Evaluation of *k-t* BLAST and *k-t* SENSE for dynamic 3D intestinal MRI using a 32-channel phased array coil

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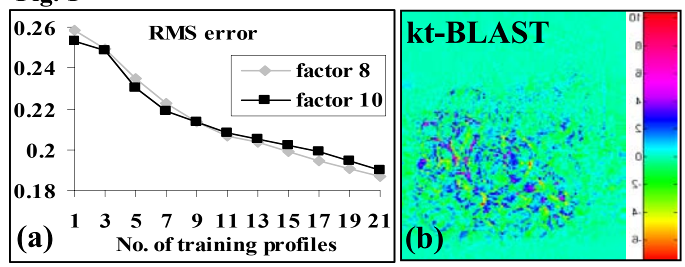
Introduction: The improvements in MRI gradient performance and application of dedicated imaging sequences have increased image acquisition speed and quality allowing excellent dynamic 2D MRI of bowel function (1-3). With the advent of *k-t* BLAST and *k-t* SENSE (4), which utilize the concept of compression to allow significant additional acceleration by reducing the number of sequential encoding steps, dynamic 3D abdominal imaging with high image and temporal resolutions has also become feasible. In this study, the *k-t* methods were applied and evaluated for the assessment of intestinal function. Resulting image quality was analysed and compared in terms of image processing performance.

Methods: For distension and delineation of the small bowel, a non-invasive oral preparation regime was applied in two volunteers (5). Imaging was performed during breathhold with volunteers in prone position positioned in a 32-channel phased array coil on a 1.5 T MRI system (NT Intera, Philips Medical Systems, Best, The Netherlands). A dynamic 2D acquisition (1 slice of 6mm, FOV=400mm, matrix=176x176 pixel, b-SSFP, TR/TE=2.8/1.4ms, flip=60°, 30 dynamics of 436ms) of the small bowel was performed to generate a reference data set for simulation of *k-t* BLAST/SENSE. Simulations were performed for different acceleration factors (*k-t* factors) and numbers of training profiles. The root-mean-square (RMS) error and difference images were computed. Applying 9 training profiles in both y- and z-direction, dynamic 3D imaging was then performed with acceleration factors of 8 and 10 for different volumes and slice thicknesses. The undersampled data was reconstructed using *k-t* BLAST and *k-t* SENSE. A semi-automated analysis tool, previously applied for the detection of gastric motility (6) was used to detect peristaltic frequency for selected small bowel loops.

Fig. 1



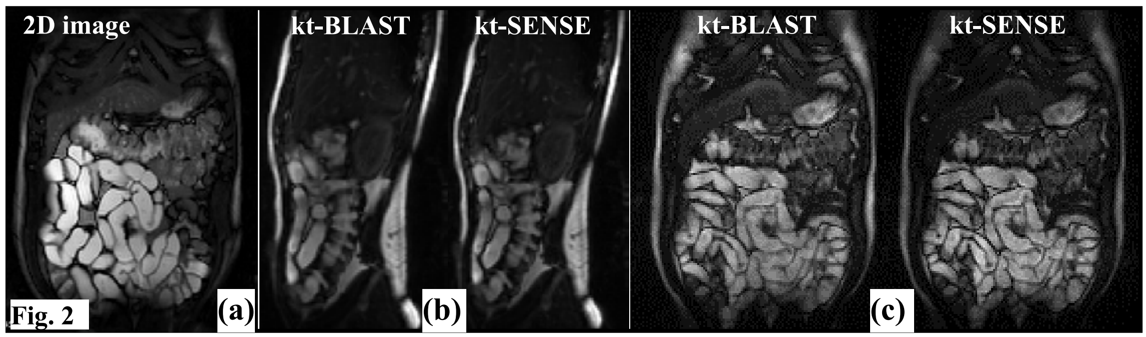
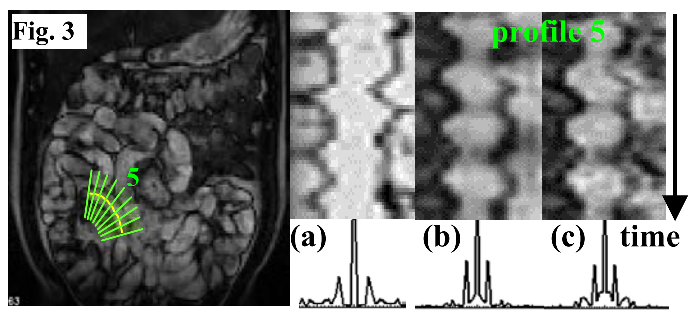


Fig. 2

Results: In Fig.1 (a), the RMS error is plotted for different training profiles (1-21) and acceleration factors (8 and 10). In Fig. 1 (b), a corresponding color-coded difference image is presented. Fig. 2 displays (a) a 2D image slice of the reference data, (b) image slice from sagittal 3D data (20 slices of 6mm, FOV=400mm, matrix=176x176 pixel, b-SSFP, TR/TE=4.2/2.1ms, flip=60°, 20 dynamics of 925ms) and (c) from coronal 3D data (8 slices of 6mm, FOV=400mm, matrix=176x176 pixel, b-SSFP, TR/TE=4.2/2.1ms, flip=60°, 50 dynamics of 590ms) both acquired with *k-t* factor of 10 and reconstructed using *k-t* BLAST and *k-t* SENSE. As expected, SNR is lower for the k-t methods and lowest for *k-t* SENSE, however, more temporal blurring of the intestinal walls is observed for *k-t* BLAST. Fig. 3 depicts the analysis method (left) and computed motility plots (right) that were used to investigate the influence of the resulting lower SNR and blurring on image processing performance. Wall motion of the small bowel is clearly visible ((a) reference, (b) *k-t* BLAST and (c) *k-t* SENSE) and peristaltic frequency detectable by spectral analysis in all three motility plots.

Fig. 3



Discussion: The *k-t* methods enable for the first time the dynamic acquisition of large 3D abdominal volumes at sufficient temporal resolution and image quality. Resulting image quality appears suitable for automated image analysis which is essential considering the huge amount of recorded MRI data. Besides this challenge in image processing, restricted memory and computer power are currently the major limitations in applying this method in the physiological setting.

References: **(1)** Froehlich, J.M. et al. Small bowel motility assessment with magnetic resonance imaging, *J Magn Reson Imaging*, 2005, 21(4), pp. 370-5. **(2)** Debatin, J.F et al. *Eur Radiol*, 1999, 9(8), pp. 1523-34. **(3)** Buhmann, S. et al., 2005, *Rofo*, 177(1), pp. 35-40. **(4)** Tsao J. et al. *Magn Reson Med*, 50(5), pp. 1031–1042. **(5)** Patak, M.A. et al. *Lancet*, 2001, 358, pp. 987-8. **(6)** Treier R. et al. *Proc. Intl. Soc. Magn. Reson. Med.*, 11, 2003.