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Dark Lumen MR Colonography: Can High Spatial Resolution VIBE Imaging Improve the Detection of Colorectal Masses?

Dunkellumen-MR-Kolonographie: Kann hochaufgelöste VIBE-Sequenz die Detektion von kolorektalen Läsionen verbessern?

Zusammenfassung

Ziel: Beurteilung, ob die Detektion von kolorektalen Läsionen durch die Verwendung hochaufgelöster VIBE-Sequenz verbessert werden kann. **Material und Methoden:** 48 Patienten wurden am selben Tag mit Dunkellumen-MR-Kolonographie (DL-MR-K) und konventioneller Koloskopie (KK) als Standardverfahren für die Detektion von kolorektalen Läsionen untersucht. Die DL-MR-K wurde durchgeführt nach Akquisition einer T1-gewichteten kontrastverstärkten Standard- und hochaufgelösten VIBE-Sequenz. Befunde und Bildqualität der Standard- und hochaufgelösten VIBE-Sequenz wurden miteinander qualitativ und quantitativ verglichen. Die Ergebnisse beider Sequenzen zur Detektion kolorektaler Läsionen wurden mit denen der konventionellen Koloskopie verglichen. **Ergebnisse:** Die hochaufgelöste VIBE-Sequenz zeigte zwar eine statistisch signifikante Verbesserung der quantitativen Bildqualität (CNR 54,0 vs. 36,8); allerdings konnte sie keine Verbesserung der Detektion von kolorektalen Läsionen im Vergleich zu der Standard-VIBE-Sequenz zeigen. Zusätzlich war keine der beiden Sequenzen in der Lage, Läsionen unter 5 mm Durchmesser zu detektieren (in der KK: 40 Läsionen). Im Gegenteil konnten 13 der größer 5 mm messenden kolorektalen Läsionen durch beide Sequenzen erfasst werden (KK 15). **Schlussfolgerung:** Die hochaufgelöste VIBE-Sequenz konnte keine Verbesserung der Detektion von kolorektalen Läsionen zeigen; zudem ist die DL-MR-K nicht in der Lage, Läsionen kleiner 5 mm im Durchmesser zu detektieren.

Abstract

Purpose: To assess whether the detection of colorectal lesions can be improved using high spatial resolution VIBE imaging. **Materials and Methods:** 48 patients underwent same-day dark lumen MR colonography (MRC) and conventional colonoscopy (CC) as the standard for the detection of colorectal masses. MRC was performed using contrast-enhanced standard and high spatial resolution T1-weighted 3D VIBE sequences. The findings and the image quality of the standard and high spatial resolution VIBE sequences were compared qualitatively and quantitatively. The findings of both sequences regarding colorectal lesions were compared to those of a subsequently performed colonoscopy. **Results:** The high spatial resolution VIBE sequence significantly improved the quantitative image quality (CNR 54.0 vs. 36.8). However, high spatial resolution VIBE imaging did not detect more colorectal lesions than the standard VIBE sequence. In addition, none of the sequences employed was able to detect lesions with a diameter of less than 5 mm (CC 40 lesions). However, 13 colorectal lesions with a diameter of greater than 5 mm were detected by both sequences (CC 15). **Conclusion:** High spatial resolution VIBE imaging did not improve the detection of colorectal masses and MRC fails to detect colorectal lesions with a diameter of less than 5 mm.

Key words
Colonoscopy · abdomen · MR imaging · MR colonography · VIBE imaging · conventional colonoscopy

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Introducion

Fibre-optic colonoscopy performed by the gastroenterologist represents to date the gold-standard procedure for the inspection and assessment of the entire colon and the detection of its masses [1, 2]. Advantages of fibre-optic colonoscopy are the possibility to remove and/or biopsy of colorectal lesions. Magnetic resonance imaging (MRI) with the administration of contrast agents and post-processing soft-ware paved the way for a new area to detect colorectal masses.

Dark-lumen MR Colonography (MRC) using a VIBE imaging with a matrix of 168 × 256 has been shown to be an appropriate diagnostic tool for the detection of colorectal masses [3, 4]. MRC is based on focal uptake of T1-shortening contrast material in colonic lesions which are displayed as bright areas on T1-weighted sequences, whereas the lumen is rendered totally dark due to water enema that serve as filling material [3, 4]. The latter leads to uniform luminal darkening as well as sufficient distention of the colon. The intravenous application of paramagnetic contrast agents allows the direct depiction of the colorectal wall. Thus, the bright colonic wall can be easily discriminated from the dark, water-filled colonic lumen [3, 4]. Results of several preliminary studies indicate that MRC has a high sensitivity just for detection of colorectal masses larger than 5 mm in diameter [3, 4].

The aim of this study was to assess if high spatial resolution MR VIBE imaging using a matrix of 512 × 256 improves the detection of colorectal lesions and eliminates weaknesses of MRC.

Materials and Methods

The study was conducted in accordance with all guidelines set forth by the approving institutional review board. Informed consent was obtained prior to each examination. Exclusion criteria included contraindications to MR imaging, such as presence of a pacemaker, metallic implants in the central nervous system or claustrophobia.

Subjects

Within a 10-month period 48 patients (27 men, 21 women, mean age: 51.7 years, age range 44 – 67 years) underwent MR colonography (MRC) within 24 hours prior to CC. The patient cohort included symptomatic and asymptomatic patients who had been referred to CC for various indications including first colorectal screening over 50 years of age (n = 19), abdominal pain (n = 10), suspected Crohn's disease or ulcerative colitis (n = 7), a positive fecal occult blood test (n = 3), a positive family history of colorectal cancer (n = 2), suspected diverticulitis (n = 3) and chronic diarrhea (n = 4).

Bowel preparation

All patients underwent a standardized bowel cleansing procedure with 3000 ml of a polyethylene glycol solution (Golytely®: sodium chloride 1.46 g, sodium hydrogencarbonate 1.68 g, sodium sulfate 5.68 g, potassium chloride 0.75 g, polyaethylen glykol 4000 59 g, Braintree Laboratories, Braintree, Massachusetts), of which 2000 ml were ingested the night before and 1000 ml in the morning of the examination day.

MR Imaging

MRC was performed with the patients in prone position on a 1.5 T MR system (Magnetom Sonata®, Siemens Medical Solutions, Erlangen/Germany) equipped with a high-performance gradient system characterized by a maximum gradient amplitude of 40 mT/m and a slew rate of 200 mT/m/msec. Imaging in prone position generally reduces bowel motion artifacts. A combination of two surface coils was used in conjunction with the built-in spine array coil for signal reception to permit coverage of the entire colon. To minimize bowel peristalsis, 40 mg of scopolamine (Buscopan® Boehringer Ingelheim/Germany) were injected intravenously prior to the enema. None of the patients revealed any contraindications for scopolamine. Following the placement of a rectal enema tube (E-Z-Em, Westbury, NY/USA) the colon was filled with approximately 2000 – 2500 ml of warm tap water. This enema was performed without fluoroscopic control, as the maximum amount of water that can be administered depends only on the patient's subjective feeling; also, according to our experience, the cecum is dilated in every case following this regime. Following bowel distension, a standard T1w 3D gradient echo data set with integrated fat suppression (VIBE, Volumetric Interpolated Breathhold Examination) was collected breath-held in the coronal plane. Sequence parameters were: TR/TE 3.1/1.1 msec, flip angle 12°, field of view (FOV) 400 × 400 mm, matrix 168 × 256, an effective slice thickness of 1.6 mm, and a voxel size of 2.4 × 1.6 × 1.6. Depending on the patient's size the number of slices amounted to 70 – 82 and the breath-holding period was between 17 – 20 sec. In addition, a high spatial resolution VIBE sequence was acquired in the coronal plane. Sequence parameters were: TR/TE 3.4/1.4 msec, flip angle 12°, field of view (FOV) 400 × 400 mm, matrix 512 × 256, an effective slice thickness of 2.6 mm, and a voxel size of 1.6 × 0.8 × 2.6. Depending on the patient's size the number of slices amounted to 60 – 74 and the breath-holding period was between 18 – 23 sec.

Subsequently, paramagnetic contrast agent (Gd-BOPTA, MultiHance®, Bracco, Milan/Italy) was administered i. v. at a dosage of 0.2 mmol/kg body weight and a flow rate of 3.5 ml/sec. Following a delay of 75 sec the standard VIBE sequence was acquired. Following a 100 sec delay (75 sec delay after i. v. contrast injection, 20 sec acquisition time of the standard VIBE sequence and 5 sec breathing) the high spatial resolution VIBE sequence was acquired. After the MRC-examination the water-enema was released back into the enema bag and the patients went to the bathroom.

Conventional colonoscopy procedure

CC was performed using standard equipment (model CFQ 140; Olympus, Tokyo/Japan). The attending gastroenterologist was unaware of the MR findings. All patients obtained sedatives (2.5 – 5 mg Midazolam: Dormicum®, Roche, Grenzach-Wyhlen/Germany) or, when necessary, also a low dose of analgesics (Dolantin® Hoechst, Bad Soden/Germany). Inclusion criteria for the detection of colorectal lesions were size, wall convexity and morphology (flat or polypoid). The gastroenterologist was asked to remove all removable colorectal polyps. Position and size of colorectal findings were appointed by means of location in the colonic segments and diameter of the lesions. Possible complications of CC like perforation, bleeding, allergy or cardiovascular disorders after i. v. administration of the above-mentioned drugs were documented.

Histologic analysis of colonic lesions

All removed colonic lesions were sent for histologic examination and each lesion was evaluated by a board-certified, experienced pathologist.

Data analysis

For each patient, both non-contrast and contrast-enhanced 3D data sets were transferred to a post-processing workstation (Virtuoso®, Siemens Medical Solutions, Erlangen/Germany). MR data sets were analyzed in the multiplanar reformation mode, which permitted scrolling through the 3D data sets in all three orthogonal planes by two experienced radiologists (> 4 years experience in abdominal MR imaging) in consensus who had no knowledge of the respective coloscopic findings. For purposes of analysis the colon was divided into six segments: rectum, sigmoid colon, descending colon, transverse colon, ascending colon and cecum.

Assessment of image quality of MRC

The Image quality of the 3D contrast-enhanced data-sets was assessed both qualitatively and quantitatively. Each segment was evaluated for the presence of artifacts including motions and susceptibility artifacts: 1 = no artifacts, 2 = moderate artifacts, diagnostic image quality, 3 = extensive artifacts, non-diagnostic image quality.

For the quantitative analysis contrast-to-noise ratios (CNR) were assessed for representative parts of all bowel segments. For this purpose, the coronal MR images were magnified three-fold. Regions of interest (ROI) were placed in the lumen and the adjacent wall of all segments. Image noise, defined as the standard deviation of signal intensities measured in an ROI placed outside the body was determined (Fig. **1a**, **b**). Based on these measurements CNR was calculated: CNR = (SI (colonic wall/colonic lesion) – SI (lumen))/noise. CNR values of all colorectal masses were determined in the same manner described before.

MRC findings

All MR data sets were assessed for the presence of colorectal lesions and inflammatory bowel disease. Employed criteria included increased contrast uptake of lesions and the colonic wall, wall thickening and loss of haustral folds.

Statistical analysis

Ratings were compared by an unpaired Student t-test using a p-value of < 0.05 to indicate statistical significance. For the adaptation to multiple samples, a Bonferoni correction was employed.

Results

All MRC as well as all CC-examinations were performed without any complications.

Image quality

The assessment of both sequences for artifacts failed to show a statistically significant difference in favour of the high spatial resolution VIBE-sequence. The mean value of the image quality was rated as 1.14 for the high spatial resolution VIBE sequence and 1.27 for the standard VIBE sequence. Statistically significant differences were detected when comparing the respective CNR values ($p < 0.05$). The intraindividual comparison between both sequences revealed the high spatial resolution VIBE sequence to be associated with higher CNR-values than the standard VIBE-sequence. Overall, the high spatial resolution VIBE sequence was associated with a mean CNR of 54.0, while the standard VIBE sequence resulted in a mean CNR of merely 36.8. The increased values of CNR of the rectum and transverse colon were compared to the other colonic segments based on the high blood perfusion and the resulting high contrast uptake of both segments. The parameters of all colonic segments are listed in Table **1**. In addition, the detected colorectal lesions have shown higher CNR values on the high spatial resolution VIBE-sequences compared to the standard VIBE-sequence (mean CNR: 71.4 versus 55.7).

MR findings of both sequences

There were no differences in MR findings between both sequences. In 28 patients MRC did not show any colorectal lesions or other pathologies; thus, those examinations were classified as normal. In ten patients eleven polyps with diameters between 6 – 15 mm

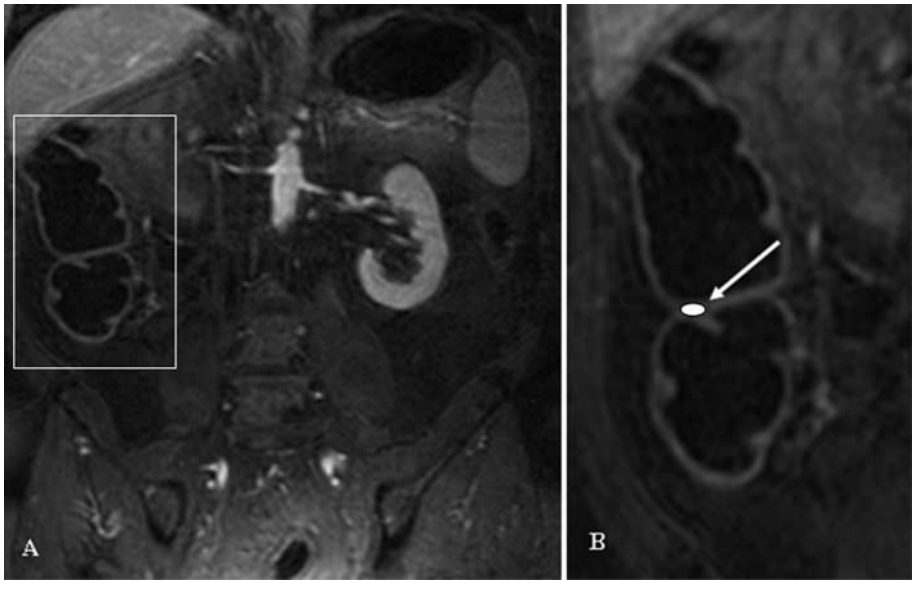

Fig. **1** Coronal source image from T1-weigted gradient-echo 3D MR imaging data set **A** using a standard VIBE sequence (TR/TE 3.1/1.1 msec, flip angle 12°, matrix 168 × 256). The coronal source image was acquired after i.v. application of contrast medium. **B** is an enlargement of **A**. Contrast-to-noise ratio (CNR) in the wall of all colonic segments can be easily determined (circle and arrow).

	rectum	sigmoid colon	descending colon	transverse colon	descending colon	cecum	mean
artifacts standard VIBE	1.17±0.3	1.29±0.3	1.30±0.5	1.29±0.4	1.29±0.5	1.29±0.5	*1.27*
artifacts high spatial resolution VIBE	1.10±0.2	1.12±0.2	1.15±0.3	1.17±0.2	1.15±0.2	1.15±0.2	*1.14*
CNR post contrast standard VIBE	47.0±6	39.0±5	31.0±5	46.0±4	29.0±6	29.0±5	*36.8*
CNR post contrast high spatial resolution VIBE	60.0±2	57.0±3	51.0±3	56.0±2	50.0±2	50.0±2	*54.0*

Table **1** Clinical data of the patients regarding image quality

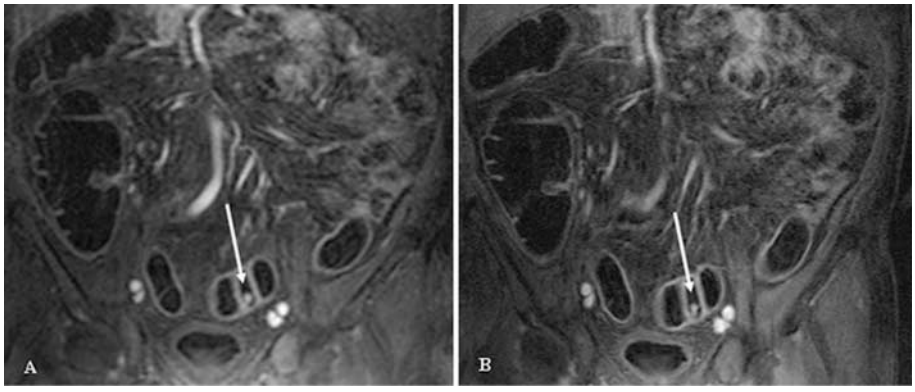

Fig. **2** Contrast-enhanced standard VIBE sequence **A** of a 60 year-old female patient who underwent MRC as part of a screening examination. In MRC a 9 mm polyp in diameter was seen in the sigmoid colon (arrow) which was confirmed in CC. **B** shows the high spatial resolution VIBE sequence (TR/TE 3.4/1.4 msec, flip angle 12°, matrix 512 × 256) of the same patient which confirmed the polyp in the sigmoid colon (arrow). An additional polyp of 5 mm in diameter was confirmed in CC which was missed in both standard and high spatial resolution VIBE sequence.

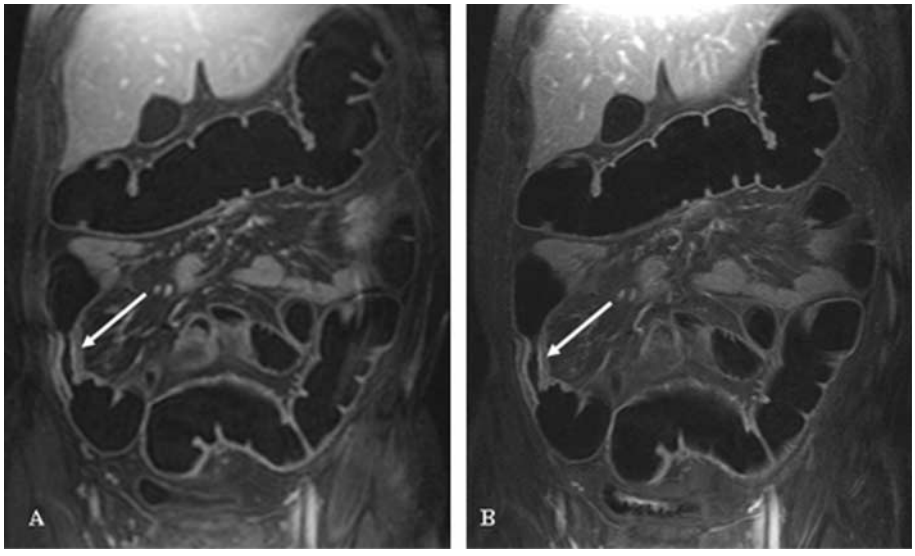

Fig. **3** Coronal image of standard VIBE sequence **A** of a 37 year old patient with Crohn's disease after intravenous administration of contrast agent. With the help of wall thickness and contrast enhancement a moderate stenosis of the ascending colon was seen (arrow) which was confirmed by means of CC. Additionally, CC found two small polyps less than 5 mm in diameter which were missed in MRC. **B** shows the high spatial resolution VIBE sequences of the same patient confirming the moderate stenosis of the ascending colon (arrow), however the two small polyps were also missed.

were seen in MRC (Fig. **2a**, **b**). In these ten patients no further colorectal pathologies were detected. In two patients with sigmoid diverticulosis two polyps with diameters of 7 and 9 mm were detected. Two patients showed a polyposis coli. One patient revealed a sigmoid diverticulitis and in four patients with Crohn's disease and ulcerative colitis inflammatory affected colonic segments were found. Additionally, in one patient with Crohn's disease a moderate stenosis of the ascending colon was seen (Fig. **3a**, **b**).

CC findings

CC did not find any pathologies in 13 patients (MRC 28 patients). In the remaining 15 patients in whom MRC did not reveal any pathologic findings two polyps (9 and 11 mm in diameter) and 25 polyps smaller than 5 mm in diameter were seen. CC confirmed eleven polyps in ten patients which were seen on the MRC data-sets. Additionally, CC was able to detect seven polyps smaller than 5 mm in diameter in these ten patients.

Furthermore, CC confirmed two polyps in two patients with diverticulosis and one of the two patients had a polyp smaller than 5 mm in diameter which was missed in the MRC. CC confirmed polyposis coli in two patients. CC confirmed diverticulitis in one patient and no polyps in this patient were seen. CC confirmed in four patients inflammatory signs and the moderate stenosis in one patient which was seen on the MRC data-sets. Additionally, CC found seven polyps smaller than 5 mm in diameter in the four patients with Crohn̈s disease which were missed on the MRC data sets. Overall, 40 polyps smaller than 5 mm and 15 larger than 5 mm

were detected in CC. However, just 33 polyps smaller than 5 mm but all 15 polyps larger than 5 mm were removed. All findings of standard and high spatial resolution VIBE sequences and CC are listed in Table **2**.

Table **2** Findings of standard and high spatial resolution VIBE sequences and CC

standard VIBE – findings –	***high spatial VIBE – findings –***	***CC – findings –***
28 patients no lesions or pathology	*28 patients* no lesions or pathology	*13 patients* no lesions or pathology *15 patients* 2 polyps (9 × 11 mm) 25 polyps < 5 mm
10 patients 11 polyps between 6 – 15 mm	*10 patients* 11 polyps between 6 – 15 mm	*10 patients* 11 polyps between 6 – 15 mm *additional* 7 polyps < 5 mm
2 patients diverticulosis and 2 polyps (7 × 9 mm)	*2 patients* diverticulosis and 2 polyps (7 × 9 mm)	*2 patients* diverticulosis and 2 polyps (7 × 9 mm) *additional* 1 polyp < 5 mm
2 patients polyposis coli	*2 patients* polyposis coli	2 patients polyposis coli
1 patient sigmoid diverticulitis	*1 patient* sigmoid diverticulitis	*1 patient* sigmoid diverticulitis
4 patients inflammatory signs due to CD and ulcerative colitis	*4 patients* inflammatory signs due to CD and ulcerative colitis	*4 patients* inflammatory signs due to CD and ulcerative colitis *additional* 7 polyps > 5 mm
1 patient moderate stenosis of the ascending colon due to CD	*1 patient* moderate stenosis of the ascending colon due to CD	*1 patient* moderate stenosis of the ascending colon due to CD
sensitivity/specificity for colorectal lesions > 5 mm in diameter 86/100 %	*sensitivity/specificity for colorectal lesions > 5 mm in diameter 86/100 %*	*standard reference*

Histological findings

The pathologist histologically examined 33 polyps with a diameter of less than 5 mm and 15 polyps larger than 5 mm in diameter. The pathologist graded the 33 polyps which were smaller than 5 mm as tubular (14 polyps), tubulovillous (6 polyps), villous (4 polyps), inflammatory hyperplastic (6 polyps) and juvenile (3 polyps). In none of the 33 polyps a carcinoma or dysplasia was seen. In the other 15 polyps lager than 5 mm in diameter just 2 polyps with dysplasia malignancy signs were seen (13 and 15 mm in diameter). The remaining 13 polyps were classified as follows: 7 were tubular, 3 tubulovillous and 3 villous.

Discussion

The presented data carry two messages we believe to be important: a) High spatial resolution VIBE sequence improved the image quality quantitatively; however, this sequence did not detect more colorectal lesions or pathologies compared to the standard VIBE sequence. b) This study confirmed the insufficiency of MRC to detect polyps smaller than 5 mm in diameter using standard or high spatial resolution VIBE sequence.

Colonic cancer is an ideal disease candidate for screening and secondary prevention. Early detection of colorectal polyps leads to a decreased incidence of colorectal cancer [5, 6]. CC is the standard of reference to detect colonic pathologies [7, 8]. As many studies have shown, discomfort and unpleasantness of CC and low acceptance of CC decreases the screening benefit for colorectal cancer [9, 10]. All those facts led to the development of other methods to detect colorectal pathologies based on 3D imaging techniques. The size as well as the histology of detected colorectal polyps is important because large polyps are neoplastic (adenomatous or cancerous) polyps and generally considered of greater clinical importance. The adenoma-carcinoma sequence describes the potential development of colorectal cancer from polyps and increases with size and atypism of polyps [5, 6]. The relative risk of malignant transformation in colorectal polyps less than 5 mm in diameter is still debatable. The reason is that severe dysplasia and malignancy are rare in adenomatous polyps less than 5 mm in diameter and they do occur more in polyps larger than 5 and 10 mm in diameter. Several studies comparing the histology of small and large colorectal adenomas have suggested that polyps smaller than 10 mm in diameter have a lower risk for subsequent malignant transformation than polyps larger than 10 mm. Other studies support the observation that polyps smaller than 5 mm in diameter are unlikely to be malignant or have a high-grade to malignant transformation [11, 12].

Dark-lumen contrast-enhanced MRC using a T1 weighted sequence in combination with an aqueous enema is a rapidly evolving, almost non-invasive method for the evaluation of the entire colon [3, 4]. Dark-lumen MRC is based on the focal uptake of T1-shortening contrast material in colonic lesions which are displayed as bright areas on T1-weighted sequences, whereas the lumen is rendered totally dark due to water or water-based solutions that serve as filling material. The latter leads to uniform luminal darkening as well as sufficient distention of the colon. Results of several preliminary studies using a standard VIBE sequence with a matrix of 168 × 256 indicate that this technique has a high sensitivity for the detection of colorectal lesions larger than 5 mm in diameter, however all mass lesions smaller than 5 mm in size were missed [3, 4].

In contrast to computed tomography the use of very thin slices in magnetic resonance tomography (MRT) leads to longer scan times and to a deterioration of the CNR signals. Very thin slices of MRC cause poor image quality and will not be feasible in a single breath-hold. In our study using a MR-Scanner with 1.5 Tesla and 8-canal technique we increased the matrix of the VIBE sequence to 512 × 256 in order to get a high spatial imaging of the colonic wall without large change of the scan times. Thus, the 3D data set could be acquired in a single breath-hold.

In a study by Hartmann et al. 92 patients underwent dark-lumen MRC using a T1-weiteged VIBE sequence [13]. In this study CC depicted 107 polyps with all different sizes (82 adenomatous und 25 hyperplastic) in 49 patients (53 %). However, MRC correctly identi-

fied based on location and size just 58 of the 107 polyps (54.2%). Furthermore, this study has shown a high sensitivity of MRC for the detection of colorectal polyps larger than 5 mm with a sensitivity of 78% for polyps between 6 – 9 mm in diameter and 100% for polyps larger than 10 mm in diameter. In addition, this study confirmed the insufficiency of dark-lumen MRC to detect colorectal lesions smaller than 5 mm in diameter. Just 4 (adenomatous) of the in CC confirmed 44 polyps (22 adenomatous and 22 hyperplastic) smaller than 5 mm could be detected using MRC (sensitivity 9.1%). So no one of the 25 hyperplastic polyps could be detected in MRC independently of size. The detection of colorectal polyps relates also to the histologic type. Overall, 4 of the 22 adenomatous polyps smaller than 5 mm in diameter (18%), 32 adenomatous polyps between 6 – 9 mm in diameter (84%) and all adenomatous polyps larger than 10 mm in diameter (100%) could be correctly identified in MRC. This shows a sensitivity of 71% of MRC for the detection of adenomatous polyps with all different sizes [13]. The insufficiency of MRC to detect all hyperplastic polyps by Hartmann et al. was assumed due to the vascular architecture which may be appears similar that of normal mucosa [13]. Thus, no pathologic high contrast uptake between hyperplastic polyps and haustral folds could be found. In a study by Fenlon et al. 100 patients underwent CT colonography (CTC) in comparison to CC as standard reference [14]. In this study CTC correctly identified 53 of the 62 colorectal polyps larger than 5 mm in diameter and just 29 of the 53 colorectal lesions smaller than 5 mm in diameter. The reason for the poor detection of small polyps was suggested that polyps smaller than 5 mm in diameter may be effaced when the colon distended [14].

In our study, none of the 40 polyps smaller than 5 mm in diameter could be detected using both sequences of dark-lumen MRC (sensitivity 0%). However, both sequences have shown identical sensitivity of 86% for the detection of colorectal polyps larger than 5 mm in diameter. Clearly, the present study is not without its limitations. First and foremost, we acquired the high spatial resolution VIBE sequence following the standard VIBE sequence. A randomisation of the MRC examination to exclude the factor of contrast agent timing was not performed. In addition, we used an effective thickness of 2.6 mm for high spatial resolution vs. 1.6 mm for standard sequences and we report about a rather heterogeneous patient cohort including symptomatic and asymptomatic patients. However, patient numbers are too small to seriously differentiate between these entities. In addition, the underlying patient cohort reflects reality of daily clinical routine for the performance of CC.

In conclusion, this study has shown that high spatial resolution VIBE sequence improved the image quality of MRC quantitatively but did not improve the detection of colorectal masses. Additionally, this study confirmed that neither the standard nor the high spatial resolution VIBE sequence was able to detect polyps smaller than 5 mm in diameter independently from their histological type. However, MRC has shown a high sensitivity to detect colorectal lesions exceeding than 5 mm in diameter. New MR techniques to improve the detection of small colorectal masses and to eliminate weaknesses of MRC must be developed in the future. Parallel acquisition techniques (iPAT) [15] in combination with MR scanners with high field strengths can improve the detection of colorectal lesions. Therefore, controlled studies should prove this hypothesis.

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