High contrast to noise ratio (CNR) using CO2 for colonic distension in 3.0 Tesla Magnetic Resonance Colonography (MRC)

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Purpose / introduction

Magnetic Resonance Colonography (MRC) is studied as screening technique for colorectal cancer. The lack of ionizing radiation and the superior contrast resolution over computed tomography (CT) make MRC a valuable alternative to CT-colonography [1]. At present the optimal scan parameters and bowel preparation, aimed at high image quality and minimized patient burden, are not known. Importantly, patient acceptance of MRC is diminished as fluid enemas are used [2]. A strategy using carbon dioxide (CO2) for bowel distension as used in CT-colonography can be expected to lead to far better patient acceptance. The objective for this study is the quantitative assessment of Magnetic Resonance Colonography (MRC) quality at 3.0 Tesla, using CO2 as intraluminal contrast medium.

Methods

In this prospective pilot study 21 healthy subjects undergo 'dark lumen' Magnetic Resonance Colonography (MRC). In order to obtain colonic distension, CO2 gas is inflated into the colon, using an automated insufflator. Fast T1-weighted three-dimensional (3D) Turbo Field Echo (TFE) and T2- weighted two-dimensional (2D) half-Fourier single-shot turbo spin-echo (HASTE) sequences are collected on a 3.0 Tesla Philips Intera scanner using a 16 channel SENSE-XL-Torso coil for signal reception of the entire colon, in prone and supine positions. The 3D-T1w turbo field echo (TFE) sequence included the following parameters: TR/TE 2.12/1.01 ms; FA 10°; No. slices 90; FOV 400 x 400 mm; VOXEL 2.00 x 2.00 x 2.00 mm. The T2w (HASTE) sequence included the following parameters: TR/TE 475/60 ms; FA 90°; No. slices 45; FOV 400 x 400 mm, VOXEL: 2.00 x 2.00 x 3.00 mm. Scans were acquired without the administration of intravenous contrast medium. For the purpose of qualitative analyses in two subjects the colon was subdivided in 6 segments: cecum, ascending colon, transverse colon, descending colon, sigmoid colon and rectum. For quantitative assessment regions of interest (ROI) were placed in lumen and wall of each of the predefined six segments *(see figures 1 and 2)*. True standard deviation of the noise (σ) was measured in a region of interest outside the body and was used to calculate signal to noise ratio (SNR= S/σ) [3]. Contrast to noise ratios (CNR) between wall and lumen were calculated as CNR = $SNR_{wall} - SNR_{lumen}$.

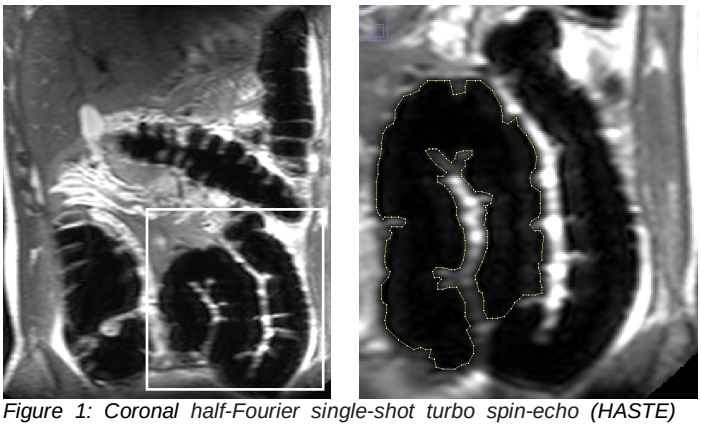

Figure 1: Coronal half-Fourier single-shot turbo spin-echo (HASTE) image. Region of interest (ROI) selected for the assessment of intraluminal signal to noise ratio (SNR).

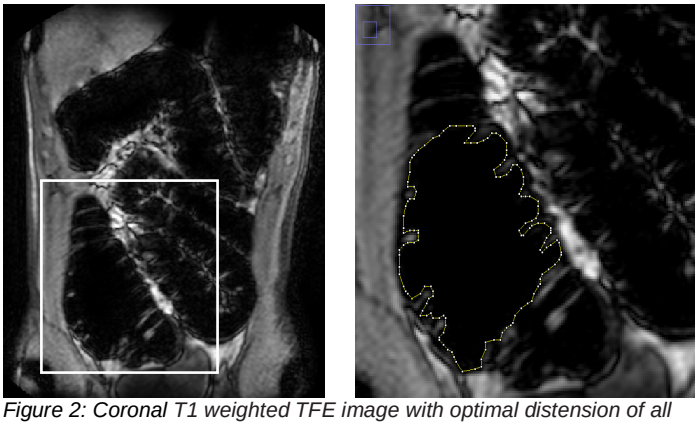

Figure 2: Coronal T1 weighted TFE image with optimal distension of all shown bowel segments. Region of interest (ROI) selected for the assessment of intraluminal signal to noise ratio (SNR).

Results

All colonic segments showed good distension in both prone and supine position. Contrast to noise ratios (CNR) were calculated for 12 colonic bowel segments as shown in table 1. Mean CNR between bowel wall and bowel lumen was 45.5 and 41.7 in resp. subject 1 and 2 during the T2 HASTE sequence. In the 3D-TFE sequence, mean CNR of resp. 21.5 and 22.4 was measured without the administration of intravenous contrast agent.

Conclusion

Magnetic Resonance Colonography (MRC) using CO2 as intraluminal contrast medium is feasible. This preliminary data show promising outcomes regarding the qualitative evaluation of this technique with high contrast to noise ratio (CNR) values without the intravenous administration of paramagnetic contrast medium.

References
[1] Kuehle CA et al. *Gut.* 2007 Aug;56(8):1079-85
[2]Florie et al. *Radiology* 2007;245:150-159
[3] Ajaj W et al. *Gut* 2003;52:1738–1743

Table 1 a + b: Quantitative assessment of MRC image quality. Contrast to noise ratio (CNR) per bowel segment and mean value is shown for a) T2 weighted images and b) T1 weighted images. (A.colon=Ascending colon; T.colon=Transverse colon; D. colon=Descending colon)

T2 HASTE	Cecum	A. colon	T. colon	D. colon	Sigmoid	Rectum	Mean
CNR Subject 1	51.4	43.9	30.6	54.5	50.6	41.7	45.5
CNR Subject 2	41.6	41.4	28.6	59.6	34.1	45.5	41.7

T1 TFE	Cecum	A. colon	T. colon	D. colon	Sigmoid	Rectum	Mean
CNR Subject 1	19.9	22.6	14.2	22.8	22.5	26.7	21.5
CNR Subject 2	25.9	28.6	12.6	32.1	17.1	18.0	22.4