Ultra Rapid Comprehensive Abdominal Imaging with 3D T1 and T2 weighted IDEAL

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Introduction: Diagnostic abdominal imaging requires characterization of focal lesions, assessment of diffuse conditions such as steatosis and iron deposition, and analysis of dynamic contrast enhancement. To achieve these goals, abdominal imaging protocols typically acquire T_1 and T_2 weighted images with and/or without fat suppression as well as in/out-of-phase images, all with volumetric anatomic coverage. Such protocols are lengthy and complex, and undesirable compromises must be made to maintain clinically acceptable scan times.

We propose the use of a different paradigm, acquiring T_2–weighted volumetric data using a 3D fast-spin-echo sequence with an extended echo train (3D FSE-XETA) (1) as well as T_1–weighted 3D spoiled gradient echo (3D SPGR) data pre- and post- contrast with all acquisitions using the IDEAL (Iterative-Decomposition of water and fat with Echo Asymmetry and Least-squares estimation (2,3)) method to produce water only, fat only, water+fat (in-phase) and water-fat (out-of-phase) images from each acquisition. The hypothesis of this work is that these 3D IDEAL approaches can acquire all necessary clinical data with similar spatial resolution compared to conventional methods in less than 20 minutes of exam time.

Materials and Methods: Our institutional review boards approved this study and informed consent was obtained from five volunteers. All data were acquired on a 1.5T TwinSpeed MR imaging system (GE Healthcare, WI) using a 32 element coil array (4). A single axial 3D IDEAL-FSE-XETA T2 weighted acquisition was acquired with respiratory triggering and the following imaging parameters: TR = 2-4 s, effective TE = 100 ms, bandwidth (BW) = ± 62.5 kHz, FOV = 36 × 28 × 20 cm^3, matrix = 256 × 160 × 50, 70% partial sampling along the slice direction and twofold parallel imaging acceleration along the phase encoding direction, acquisition time 5-8 min. This was followed by a dynamic contrast enhanced axial 3D IDEAL-SPGR acquisition: TR=6.5 ms, TE=2.0/3.4/4.8 ms, 15° flip angle, BW=±62.5 kHz, FOV = 36 × 28 × 20 cm^3, matrix = 256 × 160 × 50, six-fold parallel imaging acceleration (5), four phases (pre-contrast, arterial, venous, delayed), 20 s breath hold per phase. Each subject was injected with a single dose (0.1 mmol/kg) of Magnevist (Berlex, NJ) at 2ml/s via a Spectris Solaris power injector (Medrad, Indianola, PA). All four phases of T1 weighted data took less than four minutes to acquire.

The standard 3-point IDEAL processing algorithm (with homodyne reconstruction for partial sampling (6)) was used to reconstruct water-only, fat-only, in-phase (water+fat) and out-of-phase (water-fat) images from the T2-weighted acquisition and all phases of the T1-weighted acquisitions. All of the T1 and T2 weighted images were acquired in 15 minutes or less for each volunteer.

Results: The top row of images in Fig. 1 shows water only, fat only, in phase and out of phase images, as well as a coronal reformat of the axial water only image from a T2 weighted IDEAL acquisition in one volunteer. The bottom two rows show similar sets of images of pre contrast (middle) and arterial phase (bottom) T1 weighted IDEAL acquisitions of the same slices in the same volunteer as Figure 1. Notice the excellent fat suppression in the water images and the excellent quality of the reformatted images.

Discussion: We have demonstrated acquisition of near isotropic high resolution T2-weighted and dynamic contrast enhanced T1 weighted 3D images of both water and fat as well as in-phase and out-of-phase images in a single scan. Because the acquired volumes have high, near-isotropic resolution these images can be reformatted into any desired plane. This combination allows the large number of 2D and 3D acquisitions required in standard imaging protocols to be replaced with two acquisitions, dramatically simplifying the protocol. It is possible to acquire all the images in less than 15 minutes of acquisition time and only 20 minutes of table time. This comprehensive abdominal imaging protocol has the potential to change and improve the paradigm for routine clinical abdominal imaging.

References: 1) Busse RF, MRM 2006, 55: 1030-1037. 2) Reeder SB, MRM 2004, 51: 35-45. 3) Reeder SB, MRM 2005, 54: 636-644. 4) Zhu Y, MRM 2004;52:869-877. 5) Shankaranarayanan A, Proc ISMRM 2006. 6) Reeder SB, MRM 2005, 54: 586-593.

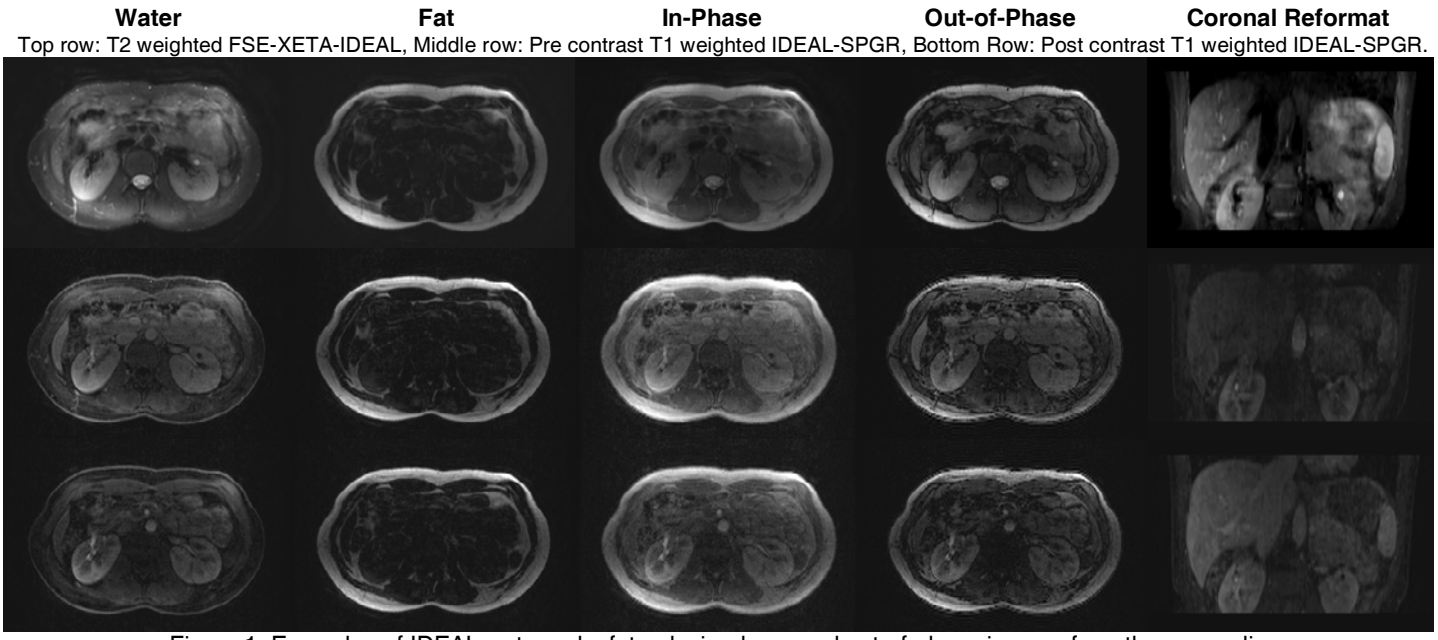

Figure 1: Examples of IDEAL water only, fat-only, in-phase and out-of-phase images from the same slice location in a single volunteer, as well as a coronal reformat of the water-only image.