Non-invasive, platform-independent quantitative analysis of mechanical dyssynchrony for cardiac resynchronization therapy

Hiroshi Ashikaga, Peter Kellman, Steven R. Mickelsen, Elliot R. McVeigh

From the Laboratory of Cardiac Energetics, National Heart, Lung and Blood Institute, National Institutes of Health, Bethesda, Maryland 20892

Cardiac resynchronization therapy (CRT) improves cardiac function in heart failure with mechanical dyssynchrony. To select potential candidates who would truly benefit from CRT, it is critical to quantify mechanical dyssynchrony. We have developed a non-invasive, platform-independent method to quantitatively assess mechanical dyssynchrony. Under general anesthesia, we induced LV mechanical dyssynchony in a normal adult canine by pacing the RV apex at 120 bpm. LV short axis cine images from the LV apex to base were acquired in a 1.5-T MR scanner using a cine true FISP sequence. Endocardial and epicardial contours were manually segmented, and the LV circumference was divided into 24 sectors. At each sector, periodic change of wall thickness over time was decomposed into a sine curve using discrete Fourier transformation to extract phase information (Figure 1). The mechanical activation time was calculated as the beginning of wall thickening by unwrapping the phase into time based on the heart rate. Mechanical activation time was color-coded in each sector as a bull's eye plot in 4 slices from apex to base (Figure 2). Activation began in the septal sectors (dark colors) where the pacing catheter was, and traveled across the LV toward the lateral wall (light colors). The time from the earliest activation to the latest activation ranged approximately 100msec, which is consistent with the data from tagged MRI. We conclude that this technique provides a simple and noninvasive method to quantify mechanical dyssynchrony in all regions of the LV to evaluate candidates for CRT. This method is potentially applicable to other imaging modalities such as echo and CT.
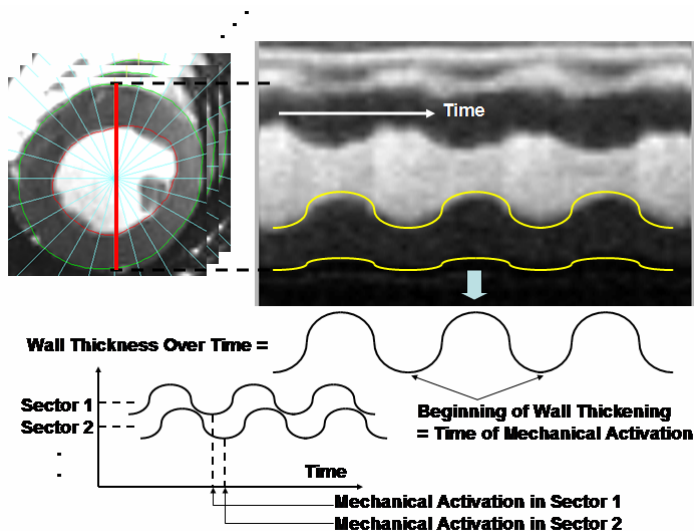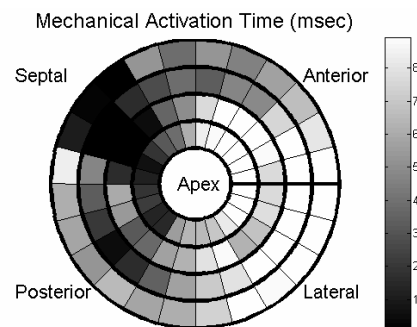
Figure 1

Figure 2