Towards Clinical Robustness in Abdominal Water-Fat Imaging

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Introduction:

Respiratory motion is a common source of artifacts in MRI, especially in abdominal imaging, which can be minimized by breath-holding. However, the ability of patients to comply with predefined breath-hold durations varies greatly. Recently, a sampling pattern was proposed [1], which supports the reconstruction of images from data acquired up to a certain point in time excluding data collected after the onset of respiration. A compromise is made between undersampling artifacts and spatial resolution. In this work, the approach is extended towards clinical applicability. Dual-echo imaging is employed to permit a water-fat separation complemented by navigator-based motion detection for automatic scan termination.

Methods:

A 3D dual-gradient-echo sequence was chosen to measure the same k-space line twice in a single TR. The specific sampling pattern [1] was generated on-line during protocol specification. A segmented acquisition was performed with a 1D pencil beam navigator interleaved, positioned at the right diaphragm. The scan was automatically terminated when a large deviation from the initial diaphragm position, the average over the first few navigators, was detected. After off-line reconstruction with l1-SPIRiT [2], a Roemer reconstruction [3] was carried out to combine the images from the individual coil elements, followed by water-fat separation [4] yielding water and fat images.

Abdominal imaging was performed on volunteers on a 1.5T scanner (Philips Healthcare, The Netherlands), using a 16-element torso coil. A typical FOV of 380 x 280 x 240 mm^3 was covered with a target spatial resolution of 1.5 x 1.5 x 3.0 mm^3, with a TE1/TE2/TR of 1.3/2.3/3.7 ms.

Results:

Imaging with termination at breathing onset was performed on 7 volunteers. A typical navigator signal causing scan termination is shown in Fig. 1. The measurement underlying Fig. 2 was stopped after 19s. For a comparison without misregistration, shorter breath holding was simulated by further undersampling retrospectively. The corresponding images in Fig. 2 and the difference images upscaled by a factor of three in Fig. 3 exhibit a lower resolution and a loss of low contrast features for shorter breath-holds.

Conclusion:

This work advances the previously proposed approach towards clinical applicability. Water-fat resolved abdominal imaging with navigator-based scan termination provides optimal image quality adapted to the breath-hold capabilities of the individual patient.

References:

[1] Gdaniec N, et al. Proc ISMRM 2012; 600; [2] Lustig M, et al. Proc ISMRM 2009; 334; [3] Roemer PB, et al. MRM 1990; 16:192-225;[4] Eggers H, et al. MRM 2011; 65:96-107.

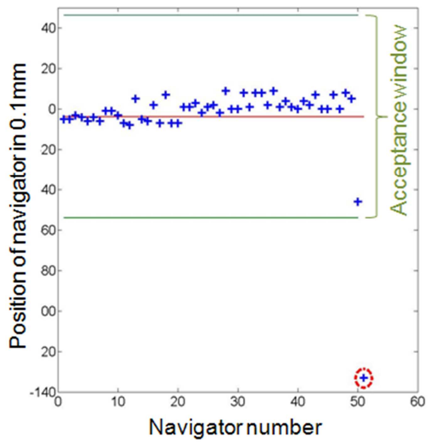

Fig.1: Typical navigator signal with little change in the position of the diaphragm during breath-holding. The second navigator after onset of breathing causes scan termination

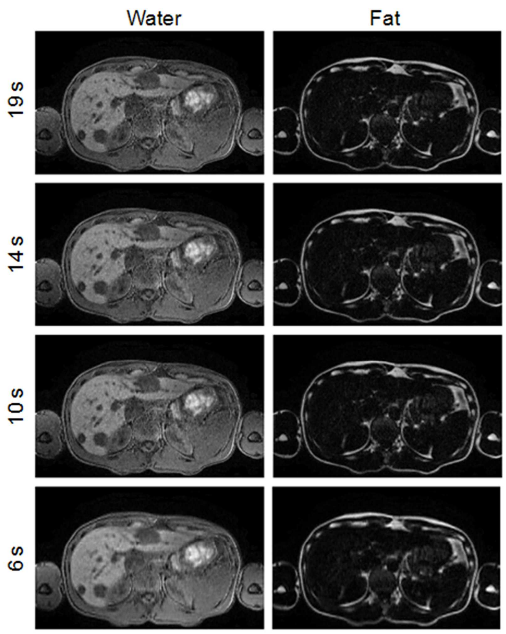

Fig. 2: Images from the same19s breath-hold. Retrospective undersampling was performed to simulate breath-holds of 14s, 10s and 6s.

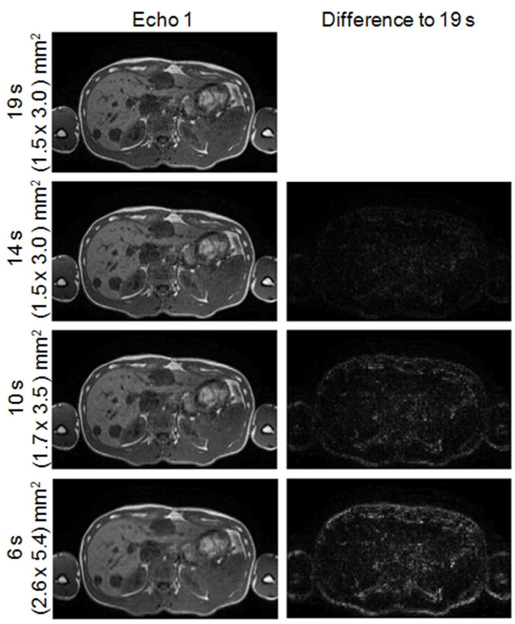

Fig 3: Echo 1 and difference images from the same 19s scan for simulated shorter breath-holds with decreasing resolution in the phase encoding directions, which are anterior-posterior and feet-head.