

Approaches for the quantification of left ventricular dyssynchrony by magnetic resonance imaging

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INTRODUCTION Mechanical dyssynchrony has been proposed as a prognostic marker for heart failure patients. Despite its relationship with cardiac resynchronization therapy response prediction remains controversial, non-invasive, imaging-based dyssynchrony markers may provide clinical value useful for patient stratification.

Dyssynchrony is often quantified as dispersion of time to peak contraction across the myocardium, however, there are evidences that this approaches may have significant drawbacks, especially when conduction defect such as left bundle branch block (LBBB) are present.

METHODS We considered multi-slice short-axis view cine magnetic resonance imaging (MRI) loops. We automatically segmented the left ventricle surface using a commercial software; subsequently we derived the radial wall motion of the endocardial border. We used cross-correlation with a subject-specific reference to derive regional contraction time estimates (RCT) as well as dynamic time warping to quantify the local distortion in the endocardial motion; we compared our approach to the analysis of time to peak contraction. We evaluated the method on animal model dataset (n=24), where isolated LBBB was surgically induced.

RESULTS Global indicators of dyssynchrony given by the standard deviation of the RCT were significantly increased ($p < 0.001$) after the induction of LBBB in animal models ($2.06 \pm 0.52\%$ at the baseline vs. $4.01 \pm 0.95\%$ after the induction). Indicators taking into account the complete cardiac cycle results in higher classification performances for LBBB respect to indicators considering peak contraction only (area under the receiver operating characteristic curve 0.73 vs. 0.93).

DISCUSSION We developed a method that allow the estimation of regional contraction time from cine MRI loops. The method can be used to visualize contraction patterns. Global dyssynchrony measures identify accurately the presence of LBBB on an animal model; a preliminary validation on human subjects is ongoing.

Further research will include validation against independent image acquisition, e.g. tagged MRI, and larger clinical validation in patients to assess the effectiveness of the proposed dyssynchrony measures for LBBB diagnosis in patients and CRT response prediction.