Quantitative Tissue Characterization of Infarct Heterogeneity in Patients with Ischemic Cardiomyopathy by Magnetic Resonance Predicts Future Cardiovascular Events

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ABSTRACT

Objectives This study evaluates how quantitative characterization of tissue heterogeneity of myocardial infarction by cardiovascular magnetic resonance (CMR) predicts cardiovascular events in patients with ischemic cardiomyopathy (ICM).

Background Prior studies show how quantifying myocardial scar volume and percentage by CMR is superior to LVEDV, LVESV, and LVEF in prognosticating future cardiovascular events in patients with ICM[1]. Studies also show how patients with non-transmural infarctions have more cardiovascular events than patients with transmural infarctions perhaps suggesting that the residual viable myocardium provides the substrate for arrhythmias and/or ischemia leading to more cardiovascular events[1,2]. Further evaluation of infarct heterogeneity by quantifying infarct core and border (peri-infarct) regions through CMR may provide a stronger predictor of cardiovascular events in patients with ICM.

Methods 77 patients with ICM (LVEF < 50%, mean LVEF: 28 ± 15%) considered for revascularization or medication therapy ± implantable cardiac defibrillator were enrolled. A 1.5-Tesla GE MRI whole-body scanner (Milwaukee, WI) was used to acquire cine and delayed enhancement images. Cine images were acquired using a steady-state free precession sequence (SSFP, TR 3.8, TE 1.6, FA 45°, slice thickness 10 mm, slice gap 0). Gadolinium delayed enhanced images (segmented k-space inversion recovery sequence, TR 7.1, TE 3.1, TI 200–250, slice thickness 10 mm, slice gap 0) were acquired throughout the entire LV 20 minutes post gadolinium administration with subsequent adjustment of the inversion time as necessary. The core and border zones of infarcted myocardium were analyzed quantitatively and the patients were followed for cardiovascular events: ventricular tachycardia, ventricular fibrillation or ICD firing, worsening CHF (defined as worse NYHA Class), hospitalization, MI, repeat revascularization, syncope and cardiovascular death. The analysis was performed by outlining each myocardial segment containing infarcted tissue. The maximum signal intensity (SI) within the infarct region was determined. Then a region of interest (ROI) was drawn in a remote region of myocardium, and the maximum SI within this region was determined. The infarct core was defined as the zone with SI > 50% of the maximal SI in the infarct while the border was defined as the zone with a SI > the maximum SI in the remote ROI but < 50% of maximal SI of the infarct[2]. The core and border zones were planimetered and the tissue mass (grams) was calculated by the following: planimetered area x slice thickness x 1.05.

Results Thirty patients (39%) had cardiovascular events (mean follow-up: 20 ± 16 months). Total scar mass and scar percentage of the myocardium were associated with more cardiovascular events (35.8 ± 22.6 grams vs. 25.7 ± 20.1 grams, p = 0.02 and 9.5 ± 6.6% vs. 6.8 ± 6.9%, p = 0.04, respectively). Precise tissue characterization was achieved by dividing the scar mass into core and border zones. A larger border zone and border zone percentage of the myocardium were associated significantly with cardiovascular events (16.6 ± 13.2 grams vs. 10.7 ± 10.1 grams, p = 0.017 and 10.4 ± 8.0% vs. 7.0 ± 7.3%, p = 0.032, respectively). However, the mass of core infarct and core infarct percentage of myocardium were not significantly different in patients with or without cardiovascular events (19.2 ± 11.7 grams vs. 15.0 ± 11.6 grams, p= 0.061 and 12.2 ± 7.1% vs. 9.9 ± 8.0%, p = 0.097, respectively). LVEDV, LVESV, and LVEF were not significantly different in patients with or without cardiovascular events (236 ± 80 ml vs. 221 ± 80 ml; 183 ± 77 ml vs. 163 ± 92 ml; and 25 ± 13% vs. 30 ± 16%, respectively).

Conclusions Quantitative tissue characterization of the border zone mass and border zone percentage of infarcts is superior to core infarct mass, core infarct percentage, LVEDV, LVESV, and LVEF in prognosticating the likelihood of future cardiovascular events in patients with ICM. This CMR-guided technique may assist in clinical management of patients with ICM.

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[1] J Cardiovasc Magn Reson. 2008 Apr 9;10(1):17.

[2] Circulation. 2007 Apr 17;115(15):2006-14.