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Meeting abstract

125 Characterization of infarct heterogeneity by fuzzy clustering

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Introduction

Infarcted tissue interspersed with surviving bundles of myocytes can cause ventricular arrhythmias via the reentry phenomena. Infarct heterogeneity as assessed by delayed-enhancement MRI (DE-MRI) has been shown to correlate with inducibility for ventricular tachycardia (VT) [1]. However, the separation of the infarct core from the periphery (or "gray zone") using conventional DE-MRI images relies on an arbitrary selection of a signal intensity (SI) cut-off. DE-MRI images generally have a low SNR; therefore, noise may influence the size of the gray zone. Recently, a new method using an inversion-recovery SSFP (IR-SSFP) sequence has been described to produce multiple infarct-enhanced images at various inversion times [2].

Purpose

In this work a new method for assessing infarct heterogeneity based on parameterization and fuzzy clustering of IR-SSFP images was developed.

Methods and results

The IR-SSFP sequence was implemented on a 1.5 T scanner (CV/i, GE Healthcare, Milwaukee, WI). Short-axis images were acquired in patients with suspected myocardial infarcts 10–20 minutes after the injection of 0.2 mmol/kg of Gd-DTPA (Magnevist, Berlex Inc., Wayne, NJ). The parameters for the IR-SSFP sequence were: BW = ± 125 kHz, TR/TE = 2.7/1.3 ms, SSFP flip angle = 45° and spatial resolution of 1.6 × 1.6 × 8 mm over a 32 cm FOV. An eight-channel cardiac array was used for signal reception. The IR-SSFP sequence yielded 20 images throughout the heart cycle each at a different inversion time. The first nine images after the inversion pulse occur during diastole and thus have minimal motion; these nine images were used for a pixel-by-pixel analysis of the inversion recovery behaviour. For each pixel, the time course of the SI during its signal recovery was extracted (Fig 1). The SIs were then fitted to the signal recovery equation for an IR-SSFP sequence [3]. The two unknown parameters in the signal recovery equation are: the apparent relaxation time T_1* (shorter than the true T_1 because of the effects of the SSFP readout pulses) and the steady-state (SS) value. From the regression analysis, pixel-by-pixel T_1* and SS parameter maps were calculated. The parameter maps in Figure 1 show a non-transmural antero-septal infarct as an area of reduced T_1* (dark band in the T_1* map) and increased SS. A scatter plot of the T_1* versus SS value for all pixels can then be displayed (Fig 2). This scatter plot was used as the input to a clustering algorithm designed to automatically detect and classify each pixel. The clustering algorithm used was the Gustafson-Kessel (GK) modification of the fuzzy C-means algorithm [4], which uses only the raw data and the number of clusters as inputs. For each pixel, the algorithm calculated the probabilities of that pixel being associated with infarct, healthy myocardium, and blood. Pixels having a probability of greater than 75% for belonging to infarct or myocardium were classified as infarct core or healthy myocardium, respectively; pixels with probabilities between 25–75% for both infarct and myocardium were classified as heterogeneous infarct and constitute the gray zone. Clustering results from one patient are shown in Figure 2 and demonstrate the infarct core (in green) and gray zone (in yellow).

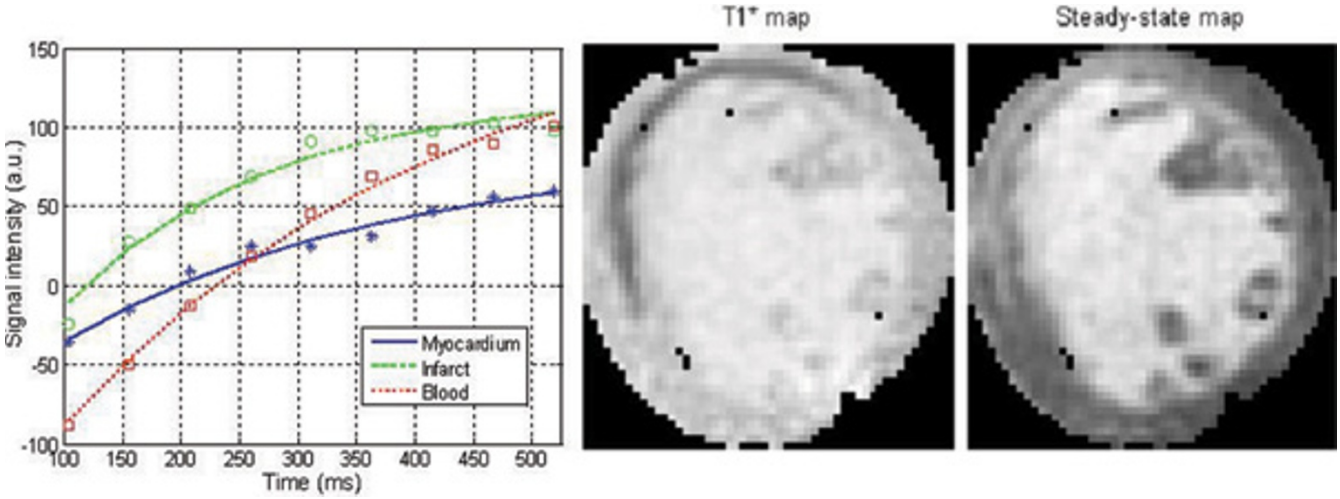

Figure 1
Signal intensities (left) for one pixel each in healthy myocardium, infarct and blood from nine IR-SSFP images, each at a different inversion time. The fitted recovery curves on a pixel-by-pixel basis yield parameter maps for T_1* (middle) and steady-state values (right).

Conclusion

Fuzzy clustering applied to IR-SSFP images can be used to classify pixels as infarct core, infarct grey zone, healthy myocardium and blood. Future work is needed to determine if heterogeneity measured by this method is predictive of VT, and to compare this method to the SI threshold method using conventional DE-MRI images.

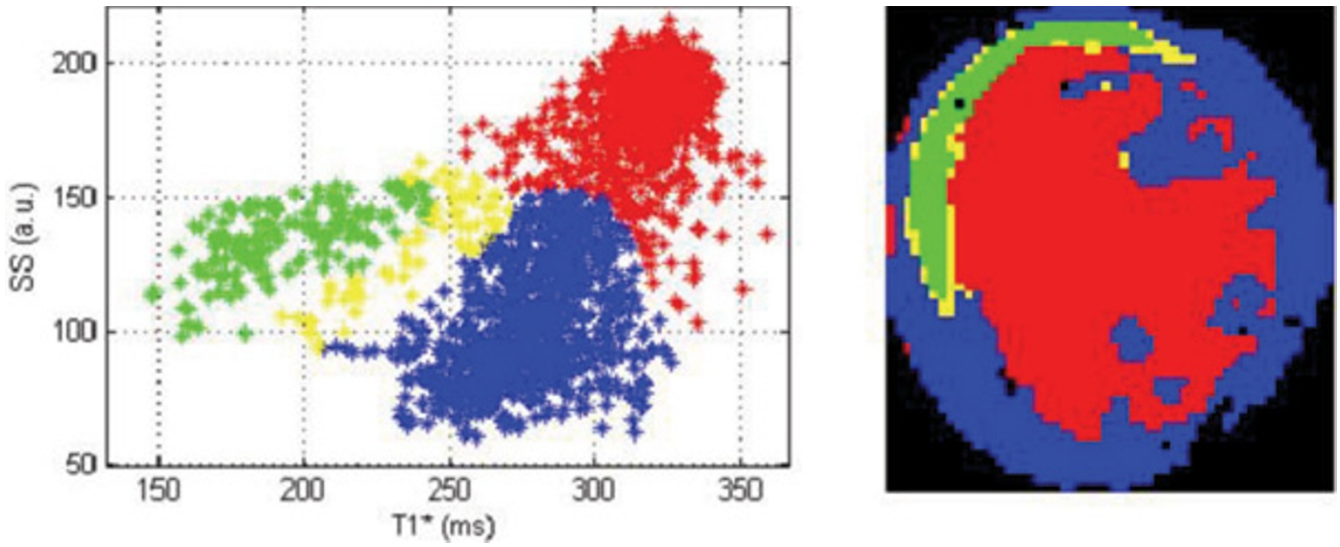

Figure 2
A T1* versus SS scatter plot (left) and corresponding image (right) showing the fuzzy clustering results with infarct core (green), gray zone (yellow), myocardium (blue) and blood (red). Inversion-recovery SSFP yields multiple delayed enhancement images at different inversion times that have been used to create pixel-by-pixel parameter maps. Fuzzy clustering methods were developed to use the paramter maps to detect areas of heterogeneous infarct.

References

1. Schmidt A: *Circ* 2007, **115:**2006-14.
2. Detsky JS: *Magn Reson Med* 2007, **58:**365-72.
3. Schmitt P: *Magn Reson Med* 2004, **51:**661-7.
4. Gustafson DE: *Proc of IEEE CDC* 1979:761-6.