RESPIRATORY SELF-GATING FOR FREE-BREATHING QUANTITATIVE FAT/WATER IMAGING IN THE ABDOMEN

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Introduction: For abdominal imaging applications, respiratory motion can lead to significant image quality deterioration and inaccurate measurements. While breath-holding (BH) is commonly employed to eliminate respiratory motion artifacts, overall slice coverage and spatial resolution are limited by the requisite BH duration. This work combines a free-breathing technology with a fat/water separation method. A revised multiple gradient echo sequence was implemented to acquire imaging data during free-breathing [1], followed by an off-line image reconstruction. A global optimization algorithm (VARPRO) was implemented for fat/water separation [2-6]. Conventional fat-water imaging methods and our free-breathing method were compared in 8 volunteers.

Materials and method: This work was carried out using a Siemens 1.5T MRI scanner (Espree). A revised multiple gradient echo sequence was implemented to acquire imaging data during free-breathing. The imaging parameters for this feasibility study were as follows: TR = 200-300ms, depending on individual respiratory rate; echo-train length=6; flip angle=25°; band-width=770Hz/pixel; matrix resolution =128×96pixels; slice thickness = 5mm; field of view=350×262.5; spatial resolution =2.7×2.7×5mm^3; slice number = 1. TEs 2.5, 4.7, 6.9ms. Image processing: An off-line image reconstruction algorithm [1] was implemented in Matlab (Mathworks, MA) for all images followed by a global optimization algorithm that imposed field map smoothness constraints for fat/water separation [7-8]. For comparison, conventional signal averaged images were generated by including all the sampled k-space data without consideration of the respiratory position. The fat-fraction (FF) value in each volunteer was calculated to quantitatively compare these for each of the three measurement approaches. For each volunteer, a region of interest (ROI) was drawn in the liver excluding blood vessels and mean FF measured within this ROI.

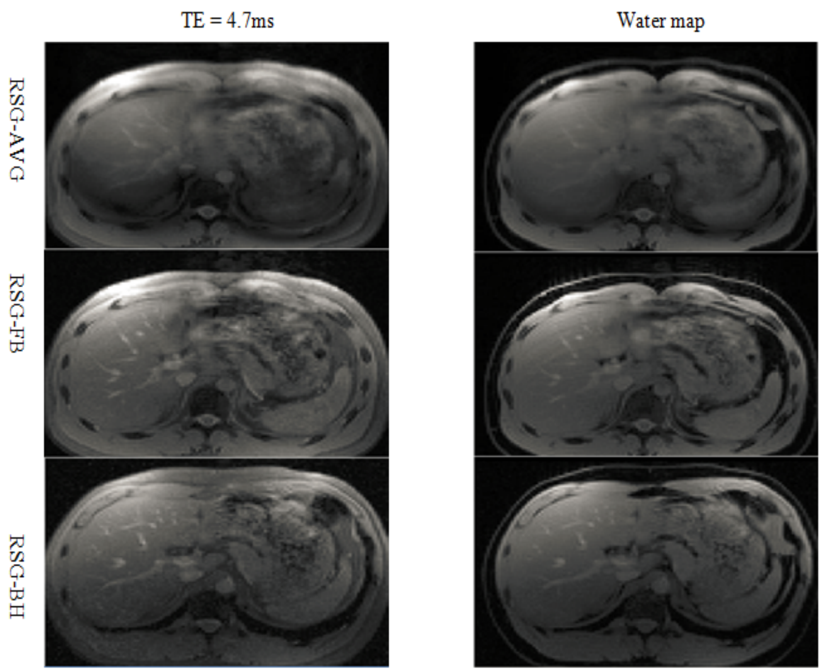

Figure 1 (a) (b) Magnitude and Water map images for three methods

Results: Magnitude images and corresponding water maps for a representative volunteer are shown in **Fig. 1** wherein RSG-BH stands for acquisition during breath-hold, RSG-FB images was acquired during FB with RSG and the RSG-AVG images included all data acquired during FB but with signal averaging rather than RSG. Magnitude images generated with RSG-AVG approach contained noticeable motion artifacts (ringing and/or blurring commonly observed). The RSG-FB method effectively mitigated motion artifacts, and provided qualitatively similar images as those generated with BH method. **Fig. 2** is a boxplot for the FF values calculated for each of the three methods. A Wilcoxon signed-rank test was performed with a significance level of 0.05 and a 95% confidence range to determine statistically significant differences between groups. The mean FF values within the liver measured using RSG-AVG were significantly lower than the values measured using RSG-BH (p = 0.036), while there was no significant difference between the mean FF measured using RSG-BH and RSG-FB (p = 0.4).

Discussion and Conclusions: In this work, we have qualitatively and quantitatively demonstrated the feasibility of applying the RSG-FB method for fat/water separation during abdominal imaging. The RSG-FB method successfully mitigated motion artifacts due to respiration and produced comparable fat-fraction values to BH approaches. In the future, these free-breathing fat/water separation methods may be valuable in clinical settings to avoid BH scan time limitations thus allowing superior spatial resolution, SNR, and imaging of sedated, non-compliant subjects.

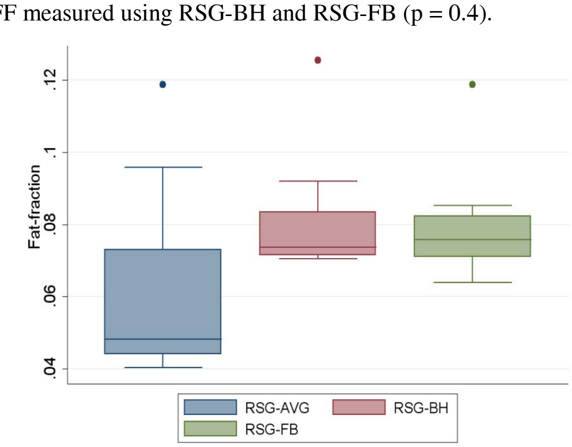

Figure 2 Liver Fat-Fraction Measurements from 8 Volunteers

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