Enhanced Detection of Myocardial Edema with Spectrally Selective Inversion Recovery-Prepared T2-weighted Imaging

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Background:

T2-weighted imaging is utilized to provide insight into the acuity of an ischemic or non-ischemic myocardial insult, as denoted by the presence of global or regional edema. T2-weighted STIR (Short T1 Inversion Recovery) imaging is widely used to detect myocardial edema. The main feature of this approach is a triple inversion preparation, which simultaneously nulls blood (using the conventional double-inversion pulse) and fat (using a slice-selective inversion pulse with a short inversion time). However, this approach is limited by reduced signal-to-noise ratio (SNR) and image quality. Magnetization preparation of the STIR approach can be improved with Asymmetric Adiabatic Spectral Inversion Recovery (AASPIR) imaging [1]. In AASPIR, the third slice-selective fat-nulling inversion pulse is replaced with a chemically selective inversion pulse, allowing for improved myocardial SNR. The purpose of this study was to compare AASPIR to STIR for detection of global and regional myocardial edema, in terms of image quality, artifacts and SNR.

Methods:

We studied 30 patients (21 males, 46±17 years), referred for cardiovascular magnetic resonance scans for myocardial tissue characterization using both T2-weighted STIR and AASPIR imaging. All images were acquired with a 1.5 T scanner (Avanto, Siemens Medical Solutions, Erlangen, Germany). A fast spin echo STIR (short-TI triple inversion recovery spin echo) sequence with blood flow and fat suppression pulses was applied, followed by turbo spin-echo AASPIR with adiabatic pre-saturation inversion recovery pulse for protons in fat. Image acquisition was performed in basal and mid-ventricular short axis slices, and apical slices were acquired if diagnostic image quality could be obtained. Signal intensity (SI) of left ventricular myocardium was normalized to skeletal muscle, generating a T2 signal intensity ratio (SIR). A SIR greater than or equal to 2 reflected the presence of global myocardial edema. SNR was calculated by myocardial SI and SI of noise, defined by the mean SI of a region of interest anterior to the chest wall. Two independent observers assessed image quality and artifact suppression using a 5-class score system. The presence of regional myocardial edema was visually assessed with a consensus between two observers in 7 additional patients referred for ischemic myocardial injury.

Results:

Diagnostic image quality was obtained in all patients assessed with STIR and AASPIR imaging. AASPIR imaging demonstrated higher SNR for basal (42.4 vs. 27.0, $p<0.001$), and mid- (52.8 vs. 31.2, $p<0.001$) ventricular myocardium, better image quality and more consistent suppression of artifacts (Figure 1). Moreover, the SIR did not differ between STIR and AASPIR imaging (1.633 vs. 1.626, $p=0.845$). STIR was not able to visualize regional edema in one patient, which was clearly visible in AASPIR. In addition, AASPIR allowed for 17% and 14% improvement in image quality and artifact suppression, respectively (Figure 2).

Conclusion:

Our results demonstrate that AASPIR allows for markedly improved T2-weighted CMR imaging of global and regional edema, with greater SNR and reduced image distortion from artifacts.

References:

1. Shea SM et al. ISMRM 2007; 2475.

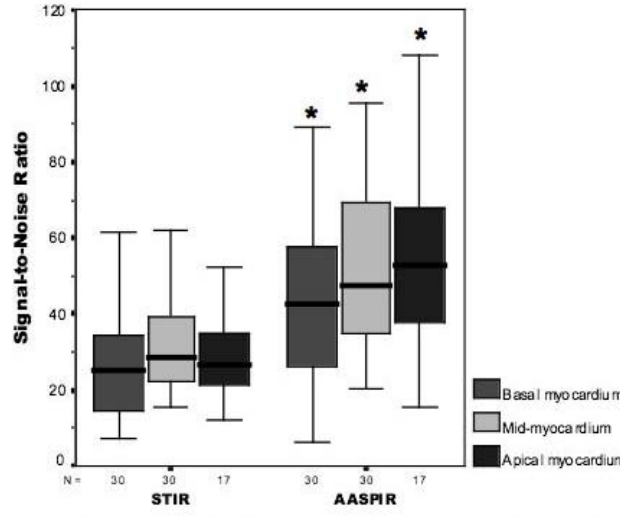

Figure 1. Improved signal-to-noise ratios for basal, mid- and apical myocardium with AASPIR T2-weighted imaging. *p≤0.05 AASPIR vs. STIR.

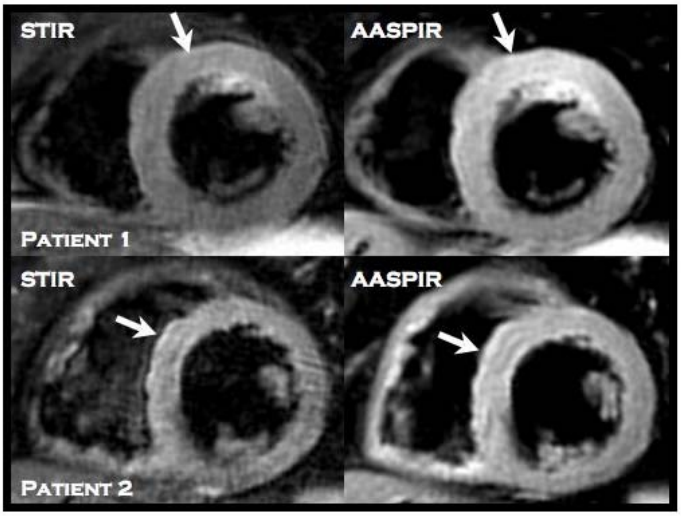

Figure 2. Enhanced delineation of regional myocardial edema with AASPIR imaging in two patients. Regional edema is defined by areas of increased signal intensity (arrows). Note the improved image quality in AASPIR.