**Abdominal imaging at 3T with fat suppressed PSIF using fat water separation**

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***Introduction*** T2-TSE is commonly used for lesion detection in abdominal imaging. However, the scan time is long and the images suffer from the motion artifact due to respiration. Time reversed fast imaging with steady-state precession (PSIF) can be a good alternative to T2-TSE at 3T for its speed and good T2 contrast in abdominal imaging [1]. To suppress fat in PSIF and improve lesion contrast in the abdomen, water excitation can be used but it is sensitive to $B_0$ inhomogeneity. We propose to apply fat/water decomposition to PSIF for fast fat suppressed T2 weighted abdominal imaging at 3T.

***Theory*** PSIF is a gradient echo technique and the phase difference between fat/water depends on TE. Robust fat/water decomposition requires at least 3 images with different TEs [2]. In PSIF, collecting multiple echoes in one TR is unfavorable as the low SNR sequence prefers short TR for higher signal. In this study, PSIF with three different TEs are acquired in an interleaved way, as shown in Figure 1. To ensure a short TR, the TE increment was chosen as 0.57ms (~π/2 for fat water phase shift at 3T).

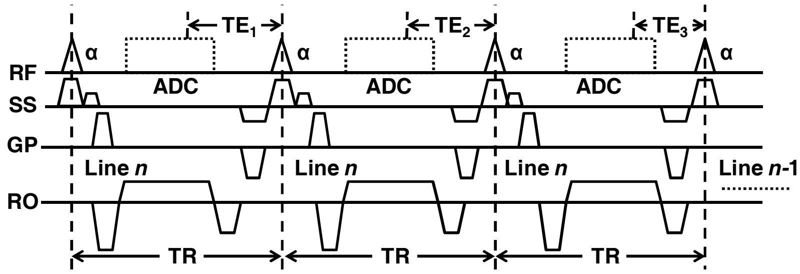


**Figure 1**: PSIF with three different TEs in the study.

***Methods*** The basic PSIF sequence used is the same as in [1]. The experiments were implemented on a 3T system (TIM TRIO, Siemens, Germany). Phantom experiment was performed to validate the feasibility of fat/water decomposition with PSIF. The water/oil phantom was scanned by the PSIF with three TEs (3P-PSIF). In the volunteers study, six volunteers with informed consent (IRB approved) were recruited. PSIF with water excitation (WE-PSIF) and 3P-PSIF were scanned for each volunteer for comparison. The common protocols for both studies were: number of slices = 5, imaging FOV = 380×285mm$^2$, voxel size = 1.2×1.7×6.0 mm$^3$, flip angle = 35$^o$, bandwidth = 610Hz/pixel, asymmetric echo was used. For 3P-PSIF, TE = 2.55/3.12/3.69 ms. The minimal TR (=5.89 ms) allowed by the longest TE was used. For WE-PSIF, TR/TE = 5.89/2.55 ms; 1-1 binomial pulse was used for fat suppression. The acquisition time for 3P-PSIF is 15s while it was 5s for WE-PSIF. Both sequences were scanned with breathholds. Fat/water decomposition was then done for each slice using the VARPRO algorithm [3] implemented in MATALB (Mathworks, NATICK, USA). The derived water images were compared to images obtained by the WE-PSIF images in the same positions.

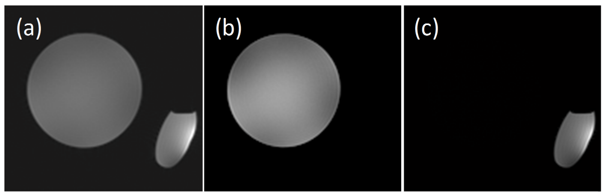


**Figure 2**: (a) PSIF in-phase image with TE = 2.45 ms. (b-c) decomposed water and fat images.

***Results*** Fat/water images were successfully derived from the 3P-PSIF images in the phantom and volunteer experiments. Figure 2(a) shows the in-phase image of the water/oil phantom. Figure 2(b-c) shows the decomposed water and fat images. In Figure 3(a), the black edge around spleen indicates the out-of-phase effect in abdomen. Figure 3(b-c) shows the decomposed water and fat images using VARPRO. The fat signal was uniformly suppressed in Figure 1(b) while residual fat signal appear at upper part of WE-PSIF image (see arrow in Figure 3(d)) probably due to $B_0$ inhomogeneity.

***Discussion*** Due to the short TEs used in this study, $T_2^*$ decay was assumed negligible in the signal model. The TE increment chosen was different from the optimal value of 2π/3 suggested in [3], as the corresponding minimal TR would be 7.45 ms, resulting in a 15% SNR loss (according to [4]) and would be undesirable. The scan time can be reduced by using multi-echo acquisition in a single TR, but this would increase TR resulting in SNR loss too. Hence for fat/water separation in PSIF, choice of TEs and acquisition strategy and their effect on the PSIF signal must be considered.

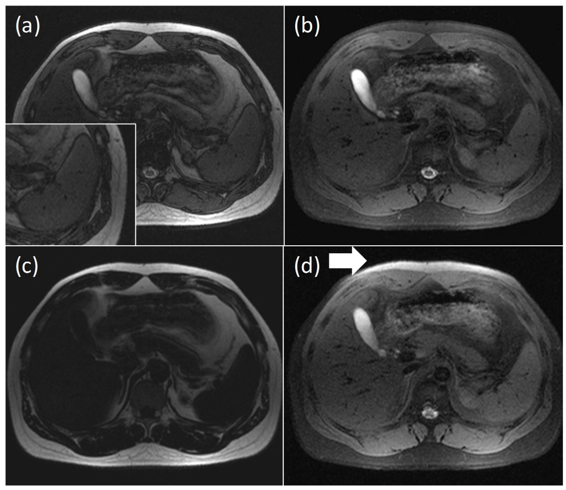


**Figure 3**: (a) PSIF out-of-phase image with TE = 3.69 ms. (b-c) decomposed water and fat images. (d) PSIF image with water excitation.

***Conclusions*** A fast fat suppressed T2 weighted imaging method by PSIF in abdomen using fat/water decomposition was proposed. T2 weighted PSIF water images are derived with improved diagnostic quality. The proposed method may be useful for fat quantification in liver as well.

***References*** [1] Zou C et al., ISMRM 2012, p.1331; [2] Reeder SB et al., MRM 2004, 51:35-45; [3] Hernando D et al., MRM 2008, 59:571-580; [4] Hanicke W et al., MRM 49: 771, 2003;