

Comparison of Myocardial Velocities Obtained with Magnetic Resonance Phase Velocity Mapping and Tissue Doppler Imaging in Normal Subjects and Patients with Left Ventricular Dyssynchrony

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Introduction: Patients are diagnosed with ventricular dyssynchrony based on prolonged QRS duration on a surface electrocardiogram or by velocity and timing parameters from Tissue Doppler imaging (TDI). TDI is an echocardiographic method that measures longitudinal (apex-to-base) velocity of the myocardial wall. Magnetic Resonance Phase Velocity Mapping (MR PVM) can also measure myocardial wall velocities and has some potential advantages over TDI, including the ability to measure three velocity directions throughout the myocardium. However, MR PVM has not been evaluated in dyssynchrony patients, has not been rigorously compared to TDI, and the repeatability of both techniques has not been evaluated in the same set of subjects.

Purpose: The purpose of this study is to compare measurements of longitudinal myocardial velocities by MR PVM and TDI in normal volunteers and patients with ventricular dyssynchrony, and to assess the repeatability of both techniques in normal volunteers.

Methods: Ten normal volunteers (age 28.6±7.72) and ten patients (age 61.8±15.63) diagnosed with dyssynchrony (QRS >120 msec and LVEF < 35%) participated in the study. 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 (8x8 mm) were placed in the myocardial wall at 70% of the distance from apex to base. Values of velocity vs. time were digitized and exported to a spreadsheet.

MRI scans were performed on a 1.5T Philips Medical Systems Intera CV MRI scanner on the same day as TDI. A segmented, navigator-echo and ECG-gated sequence acquired velocity in the thru-plane (apex-to-base) direction on a short axis slice positioned at 70% of total LV length. Regions of interest (8x8 mm) corresponding to the locations measured by TDI were selected in the septal and lateral walls. Both the TDI and MR PVM imaging protocol was repeated on a subsequent day in normal subjects to assess reproducibility.

MR-TDI velocity values were compared using a linear regression analysis. Peak velocities (systolic and diastolic) measured by TDI and MRI were compared using a two-tailed t-test. Agreement between MR PVM and TDI was assessed using Bland-Altman analysis. Reproducibility of MR and TDI data was calculated by comparing peak velocities and time to peak velocities between repeated scans by the coefficient of variation (CV=standard deviation of repeated measurements divided by their mean).

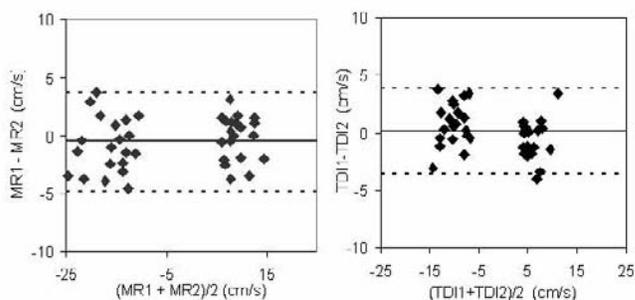
Results: Velocities measured with MR PVM correlated well with velocities measured by TDI in both normal subjects and dyssynchrony patients (r=0.86). The correlation coefficient was greater for normal subjects (0.88 in the septal wall, 0.88 in the lateral wall) than for dyssynchrony patients (0.78 in the septal wall, 0.72 in the lateral wall), possibly due to the lower wall velocities in patients (Figure 1). The magnitude of myocardial velocities was consistently greater when measured with MR PVM than with TDI.

Excellent reproducibility was observed in repeated MR PVM and TDI measurements. The coefficient of variation (CV) between repeated measurements of peak velocity was 11.0 % for MR and 13.1 % for TDI, p=NS. Bland-Altman analysis showed a mean difference of 0.12±1.9 cm/s for repeated TDI measurements and -0.51±2.1 cm/s for repeated MRI measurements, Figure 2. The CV for repeated time to peak velocity measurements was 5.7 % by MR and 9.1 % by TDI, p=NS.

Conclusions: MR and TDI correlate strongly in measuring myocardial tissue velocity and time to peak velocity in both normal subjects and patients with dyssynchrony. Reproducibility was comparable for MR PVM and TDI for measuring both peak longitudinal myocardial tissue velocity

and time to peak velocity. MR may provide an alternative method for detecting cardiac dyssynchrony.

Figure 1: Example of TDI (triangles) and MR PVM (squares) velocities measured in the septal ROI for a normal volunteer (left) and a dyssynchrony patient (right). There is high correlation between the curves (r=0.926 for the normal volunteer, r=0.910 for the



dyssynchrony patient), but peak systolic and diastolic velocities are higher in magnitude when measured by MR

Figure 2: Bland-Altman plots illustrating the reproducibility to peak velocities for MR (left) and TDI (right). The solid line denotes the average difference, and the dashed lines denote ± 2 standard deviations

