MR colonography with parallel acquisition techniques to increase spatial resolution: a feasibility study

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Introduction:

Magnet resonance colonography (MRC) is a promising method for the depiction of colorectal pathologies. For colorectal masses exceeding 10mm, high accuracy values (92% to 100%) have been reported (1). However, due to limited spatial resolution, the detection rate of smaller pathologies is only fair. Another limitation of current MRC protocols is related to relatively long data acquisition of up to 25 seconds, which need to be performed under breath-hold conditions. Especially in elderly patients or patients with diseases of the respiratory tract, this can result in severe motion artefacts hampering a reliable assessment of the colon. The underlying problems may be solved by new image acquisition techniques providing a higher spatial resolution and / or a decreased acquisition time. These parallel acquisition techniques (PAT) have recently been successfully applied for MR colonography in an in-vitro study (2). Aim of the current trial was to prove the practicability of PAT imaging for MR colonography in-vivo.

Methods:

9 healthy volunteers were examined on three separate occasions each. MRC was performed on a 1.5 T MR system (Magnetom Sonata, Siemens Medical Solutions, Erlangen, Germany). Following intravenous administration of 40mg scopolamine (Buscopan®; Boehringer Ingelheim, Germany) to minimize bowel peristalsis and to reduce colonic spasms, the colon was filled with approximately 2000ml of warm tap water via a rectal tube using hydrostatic pressure. Paramagnetic contrast (Gd- DTPA, Magnevist®, Schering, Germany) was administered at a dosage of 0.1mmol/kg BW and a flow rate of 2ml/s. A T1w 3D gradient echo data set was collected in coronal plane in a single breathhold (TR/TE/flip 3.08/1.13/35°). The following sequence parameters were randomly varied for the three examinations: (A) without PAT, matrix 256 x 168, acquisition time 24s; (B) PAT applied with GRAPPA, acceleration factor 2, matrix: 320 x 245, acquisition time 24s; (C) PAT applied with GRAPPA, acceleration factor 2, matrix: 256 x 168, acquisition time 15s. All data sets were evaluated regarding presence of artefacts (including motion or wrap-around) using a three-point scale: 1 = no artefacts, 2 = moderate artefacts, diagnostic image quality, 3 = extensive artefacts, not diagnostic. Besides, the ability to depict small anatomical structures was assessed (1 = good, 2 = moderate, 3 = poor depiction). Eventually, the colon was divided into five segments: ascending / transverse / descending / sigmoid colon / rectum and the contrast between bowel wall and lumen was rated for each segment using a three-point scale (1 = high, 2 = moderate, 3 = poor contrast). Results between the three examination types were compared using a Wilcoxon test.

Results:

MR colonography using PAT was applicable in all volunteers. Although protocol C led to a slightly reduced mean level of artefacts (1.4), results were not statistically significant different within the three groups (A: 1.5; B: 1.5) (fig.1). Voxel size could be reduced from 2.5x1.9x1.8mm^3 (A and C) to 1.8x1.5x1.8mm^3 (B). Thus, significant differences ($p<.05$) were found between group B and group A/C for the depiction of small anatomical structures with average values of 1.7 (A) vs. 1.3 (B) (fig.2) vs. 1.8 (C). Contrast parameters were best for the non-PAT group A (1.1) with significant lower, but still high values for group B an C (1.4 each).

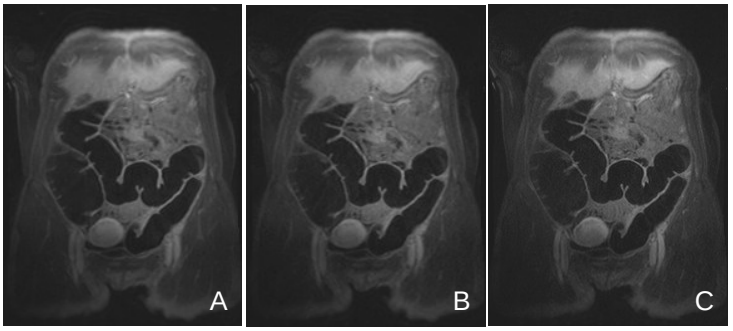

Fig.1: contrast-enhanced T1w GRE data set (A) without PAT, matrix 256 x 168, (B) PAT applied with GRAPPA, acceleration factor 2, matrix: 320 x 245, (C) PAT applied with GRAPPA, acceleration factor 2, matrix: 256 x 168

Discussion:

Our data indicate that MR colonography can be performed using PAT to increase spatial resolution. Thus, more detailed anatomical structures can be depicted and a detection of smaller colorectal lesions may be possible. Furthermore, acquisition time can be reduced, which may be helpful especially in patients not able to adequately hold their breath. Both PAT protocols did not result in a higher presence of image artefacts, but led to a lower contrast between bowel wall and lumen compared to non-PAT. However, both PAT protocols provided sufficient image contrast and allow for a reliable assessment of the bowel wall.

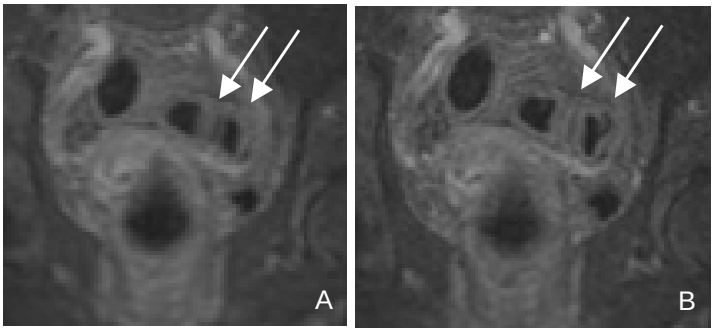

Fig.2: contrast-enhanced T1w GRE data set (A) without PAT, matrix 256 x 168, (B) PAT applied with GRAPPA, acceleration factor 2, matrix: 320 x 245.

References:

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2. Steidle G, Schäfer J, Schlemmer HP, Claussen CD, Schlick F. Two-Dimensional Parallel Acquisition Technique in 3D MR Colonography. RoeFO. 2004; 176:1100-1105