Quantification of infarct size and mixing of necrotic and viable tissue with signal-intensity-based percent infarct mapping

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Determination of viable myocardium is clinically important because the extent of viable tissue is a major determinant of patient outcome. The extent of viable tissue is determined by the level of myocardial contractile function, which is demonstrated by delayed gadolinium-enhanced magnetic resonance imaging (DGE) or positron emission tomography (PET) imaging. DGE is performed using a gadolinium-based contrast agent and has a high spatial resolution but a low signal-to-noise ratio, whereas PET is more suitable for quantitative analysis but has a lower spatial resolution. Therefore, a combination of imaging techniques is required to accurately determine the extent of viable myocardium. This study evaluated the use of signal intensity mapping (SIM) to measure the level of myocardial contractile function and the extent of viable myocardium. The study demonstrated that SIM can accurately determine the extent of viable myocardium, which is consistent with previous studies showing that SIM can accurately determine the extent of viable myocardium.

**Methods**

In swine (n=6), reperfused MI was generated either by the Left Anterior Descendent (LAD) or the Left Circumflex (LCX) coronary artery by an angioplasty balloon for 90 min. Gd(DTPA)-enhanced, inversion-recovery gradient-echo (IR-GRE) acquisitions were carried out (1.5 T, Sigma-Horizon CVI) on day 28 after MI, 15 min after intravenous injection of 0.2 mmol/kg Gd(DTPA).

2,3,5-triphenyltetrazolium chloride (TTC) staining was used to validate the existence and to determine the accurate size of myocardial infarct. Tissue samples were taken and stained with Hematoxylin-Eosin and Masson’s trichrome for histological assessment of the infarct and the perinfarct zone. The percent-infarct (PI) value was assigned, applying the PI-mapping method [10], calculating the amount of infarcted tissue per voxel. SI values less than, or equal to the mean SI of healthy (remote) myocardium were denoted as 0% infarcted, while the center of the infarct (10% maximally enhanced pixels) was assigned as 100% injured. PI values were shown on color scales in the image matrix provided the pseudo-color SI-PIM (Figure 1). Total left ventricular (LV) infarct volume (IVPV) was determined as the sum of the PI values times the volume of all individual voxels in the entire LV. As reference, voxels enhanced over the SIthRETO252 threshold were counted as 100% infarcted, using the traditional method. Infarct Volume (IVPV-252) was determined as the sum of the volume of those voxels having SI values above this threshold. The signal intensity percent-infarct-mapping data were compared with corresponding data from the Gd-DTPA images analyzed with SI-PIM thresholding, and with corresponding triphenyltetrazolium chloride (TTC) staining, using Friedman’s Repeated Measure Analysis of Variance on Ranks.

The short axis LV slices stained with Hematoxylin-Eosin and Masson’s trichrome were assessed by a pathologist. The analysis of correspondence between SI-PIM and histology was assisted by quantitative computerized morphometry using an Olympus BX51 microscope with motorized stage and version 9.0 of Bioquant Osteo 2009 software (Bioquant Analysis Corporation, Nashville, TN). This enabled the integration of the histological details of the whole short axis LV slice in one digital image montage.

**Results**

The median IV determined by the TTC, SIPIMPMPPD and SI-PIM methods were 3.04 [2.74, 3.45], 13.62 [9.06, 18.45], and 4.27 [3.45, 6.33], respectively. The median IV determined by SIPIMPMPPD and SI-PIM methods were 3.04 [2.74, 3.45], 13.62 [9.06, 18.45], and 4.27 [3.45, 6.33], respectively. These results were compared with the IV determined by TTC (p=0.05). The Bland-Altman’s overall bias (see the corresponding plot on Figure 2) was 12.49% of the LV volume. Median IV determined by SI-PIM, however, did not differ significantly (NS) from the IV determined by TTC. The SI-PIM yielded only a 1.99 % Bland-Altman’s overall bias of the LV volume (see Figure 3).

**Conclusions**

This in vivo study in the porcine, reperfused MI model demonstrates that SI-PIM is a highly accurate method for the determination of the extent and distribution of myocardial infarct. SI-PIM can help the cardiologist in the assessment of the often complex structure of the infarct scar by in vivo visualization of infarct inhomogeneity on a color percent scale. As SI-PIM is obtained with the pulse sequence of conventional LGE CMR imaging, it is acquired within a clinically acceptable scanning time. These features make SI-PIM a practical method for clinical implementation.

**References**