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Meeting abstract

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108 Accelerated 3D tagging to assess left ventricular dyssynchrony in patients with sub-acute myocardial infarctions

Andrea K Rutz*[1], Sebastian Kozerke[1], Peter Boesiger[1] and Juerg Schwitter[2]

Address: [1]Institute for Biomedical Engineering, University and ETH, Zurich, Switzerland and [2]Clinic of Cardiology, University Hospital, Zurich, Switzerland

* Corresponding author

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Introduction

Cardiac resynchronization therapy (CRT) proved successful in larger patient populations. However, individual responsiveness to CRT is not yet highly predictable. Around 30% of patients do not appear to benefit from CRT [1]. Accurate measurement of dyssynchrony could help in discriminating CRT responders from non-responders. Individual responsiveness of patients could be improved with the knowledge of temporally resolved, regional motion patterns. The acquisition of multi-slice MR tagging data [2] covering the whole heart in short- and long axis orientations is associated with long acquisition times and prone to slice misregistration. A novel accelerated 3D tagging acquisition scheme [3,4] allows assessing detailed 3D motion patterns of the entire left ventricle (LV) in only three breath-holds. Accordingly, the method is easily integrated into a clinical protocol including volumetric, perfusion and viability measurements.

The 3D tagging technique was applied to quantify LV dyssynchrony in patients with sub-acute myocardial infarctions as a model causing dyssynchrony relative to healthy controls. Features of three-dimensional motion patterns were correlated with the presence of scar tissue as measured with late enhancement images.

Purpose

To quantify the spatial extent and temporal characteristics of LV dyssynchrony in controls and patients with sub-acute myocardial infarctions by application of a novel 3D tagging technique in combination with CMR viability imaging.

Methods

3D CSPAMM-tagged [5] images of the entire LV were acquired in 16 patients (14 male/2 female, age = 60.7 ± 11.5 years) with sub-acute myocardial infarctions and in 17 controls (9 male/8 female, age = 36.0 ± 13.9 years). Patients were measured 10.5 days (minimum 2 days, maximum 39 days) after myocardial infarction and showed an ejection fraction of 40.7 ± 9.5%. A hybrid multi-shot, segmented echo-planar imaging sequence was applied to acquire motion encoded data in all three orthogonal directions (Philips 1.5 T, Best, NL) [3,4]. Spatial resolution in each encoding direction was 3.0 × 7.7 × 7.7 mm^3 with a temporal resolution of 30 ms. Data acquisition was split into three breath-holds of 18 heartbeats duration each. For viability assessment late enhancement images were acquired in all patients (Gadovist, 0.25 mmol/kg).

Midwall circumferential shortening (*csh*, %) and time to maximum *csh* (T_{max}) were extracted from 48–66 segments/heart using a home-written peak-combination HARP [6,7] software. The standard deviation of T_{max} of all segments was calculated as a measure of LV dyssynchrony. In addition, for each segment the absolute time difference (T_{diff}) for maximum *csh* relative to the mean T_{max} of the entire LV was calculated.

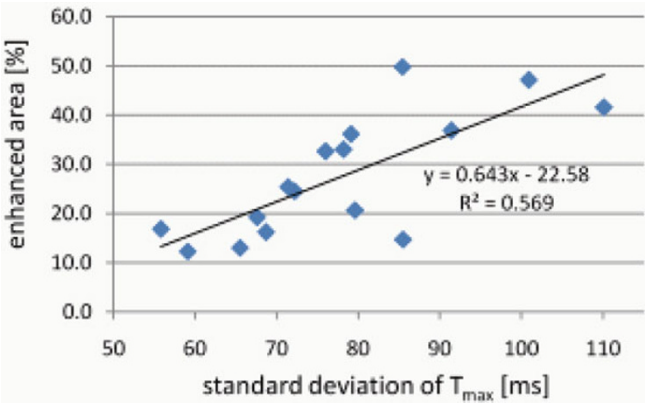

Figure 1
Linear regression between LV dyssynchrony and amount of scar tissue for patients with sub-acute myocardial infarctions ($p < 0.01$).

Results

In patients, T_{max} of 351.7 ± 34.7 ms was not different from the controls with 351.4 ± 39.2 ms. However, the standard deviation of T_{max}, which served as a measure of dyssynchrony, was significantly higher in patients (77.9 ± 14.4 ms vs. 43.9 ± 9.1 ms, $p < 0.0001$) and linearly dependent on LV enhanced area (Fig. 1, $p < 0.01$). Mean LV *csh* at end-systole was significantly reduced in patients (12.0 ± 3.3%) compared to healthy volunteers (18.1 ± 1.9%, $p < 0.0001$). Similarly, the standard deviation of LV *csh* at end-systole was different between patients (7.0 ± 1.1%) and controls (4.3 ± 0.7%, $p < 0.0001$). Results for a representative patient with anterior myocardial infarction are shown in Fig. 2.

Conclusion

Accelerated 3D MR tagging acquisition provides detailed information on dyssynchrony of the entire left ventricle. In combination with viability information obtained from

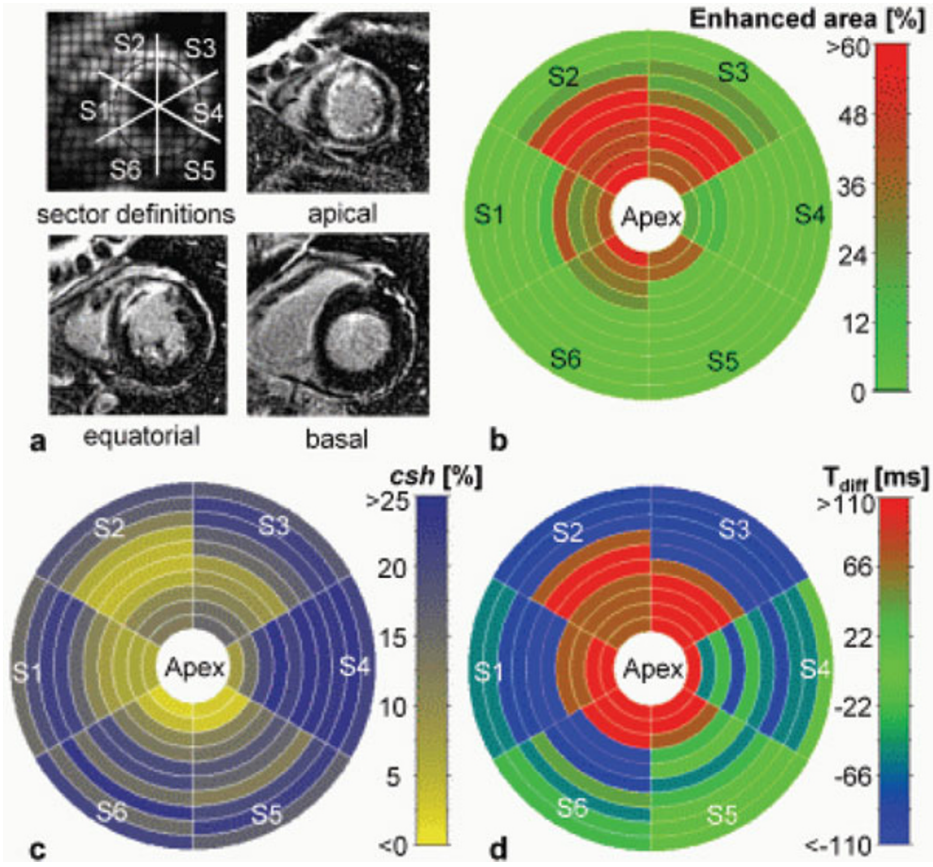

Figure 2
Results for a representative patient with anterior myocardial infarction. (a) Tagged image (slice through 3D data set) with sector definitions and exemplary late enhancement imges on 3 cardiac levels. (b) Polar map of viability: Regions exhibiting late enhancement due to scar tissue. (c) Polar map of deformation: Circumf. shortening (csh) at end-systole. (d) Polar map of dyssynchrony: Time difference T_{diff} map for maximum csh relative to the mean T_{max}. Blue = early, red = delayed, green = regular timing of contraction.

late enhancement images, this approach shows potential to quantify both dyssynchrony and scar fast and accurately and thus may prove an important measure for CRT planning.

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