T2-weighted Imaging Using a Combined Two-point Fast Spin Echo Dixon and SENSE Technique

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Introduction

In comparison to the conventional chemical shift selective (CHESS) technique for fat suppression, Dixon techniques [1,2] are relatively insensitive to magnetic and RF field inhomogeneities and thus potentially very useful where CHESS fat suppression is difficult (e.g., large FOV, extremities). A serious drawback of the Dixon techniques, however, is their increased scan time, often necessitated by acquisitions of multiple images of varying phase differences between water and fat. Partially parallel imaging such as SENSE [3] has been proven effective for accelerating image acquisition in general. The method undersamples the full k-space and uses the individual receiver coil sensitivity profiles to unwrap the otherwise spatially aliased images. Initial investigations indicate that three-point Dixon and SENSE techniques are compatible and can be complementary in acquisition speed and SNR [4,5].

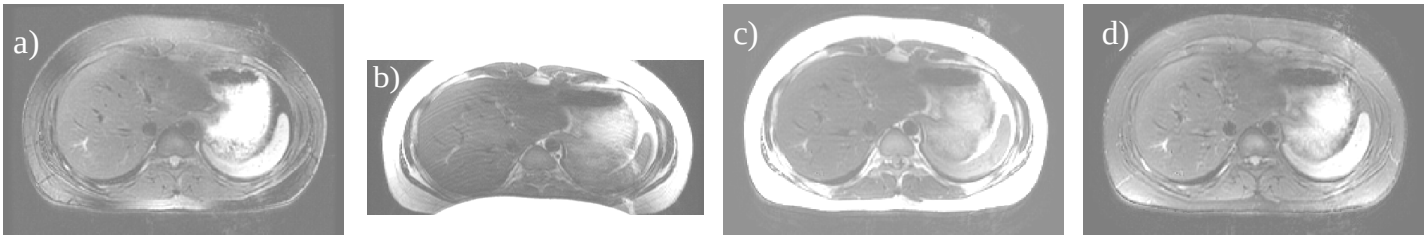
In this work, we investigated the feasibility of a technique combining fast spin echo two-point Dixon and SENSE. Using this technique, we demonstrate that the acquisition time can be as short as that by the conventional techniques. As a result, applications such as in vivo T2-weighted imaging of an entire abdomen can be completed in just two breath holds.

Methods and Experiments

All imaging was performed of a healthy volunteer on a 3 Tesla whole body clinical scanner (GE Heathcare, Waukesha, WI) using a commercially available, 8-channel torso-phased array coil. For data acquisition, a conventional fast spin echo pulse sequence was modified to allow for interleaved collection of an in-phase and an opposed-phase image (with the relative phase between the water and fat signals separated by 0 and 180^{o}, respectively). Using SENSE, the total imaging time of a fully encoded two-point Dixon acquisition was reduced in half by reducing the field of view along the phase-encode direction and halving the number of phase-encoding repetitions. The coil sensitive profile, as required in SENSE reconstruction, was measured with low-resolution fast gradient echo images acquired in a separate acquisition. For comparison purpose, images of the same volunteer were acquired with the conventional FSE with CHESS fat suppression.

For image reconstruction, a SENSE algorithm [3,6-7] available on the scanner as a commercial product feature was used to generate unaliased complex images for each slice (both in-phase and opposed-phase). An offline Dixon reconstruction algorithm was then used to automatically generate separate water-only and fat-only images. The Dixon algorithm was implemented in Matlab (MathWorks, Natick, MA) and was based on a region-growing scheme, originally reported in Ref. [8].

For all the images shown below, the scan parameters were as follows: TR/TE = 2500/85ms, echo train length = 20, receiver bandwidth = ±41.67 kHz, FOV =40x28 cm, slice thickness/gap = 6/1mm, acquisition matrix = 256x192. For both Dixon and fat-suppressed FSE, a total of 26 slices were acquired in two breath holds with a breath hold time of 25 seconds each.



Results

Fig. 1a) shows a T2-weighted FSE image with conventional CHESS fat suppression through the liver. Due to the breath hold acquisition, respiratory motion was effectively minimized. For the same slice, Fig. 2b) shows the magnitude in-phase image after direct FFT of the data using SENSE-Dixon acquisition. Fig. 1c) shows the SENSE reconstructed magnitude in-phase image and Fig. 1d) shows the water-only image using the combined SENSE and Dixon technique. As in Fig. 1a), respiratory motion is minimal in Fig. 1d) because of the breath hold. In comparison, fat suppression is more uniform in Fig. 1d) than in Fig. 1a).

Conclusions

Using the technique combining fast spin echo two-point Dixon and SENSE, the total acquisition time can be as short as that by the conventional techniques. With the increased scan efficiency, T2-weighted imaging of an entire abdomen can be completed in just two breath holds. At the same time, the sensitivity to field inhomogeneity of the conventional fat suppression techniques is reduced with the Dixon processing. The combined Dixon and SENSE technique could therefore be useful when requirements for scan time and field inhomogeneity are difficult to be met.

References

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