T2 Mapping In A Breathhold with KWIC FR-FSE

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Introduction: T2 quantitation has several potential body applications such as lesion characterization or tissue iron concentration determination. Measurement of T2 by multiple fast spin echo (FSE) acquisitions, however, is time-consuming and easily susceptible to motion-related artifacts. Radial (projection reconstruction) FSE presents the potential for quick T2 mapping using a single acquisition since all views traverse the center of k-space. In the KWIC (k-space weighted image contrast) technique (1), images with different T2 contrast are reconstructed using different subsets of the data acquired in a radial FSE acquisition. While the outer region of k-space is shared for all the images, the inner region for a given subset consists only of views from a specific TE (Fig. 1). In this work, we investigated the feasibility of extending the approach to data acquired with a fast recovery FSE (FR-FSE) pulse sequence (driven equilibrium Fourier transform imaging) (2). Our aim is to develop an imaging technique that allows for multislice T2 determination with breathhold acquisition time.

Methods: All imaging experiments were performed on a Signa EXCITE 3T scanner (General Electric Healthcare, Waukesha, WI) with Twinspeed gradients and G3 software, using product 8-channel head and 8-channel torso array coils. Axial slices through the abdomens and heads of healthy volunteers were acquired with a radial FR-FSE sequence, prescribed with the following parameters: TR = 650 ms, ETL = 8, readout bandwith = +/- 15.63 kHz, echo spacing = 13.152 ms, FOV = 38 cm, slice thickness = 5 mm, slices = 4, 256 views, 256 pts/view, refocusing pulse flip angle = 160°, total acquisition time = 27 sec. View ordering followed a "bit-reversed" order (3). KWIC reconstruction was performed with MATLAB software (Mathworks, Natick, MA) running on a 1.2 Ghz Pentium III personal computer. With ETL = 8, 8 regridded sets of k-space data were formed by selective regridding and weighting of a single set of acquired raw data. The data in the central region of each regridded k-space was restricted to data from views acquired at a single echo time to produce contrast expected at that echo time. Surrounding regions are filled with data acquired at similar echo times. T2 maps were created from the reconstructed images using a linear fit to the log of the signal decay from image to image.

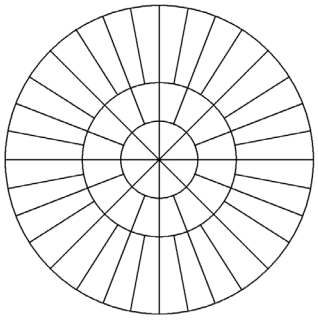

Figure 1. KWIC drops views at inner regions while satisfying Nyquist criterion

Results: Figure 2a-2e shows volunteer abdominal images and their corresponding T2 map, while figure 2f-2j shows head images and T2 map. T2 maps were similar to that expected from conventional T2 mapping techniques (e.g., high T2 in CSF, gallbladder, spleen).

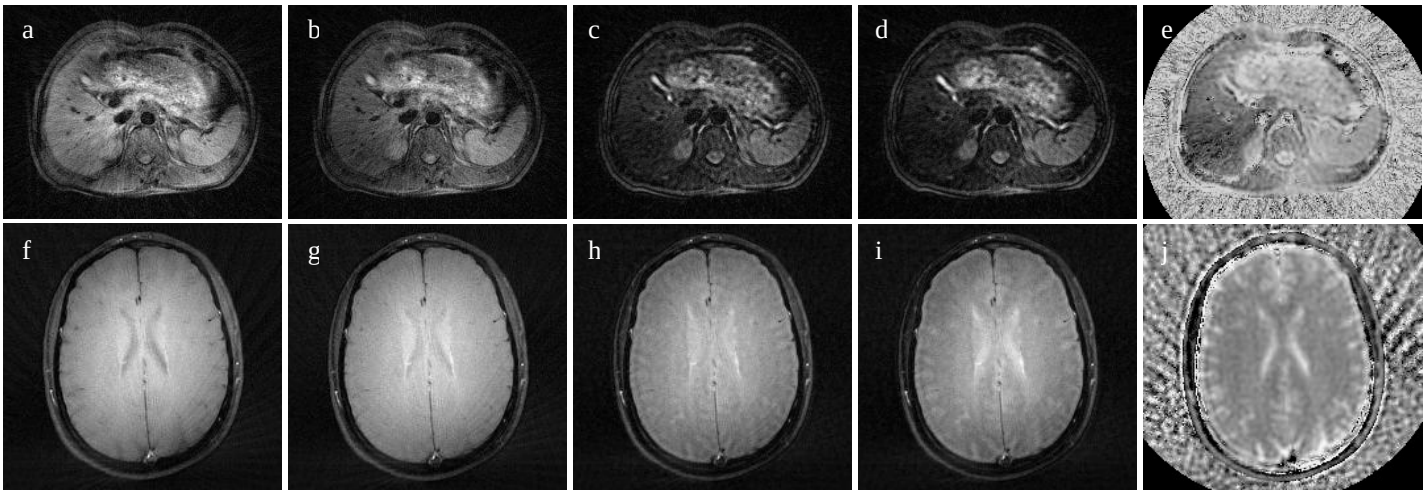

Figure 2. FR-FSE images at TE = 13.2 (a,f), 39.5(b,g), 65.7(c,h), and 92.0(d,i) ms, and T2 maps (e,j) in the head (a-e) and abdomen (f-j) of a healthy volunteer.

Discussion: The tipback pulse in FR-FSE typically introduces additional T1 weighting in the acquired echoes, negatively affecting T2 contrast in the reconstructed images in FR-FSE compared to conventional FSE. However, despite the reduced contrast, quality T2 maps can be created based on the decay of signal with increasing TE. Reduced acquisition time of this method also minimizes motion or misregistration problems common with long T2 mapping techniques. The KWIC technique relies on the fact that the central region of k-space is oversampled in a radial acquisition, which suggests that if data masking is limited to this region, the undersampled condition that results in artifacts can be avoided. Since image contrast is mostly dependent on data in this region, the area can be filled by selected subsets of the acquired data to produce multiple artifact-free images with progressive contrast properties.

Conclusion: KWIC FR-FSE produces high quality T2 maps within a breathhold, and enables T2 mapping in the abdomen.

References: 1) Song and Dougherty, MRM 44:825-832 (2000), 2) Hargreaves et al, MRM 42:695-703 (1999), 3) Theilmann et al, MRM 51:768-774 (2004).