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Title: Real-time Myocardial Function during Arrhythmia

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Introduction:

It has been previously shown with tagged MRI that mechanical asynchrony during ventricular contraction tracks with electrical asynchrony of activation. Unfortunately, to date, patients with non-periodic ventricular arrhythmia have not been studied with these techniques due to the need for reproducible heartbeats during the segmented data acquisition. In this study, we demonstrate the ability of real-time MRI SSFP acquisition with TSENSE to quantify regional function in the heart with non-periodic ventricular arrhythmia. This technique may provide a method to measure the spatial pattern of the underlying asynchrony of activation, where high resolution electrical mapping is unavailable.

Purpose:

To demonstrate ability to quantify regional wall function by generating a time series of wall thickening during non-periodic ventricular arrhythmia.

Methods:

Six dogs underwent MR studies 4 weeks after antero-septal myocardial infarction (MI) by proximal LAD occlusion. MI location and geometry were evaluated with a high-resolution late enhancement inversion recovery sequence. Polymorphic ventricular tachycardia (VT) was induced by a standard programmed stimulation protocol.

Real time imaging used a true-FISP sequence accelerated using the TSENSE [1] parallel imaging method. During free-breathing without ECG triggering, a single short-axis slice containing the MI region was imaged during the first minute after inducing VT. Imaging was conducted using a 1.5T Siemens Sonata. Imaging parameters were: BW 1395 Hz/pixel, TE/TR 1.2/2.4 ms, 55° readout flip angle, 128x52 image matrix. SENSE acceleration (rate R=4) was used to obtain the full 52 line resolution using 13 phase encodes, corresponding to a temporal resolution of 31.5 ms (32 frames/s). The FOV was 250x172 mm² corresponding to an in-plane spatial resolution of 2x3.3mm², with a 6 mm slice thickness. The number of frames acquired was 480 corresponding to approx 15 s. A custom 8-element linear surface coil array from Nova Medical Inc. (Wilmington, MA) was used.

LV endocardial and epicardial contours were traced manually and a time series of regional wall thickening was computed at 32 equidistant angles. A respiratory signal was derived from the images by measuring the centroid of the signal intensity profile through the diaphragm.

Results:

Results are shown for a case of polymorphic VT. A time series of 10 consecutive example

images are shown in Fig. 1. The regional wall thickening versus time is displayed in Fig. 2(a) for 32 angles with wall thickness (intensity) displayed between 12 mm (dark) and 20 mm (bright). The MI region corresponds to the angle with thin and hypokinetic myocardium (dark horizontal band). A time series of the LV endocardial area (mm^2), is shown in Fig. 2(b) and respiratory signal in Fig. 2(c). The time window between the two arrows in Fig. 2(a) is magnified in Figure 3. The ventricular contraction is highly irregular with cycle lengths of 180-450 ms. [Figure 3](#) clearly shows short runs of reproducible activation (B3-B5). It is seen that at times (B1-B2) the LV is contracting synchronously (i.e, postero-lateral contracts with anterior wall), while at other times (B3-B7) regions become localized focii for independent mechanical activation.

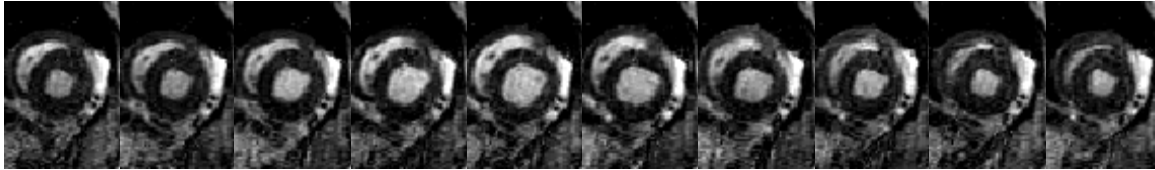


Figure 1. Example real-time images during ventricular tachycardia.

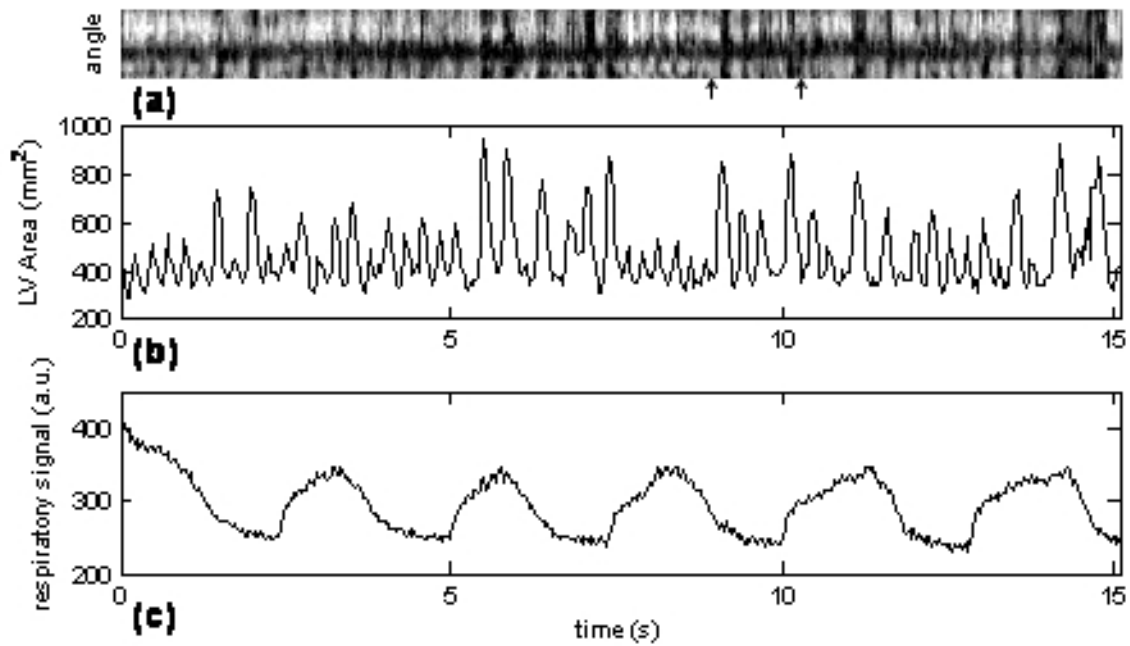


Figure 2. (a) regional wall thickening vs time, (b) LV area, (c) respiratory signal.

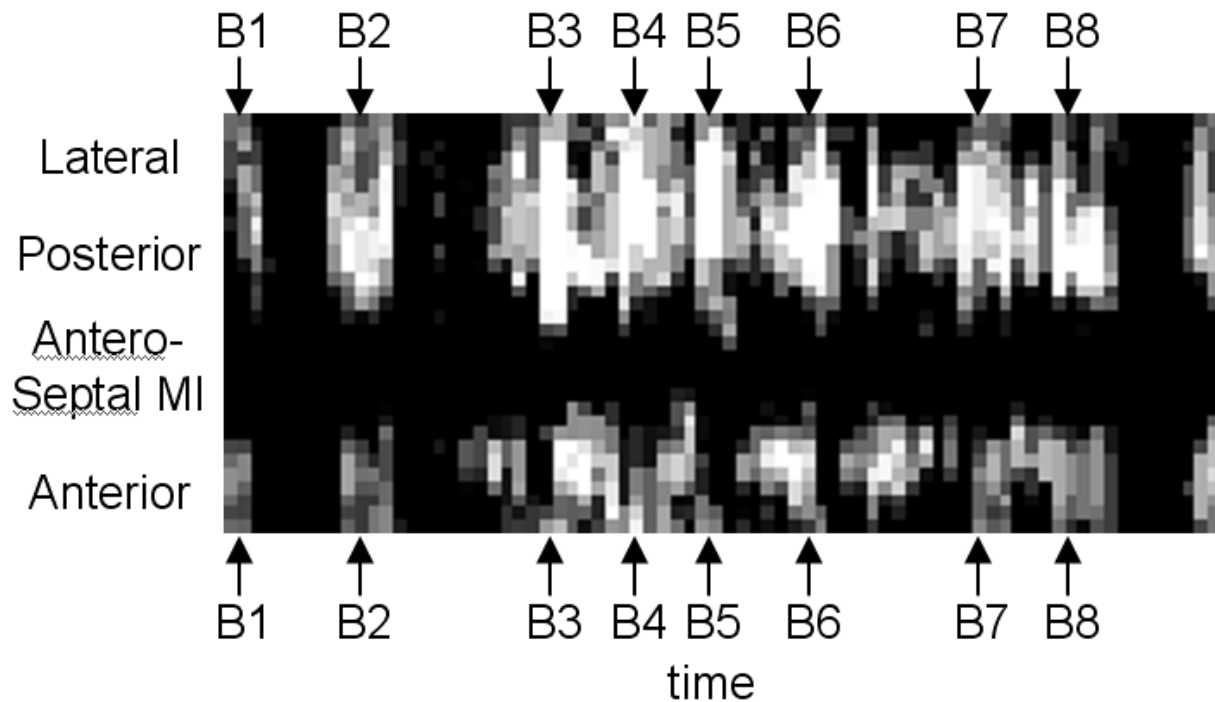


Figure 3. Regional wall thickening for several beats.

Conclusions:

We demonstrate that real-time MR imaging allows quantification of regional myocardial function during non-periodic ventricular arrhythmia. The time series of regional wall thickening provides not only a noninvasive method to quantify the myocardial function in each region but also the onset of wall thickening and thinning, which corresponds to the timing of mechanical activation and deactivation, respectively.

References:

1. Kellman P, et al. MRM. 2001; 45:846-52.