The use of SPAMM for the assessment of motility patterns in the small bowel

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Purpose / introduction
Small bowel dysmotility is a frequent cause of a variety of gastrointestinal disorders [1]. Several diagnostic tests are available for the assessment of small bowel motility including scintigraphic techniques in the evaluation of transit time, impedance monitoring and manometry [2]. Implementation of these tests as a clinical method is hampered by their invasive character. SPAtial Modulation of the Magnetization (SPAMM) is a motion-sensitive MRI technique which was first described by Axel et al. in 1989 [3]. The aim of this study is to evaluate non-invasive 3.0 Tesla MRI as a diagnostic tool in the assessment of gastrointestinal motility patterns using the SPAMM method.

Methods
SPAMM is a widely applied technique in myocardial MRI imaging. The cardiac motion related deformation of the line pattern, induced in the magnetization by the SPAMM prepulse, is used to calculate strain properties of the heart muscle. In contrast to cardiac imaging, SPAMM in motility imaging must be applied non-triggered with high temporal resolution.

To configure SPAMM for abdominal imaging, we used a 1st order SPAMM pulse and inserted a delay of 250 ms between SPAMM and readout (see Figure 1). The delay causes the line pattern to deform from which local motion information can be extracted. During every readout an entire volume is scanned in 300 ms using a Turbo Field Echo (TFE). All scans were acquired on a 3.0 Tesla Philips Intera scanner using a 16 channel SENSE-XL-Torso coil. The TFE sequence included the following scan parameters: TR/TE 2.9/1.8 ms; FA 8°; no. slices 14; FOV 400 x 400 mm; voxel size 3.0 x 3.0 x 3.0 mm. Prior to the MR exam healthy volunteers received a standardized oral preparation, which consists of 1000 ml of Mannitol 2.5% solution. Subjects were scanned in supine position before and after the intravenous administration of Buscopan, which has an akinetic effect on peristalsis. Motion information stored in the deformed SPAMM lines was analyzed and expressed as a local translation vector as a function of time.

Results
Using the abdominal SPAMM sequence, we were able to visualize and quantify both the overall and regional motion occurred between SPAMM pulse and readout. Overall motility assessment is visualized in Figure 2 and 3. Deformation of the SPAMM lines is shown in the image plane and in the time direction. After Buscopan injection the deformation of the lines noticeably decreased.

Figure 4 illustrates the assessment of regional motility. ROIs were drawn in two proximal small bowel segments and consecutively local translation of the SPAMM lines as function of time was plotted. Injection of Buscopan directly translated into a decreased regional motility. Due to the akinetic effect of Buscopan injection the mean translation of the SPAMM lines decreased from 0.8 to 0.3 mm (ROI 1) and from 1.1 to 0.5 mm (ROI 2).

Conclusion
Three-dimensional Magnetic Resonance Imaging (3D-MRI) using SPAtial Modulation of the Magnetization (SPAMM) is a promising technique for the qualitative and quantitative assessment of gastrointestinal motility patterns with high temporal and spatial resolution. It can provide a non-invasive alternative to presently used diagnostic tests that might offer diagnostic accuracy and patient acceptance. Further clinical studies in larger populations are vital to prove if this method is a validated method for the detection of gastrointestinal motility disorders.

Figure 1: The use of SPAMM for the assessment of small bowel motility as proposed in this abstract. For the application of SPAMM there is only one readout phase, whereas the line pattern is refreshed every 550 ms.

Figure 2: SPAMM lines before (left) and after (right) intravenous injection of Buscopan, in coronal slice. In the image plane deformation of the SPAMM lines is visible in the small bowel before Buscopan injection.

Figure 3: SPAMM lines visualized in time direction at the position indicated by the vertical red/green lines in Figure 2 (A and C). The green portion of the lines represents small bowel and is enlarged in figures B and D. The amount of deformation in the lines indicates regional bowel motility. Lines after Buscopan injection are straighter due to the decrease of motility.

References