Comparison of T2-weighted MRI of the Small Bowel at 7 Tesla and 1.5 Tesla

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Target audience: Scientists working at ultra-high field (UHF) MR systems with interest in abdominal imaging.

Purpose: Magnetic resonance imaging (MRI) of the small bowel has become a highly reliable technique in clinical routine to assess diseases of the small bowel, e.g. inflammatory bowel disease, tumors or bleedings, as well as associated extraluminal manifestations[1]. Despite the advantages of higher magnetic field strengths[2], some challenges exist[3]. An increase in imaging artifacts, especially in T2-weighted (T2w) imaging in 3 Tesla (3T) MRI of the small bowel compared with 1.5 Tesla (1.5T) have been described[4]. In comparison to brain imaging[5], T2w imaging of the abdomen at 7 Tesla (7T) is extremely limited in B1-homogeneity and choice of sequences[6]. The purpose of the present study is to investigate the possibilities of T2w ultra-high field (UHF) MR imaging of the small bowel focusing on the image quality and general feasibility. In addition, results of 7T imaging are compared with the current standard imaging field strength of small bowel MR imaging at 1.5T.

Methods: A 7T MR system (Magnetom 7T, Siemens AG, Healthcare Sector, Germany) was used in combination with an eight-channel transmit-receive body coil and an add-on system for subject-individual static RF shimming. MRI at 1.5T (Magnetom Avanto, Siemens Healthcare, Germany) was performed with a combination of a body-array surface receive coil covering the whole abdomen/pelvis and an integrated spine array receive coil (total number of 12 coil elements). Twelve healthy volunteers were examined prospectively. Small bowel was prepared with an oral contrast fluid. The following sequences were acquired: Coronal and axial T2w true fast imaging with steady-state precession (TrueFISP; 1.5T: 2.0×2.0×3.0 mm^3, 7T: 0.8×0.8×2.0 mm^3) imaging and a coronal T2w half-Fourier-acquisition single-shot turbo spin-echo (HASTE; 1.5T: 2.6×2.0×6.0 mm^3, 7T: 1.0×1.0×5.0 mm^3). At 7T, the TIAMO B_1-shimming technique was applied to reduce B_1^+ inhomogeneities.[7] Image analysis was performed by visual evaluation of tissue contrast and detail detectability. In addition, signal difference between bowel wall and lumen were measured for calculation of contrast ratios. Finally, image impairment due to artifacts was assessed. The Wilcoxon rank test was used for statistical analysis.

Results: Image quality and contrast regarding the small bowel at 7T is equal to 1.5T and useful for diagnostic purposes (Figure 1). Quantitative analysis of tissue contrast between wall and bowel lumen showed significantly higher contrast in the coronal HASTE at 7T (Figure 2), whereas contrast of tissue in the axial TrueFISP ($p = 0.0210$) was significantly higher at 1.5T ($p = 0.0425$). Coronal TrueFISP ($p = 0.5693$) revealed no statistical different tissue contrast. Susceptibility artifacts and B_1 inhomogeneities are significantly higher at 7T and result in an overall impairment of image quality when compared to 1.5T.

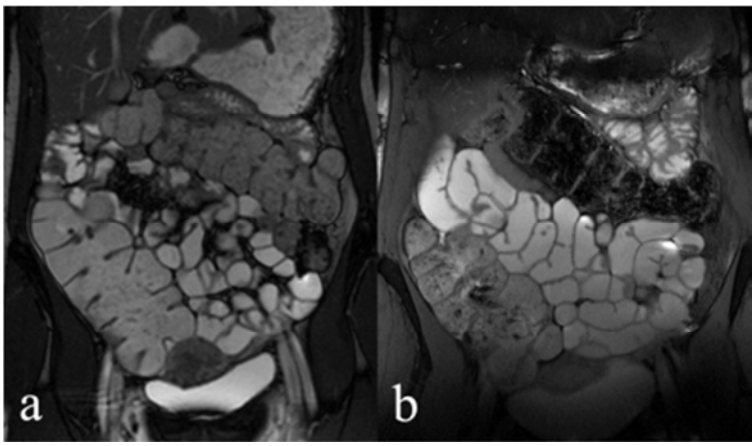

Figure 1 *Coronal TrueFISP of the same volunteer revealing equal tissue contrast and details of the small bowel at 1.5T (a) and 7T (b).*

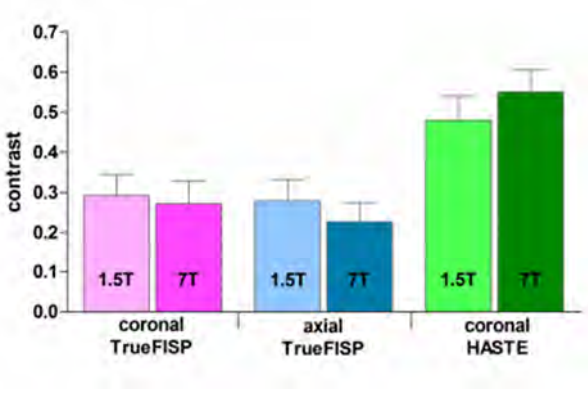

Figure 2 *Comparison of tissue contrast between bowel wall and bowel lumen at 1.5T and 7T.*

Discussion & Conclusion: T2-w imaging of the small bowel at 7T is feasible. Furthermore, this study provides first insights into T2w UHF MR imaging of the small bowel. Despite significantly increased impairment of image quality this study showed diagnostic useful T2w imaging of the small bowel at 7T. Known limitations due to susceptibility artifacts by gas content of the colon and rectosigmoid should be reduced. Additionally, further improvements in B_1 shimming should be the focus of future studies to minimize B_1 inhomogenieties. The possibility of improved detection of pathologic conditions in higher field strengths remains to be seen in future studies including patients with small bowel pathologies.

References:

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