

Imaging of Myocardial Edema and Function at High Resolution with T2-meta-DENSE: The hypokinetic zone corresponds to the area of edema

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Introduction

We present a modified Displacement Encoding with Stimulated Echoes (DENSE) (1) pulse sequence (T2-meta-DENSE) which can acquire T2-weighted images and DENSE strain data that are registered on a pixel-by-pixel basis so as to study the relation between myocardial edema and function at end-systole with high spatial resolution.

Theory

meta-DENSE (2) myocardial strain imaging uses a readout of refocusing 180 degree pulses. The new T2-meta-DENSE uses a TE of 60ms to yield systolic magnitude images with T2 contrast on top of the stimulated echoes' inherent T1 contrast. Black-blood contrast due to intravoxel dephasing by the motion encoding gradients exists in these systolic images. The black blood mechanism of T2-meta-Dense is different than that of Double Inversion Recovery FSE (3), where black-blood contrast is achieved by bulk motion of blood through the imaging plane, a condition that is not always achieved in the presence of severe wall motion abnormalities.

Methods

Six mongrels underwent a 90 minute transient occlusion of the LAD. Two days later, short axis mid-ventricular images were acquired at 1.5T with T2-meta-DENSE (TE 6.5ms and 60ms). Other imaging parameters were: 1.0x1.0x7.0 mm³ voxel, ±32kHz bandwidth, 2 heartbeat TR, echo train length 12, 1.2mm/π encoding strength, 4 averages. Strain maps were phase-reconstructed from short TE images whereas long TE images were magnitude-reconstructed to visualize edema. Radial strain below 10% was considered abnormal. The edematous region was defined as having more than 50% signal enhancement with respect to a remote segment.

Results

T2-meta-DENSE images are shown below along with the corresponding strain maps (scale -10 to +30%). Note the correspondence between the hypokinetic zone (blue) and the edematous zone. The size of the edematous region by T2-meta-DENSE correlated well with the size of the hypokinetic zone (R=0.97) as seen below.

Discussion

In recent MRI studies of edema and function, one limiting factor has been the acquisition of strain maps at end systole and T2 images at end diastole. T2-meta-DENSE allows the direct comparison of absolute areas in systolic images and shows that hypokinesia in 2-day myocardial infarction corresponds closely to the edematous zone.

References

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