRI (r=0.924 in lateral wall, r=0.824 in the septal wall). For the patients, longitudinal velocity values measured by TDI also correlated well with MRI (r=0.750 in the lateral wall, r=0.776 in the septal wall).



Peak diastolic velocities measured by TDI and MRI in normal volunteers were similar (10.6+/-2.9 cm/sec for TDI vs. 11.3+/-4.4 cm/sec for MRI, p=NS). In patients, peak diastolic velocities were 3.7 +/- 3.1 cm/sec by TDI, and 4.5 +/- 3.7 cm/sec by MRI, p=NS (Figure 2).



Conclusions: MR phase velocity mapping correlates well with TDI for the measurement of longitudinal myocardial tissue velocity in both normal subjects and patients with dyssynchrony. Further study with more patients is warranted to examine the ability of MR to evaluate and diagnose dyssynchrony, particularly taking advantage of three-dimensional velocity measurements MRI can provide.