Robust High resolution Fat-water separation in the abdomen during free-breathing by self-gated 2D radial TrueFISP imaging

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Target audience Physicists, clinicians.

Purpose Accurate high resolution fat-water separation of the abdomen is challenging due to respiratory motion. In this work we propose a robust high resolution fat-water separation[1-3] strategy in the abdomen during free breathing by employing radial sampling with a golden angle increment. To this end a radial TrueFISP sequence was modified enabling the echo time TE to change from projection to projection, to force fat signals to behave in a conspicuous manner through time, so they can be detected and separated from water signals through temporal processing. Thus, the center signal (DC) of each radial readout can then be used for respiratory gating[4] allowing the generation of multiple images at different TEs at multiple breathing states. Finally any fat-water separation technique can be used to synthesize high resolution fat and water images at arbitrary breathing states.

Material and Methods A radial TrueFISP pulse sequence was modified, wherein TE was made to vary between subsequent read-outs. Specifically, a series of 4 TEs was employed and periodically repeated, thereby distributing the acquired fat signal over the temporal frequency domain[3]. Experiments were carried out on a 3.0T clinical scanner using following imaging parameters: TR = 4.0ms, flip angle = 40°, FOV= 400x400 mm^2, radial readout points = 256 and TEs of TE1 = 1.6, TE2 = 2.0, TE3 = 1.6, TE4=2.4 ms. The coil channel providing the highest sensitivity towards respiratory motion was selected manually and gating windows was derived from the DC signal. Signals within each gating window were used to generate images at different TEs using non-uniform fast Fourier transform (NUFFT) gridding[5]. Each window included 631 radial projections. Finally, the application of appropriate filters to the image series allows one to discriminate fat and water as described in Ababneh et al[3].

Results Figure (1) shows the self-gating signal vs. the projection number from the coil channel #15. Figure 2 show the calculated water (a and b) and fat (c and d) images on a healthy volunteer, in one out of 12 reconstructed breathing states, where a and c images are the inspiration state, and b and d images are the expiration state.

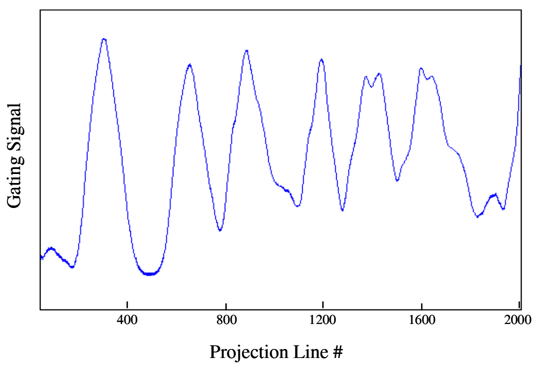

Fig. 1: Self-gating signal

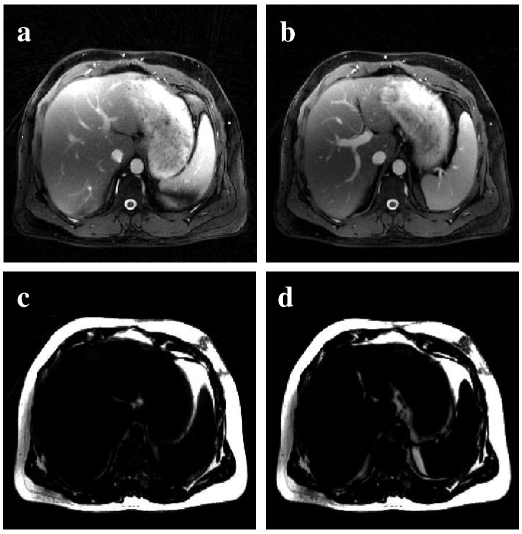

Fig. 2: Inspiration state (a,c) and expiration state (b,d) where (a,b) feature water content and (c,d) fat

Discussion & Conclusion A robust approach to separate fat and water signals combined with a self-gated reconstruction of different respiratory phases in free-breathing was presented. The self-gating reduces blurring artifacts caused by respiratory motion and enhances the image resolution. Fig. 2 shows that even small variations in TE (≤ 0.4 ms) were sufficient to allowing for accurate fat -water separation. In conclusion, the approach was tested in time resolved abdominal imaging. Good separation without streaking artifacts or blurring due to respiratory motion was obtained in all studied cases. While the concept has been demonstrated in 2D, future work will be targeted on extending the method to self-gated 3D radial imaging for robust fat-water separation in the abdomen**.**

Acknowledgements: The Deutsche Forschungsgemeinschaft DFG BR 4356/2-1 for funding, SIEMENS, Healthcare Sector, Erlangen, Germany.

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