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The sensitivity of MR colonography using dark lumen technique for detection of colonic lesions

COLON

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Original Article

ABSTRACT

Background/Aims: To assess the detectability of the lesions with magnetic resonance (MR) colonography using dark lumen technique that had been detected on conventional colonoscopy.

Materials and Methods: A total of 38 patients who were suspected to have a colorectal mass between April 2008 and June 2010 were included in this prospective study. Warm tap water was administered via a rectal tube to the patients in prone position. Then, axial T2 true- fast imaging with steady-state precession (FISP), axial T2 half-Fourier acquisition single-shot turbo spin-echo (HASTE), diffusion-weighted images, and T1 vibe fat suppression coronal sequences were obtained. T1 vibe fat suppression sequences on axial coronal planes were repeated after gadolinium contrast medium intravenous injection. MR images were analyzed by two radiologists concurrently. Assessments were done by comparing with conventional colonoscopy and histopathologic findings.

Results: Thirteen out of 20 lesions that had been detected on conventional colonoscopy were correctly obtained by MR colonography. None of the three lesions 5 mm or below was seen on MR colonography. Two out of 4 lesions measuring 6-9 mm were seen on MR colonography (50%). Eleven out of 13 lesions 10 mm and above were correctly detected on MR colonography (84.6%). Sensitivity was estimated as 65% when all lesions were evaluated together.

Conclusion: MR colonography has a high sensitivity in the diagnosis of colonic pathologies without ionizing radiation. Future investigation will likely lead to wider acceptance of this method to detect colonic pathologies, including perhaps their use in colon cancer screening programs.

Keywords: MR colonography, dark lumen, colorectal cancer, screening

INTRODUCTION

Colorectal cancer is the third leading type of cancer in Western countries and the second leading cause of cancer-related deaths (1,2). It accounts for approximately 10% of cancer-related deaths among men and women (3,4). The incidence and mortality of colorectal cancers have decreased in recent years. This reduction arises from the increase in use of colonoscopy and removal of premalignant polyps. Many studies have indicated that colorectal cancers are subjected to a series of genetic mutations, and small adenomas (<0.5 mm) transform into large adenomas (>10 mm) and large adenomas transform into noninvasive carcinoma and finally into invasive carcinoma (5-7). The risk of malignancy increases with the size of the polyps; risk is 1% if the polyp size is 5-10 mm, 10% if the polyp size is 10-20 mm, and 45%-50% if the polyp is larger than 20 mm (8). The time from polyp to cancer development is approximately 10 years. Early diagnosis of colorectal cancers is of importance due to the long natural course of the disease. Detection and treatment of adenomatous polyps that have not transformed into cancer yet and early localized cancers are possible through screening programs. Early diagnosis and treatment of colon polyps may reduce the incidence of colorectal cancers by more than 80% (8,9). Fecal occult blood test, single- and double-contrast colonographies, sigmoidoscopy, and conventional colonoscopy are the methods used

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for diagnosis of colorectal cancers (10,11). However, all of these methods have some limitations. Complications, like perforation (0.1%) and bleeding (0.3%), may also be seen in diagnostic and therapeutic colonoscopy (12,13). That the whole colon must be screened for colorectal cancer is emphasized in recommendations of the American Cancer Society, revised in 1997, and this is called examination of the whole colon (14). Newly developed non-invasive methods, such as computedtomography (CT) and magnetic resonance (MR) colonography, besides conventional colonoscopy and double-contrast colonography, may be included in colorectal cancer screening techniques that meet this criterion. Three-dimensional endoscopic imaging of the mucosal surface of the colon is defined as 'virtual colonoscopy.' Clinical assessments of CT colonography indicate that it is promising, with its sensitivity value of 75%-100% for detection of colon and rectum cancers and polyps 10 mm and above (15). Conventional colonoscopy is the gold standard method for detection of colonic pathologies (16,17). However, the method is invasive and disturbing, reducing its acceptability (18,19). Ionizing radiation exposure is an important disadvantage for CT colonography (7,8). MR colonography, which began to be used in 1997, may be a valuable method for colorectal cancer screening, as it is safe and does not have ionizing radiation. Researchers report that quite promising results have been obtained with MR colonography (MRC) (20-23). In this study, we preferred MR colonography, as it is non-invasive and does not include ionizing radiation, and we aimed to measure the detectability of lesions with MR colonography that had been detected on conventional colonoscopy.

MATERIALS AND METHODS

A total of 38 patients with a mean age of 47.36 years (range 18-75) were included in this prospective study between April 2008 and June 2010. Of the patients, 50% (n:19) was male and 50% (n:19) was female. Patients suspected of having colonic lesions due to fecal occult blood test positivity, iron deficiency anemia, hematochezia, family history of colon cancer, or history of polyp or patients who could not complete conventional colonoscopy for any reason (eg, colonic obstruction due to mass lesion) were planned for conventional colonoscopy. Exclusion criteria were determined as follows: refusing written informed consent, being uncooperative with the examination, inadequate colon filling due to previous operations or stricture, involuntary defecation during the procedure, pregnancy, and contraindications for the procedure (eg, claustrophobia, metal foreign bodies, aneurysm clips, metallic cardiac valves, renal insufficiency, obesity). All patients were informed about the examination, and written informed consent was obtained. . Approval for the study was obtained from the institutional review board of Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethical Commitee. Patients applied for MRC and conventional colonoscopy after an average of 2 hours on the same day. Patients underwent standard bowel preparation with a diet given by the gastroenterology endoscopy unit. For this purpose, patients were recommended to take 3-4 liters of liquid food daily (water, tea, sour cherry juice, pudding, soup without fiber, and grain) for 2 days prior to the study. Patients took 210 mL of BT enema solution (Yenisehir Drugs; Ankara, Turkey) rectally and X-M Diet solution (Yenisehir Drugs; Ankara, Turkey) 250 mL periorally 1 day before the procedure; 210 mL of BT enema was repeated rectally on the morning of the procedure.

MR colonography technique

Analysis was done with a 1.5 Tesla MR unit, which has a maximum gradient capacity of 33 mt/m (Avanto; Siemens, Erlangen, Germany). Patients were not administered antispasmodic, analgesic, or sedating agents before the procedure. Patients were brought to the prone position, and a rectal enema tube was inserted. The colon was filled with 1800-2000 mL of warm tap water. Analysis was started with T2-weighted coronal true fast imaging with steady-state precession (FISP) sequence (repetition time (TR): 3.89 ms, echo time (TE): 1.95 ms, echo train length: 13, field of view (FOV): 18 cm, section thickness: 7 mm, Nex: 3, matrix: 448x512). Then, axial T2-true-FISP, axial T2 HASTE, diffusion-weighted images and T1 vibe fat suppression coronal sequences were obtained. The patient was administered gadolinium contrast medium (gadobenate dimeglumine, Multihance, Santa Farma, Bracco, Italy) intravenously. T1 vibe fat suppression sequences were repeated on the axial and coronal planes. So, we aimed to see the lesion by its enhancement in a dark lumen after intravenous contrast administration. Some patients had difficulty holding their breath towards the end of the imaging time. In these patients, the sequence was repeated after resting for a short while. Involuntary defecation developed during the procedure in 5 patients, and these patients were excluded from the study. Analysis was completed at the end of approximately 20-30 min (mean 25 min). MRI assessments were done on a workstation monitor (Syngo, Siemens, Erlangen, Germany) by two radiologists blinded to the pathology results.

Conventional colonoscopy technique

Conventional colonoscopy was done by the gastroenterologists who were blinded to MR colonography results and experienced in conventional colonoscopy for at least 5 years. Polyps seen on conventional colonoscopy were photographed, resected for biopsy, and sent for histopathologic analysis. Polyp size was measured in mm using open biopsy forceps technique. Localizations of polyps or mass lesions were evaluated by dividing the colon into 6 segments on conventional colonoscopy, as in MRC.

Comparison of MR colonography and conventional colonoscopy findings

Image analysis

Magnetic resonance images were evaluated concurrently by two radiologists. Assessments were done based on the lesions detected on colonoscopy. Distention and artifact levels of each colonic segment were detected in order to evaluate imaging

quality before assessment of lesions. Artifact levels were classified as no artifact: 1, moderate artifact: 2, and excessive artifact: 3 hindering diagnosis. Distention levels were evaluated as collapsed segment: 1, moderate distention: 2, good distention: 3, very good distention: 4, and excellent distention: 5. Afterwards, visibility of the lesions detected on colonoscopy was evaluated on MR sequences. For this purpose, visibility of the lesions was detected by using all sequences after true FISP, uncontrasted T1 vibe, and post-contrast T1 vibe sequences had been analyzed individually. If conventional colonoscopy and MRC detected a lesion in the same anatomic segment, with similar morphological structure and size, this finding was accepted as a true positive. If any findings were not detected in the same segment by conventional colonoscopy and MRC, it was defined as a true negative. If a lesion was shown on conventional colonoscopy but not shown in the same segment on MRC, it was accepted as a false negative. If a lesion was located in the same segment with similar morphological characteristics but different in size (up to 5 mm), it was accepted to be the same polyp.

Histopathologic analysis

The biopsy material was reported by two pathologists in terms of histopathologic features in all cases who were detected to have mass lesions and polyps on video colonoscopy. Pathology results could not be reached in one case.

Statistical analysis

Presence of colorectal lesions was investigated in all 38 patients who underwent MRC. Sensitivity values were calculated by taking conventional colonoscopy findings as the reference standard. Calculations were done based on segmental findings. Qualitative results regarding the description of colonic abnormalities with MRC were defined as true-positive, true-negative, false-positive and falsenegative findings. A true-positive finding was classified as the colorectal lesion was seen on MRC and CC, whereas a true-negative finding was defined as the absence of colorectal lesion on MRC and CC. A false-positive finding was defined as a colorectal lesion was noted on both MRC and CC. A false-negative finding was defined if a colorectal lesion was seen on CC but not on MRC. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated as follows: sensitivity: true-positive/false-negative + true-positive; specificity: true-enegative/false-positive + true-negative; PPV: true-positive/true-positive + false-positive; NPV: true-negative/true-negative+ false-negative; accuracy (%) = 100 × (true-positive + true-negative/true-positive + false-positive + true-negative+ false-negative). Calculations were done by taking polyp diameters into consideration, as sensitivity of MRC is directly proportional to polyp size (≤5 mm, 6-9 mm and ≥10 mm).

RESULTS

When the quality of images was analyzed, mean artifact values according to colon segments were as follows: cecum 1.36, ascending colon 1.36, transverse colon 1.21, descending colon 1.26, sigmoid colon 1.18, and rectum 1.1 (Table 1). According to these results, while the cecum and ascending colon had the most artifacts, the fewest were found in the rectum.

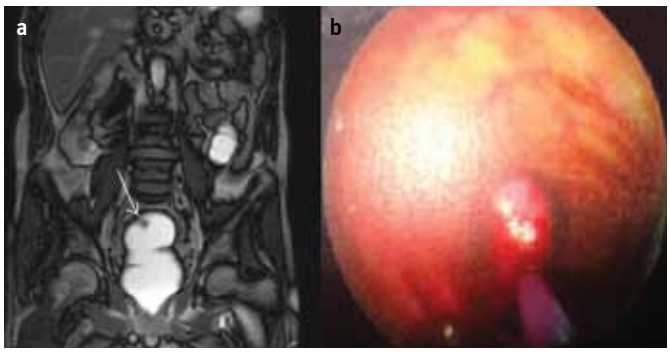

Figure 1. a, b. A 10-mm polyp was detected in sigmoid colon on a coronal T2-weighted true FISP image (arrow) in a 64-year-old male patient who had complaints of rectal hemorrhage and constipation. This lesion was verified on conventional colonoscopy **(a),** and its histopathologic examination was reported as a hyperplastic polyp **(b).**

Mean distention levels were as follows according to colon segment: cecum: 3.77, ascending colon: 4, transverse colon: 4.31, descending colon: 4.31, sigmoid colon: 4.46, and rectum: 4.85 (Table 2). According to this, the best distention was obtained in the rectum, and the worst was found in the cecum.

While 24 out of 38 cases (45.7%) were evaluated as normal, a total of 22 pathologies were detected in 14 (29.8%). The distribution of the lesions was as follows: 2 adenocarcinomas, 2 diverticulosis, 1 granular cell tumor, 1 hyperplastic polyp, 2 intraepithelial carcinomas, 1 juvenile polyp, 1 colitis-lymphoid hyperplasia, 4 tubular adenomas, and 4 tubulovillous adenomas. Histopathologic examination of the lesion could not be reached in 1 out of 14 cases in whom lesions were detected, and multiple millimetric diverticula were detected in the sigmoid colon of 2 patients. Also, 4 polyps were found in one patient, 2 polyps were detected in each of 2 patients, one polyp was found in 5 patients, 2 tumoral lesions were found in one patient, and one tumoral lesion was detected in 4 patients. Four lesions were 5 mm and below, 4 were between 6-9 mm, and 12 were 10 mm and above (Table 3).

The distribution of the lesions according to segments was as follows: 2 tumoral lesions in the cecum, 2 polyps in the ascending colon, 2 polyps in the transverse colon, one polyp in the descending colon, 2 tumoral lesions and 6 polyps in the sigmoid colon, and 2 tumoral lesions and 3 polyps in the rectum (Table 4) (Figure 1-3).

Thirteen out of 20 lesions detected on conventional colonoscopy were correctly detected by MRC. None of the 3 lesions 5 mm and below failed to be seen on MRC (0%). Two out of 4 lesions measuring 6-9 mm were correctly detected on MRC (50%). Eleven out of 13 lesions 10 mm and above were correctly detected on MRC (84.6%).

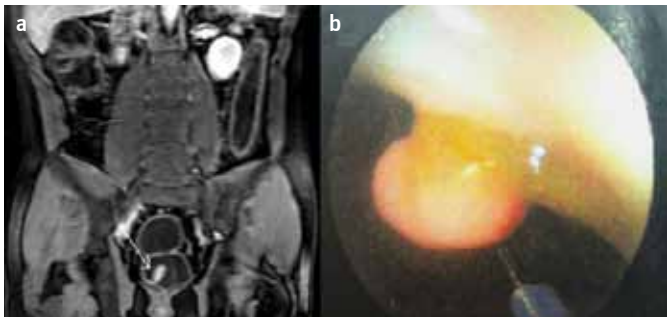

Figure 2. a, b. A pedunculated polyp measuring 20 mm was detected in the lateral wall of the rectum on a T1-weighted post-contrast coronal image (arrow) in a 27-year-old male patient who underwent colonoscopy due to the complaint of abdominal pain. The lesion was verified on conventional colonoscopy **(a),** and histopathologic examination was reported as a juvenile polyp **(b).**

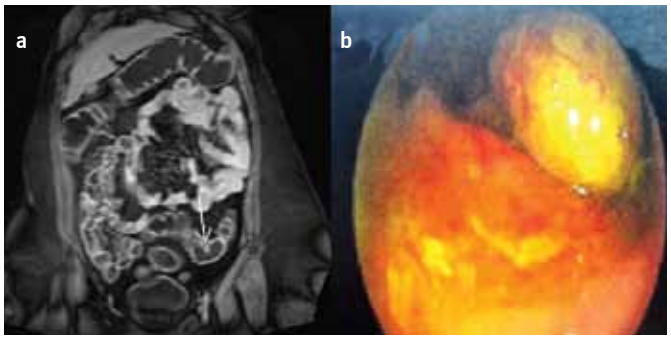

Figure 3. a, b. A polyp measuring 10 mm was detected in the sigmoid colon on T1-weighted vibe fat suppression coronal post-contrast image analysis (arrow). This lesion was verified on conventional colonoscopy **(a),** and histopathologic examination was reported as a tubular adenomatous polyp **(b).**

The specificity was 100% (Table 5). Histopathologic types were also evaluated (Table 6).

Two radiologists evaluated all lesions again and determined the detection sensitivity according to sequences (Table 7). According to this, while a significant difference was not found between coronal true FISP and coronal T1A post-contrast sequences in terms of lesion detection sensitivity, coronal T1 pre-contrast analysis sensitivity was lower than other sequences.

When extracolonic MR findings of 38 cases were analyzed, a total of 43 extracolonic findings were detected in 28 cases. Sixteen findings (37%) were carrying prognostic value for the patient, and 27 findings (63%) had no prognostic values.

DISCUSSION

Screening by conventional colonoscopy completed with colonoscopic polypectomy has been shown to decrease the prevalence of colorectal cancer by 76%-90%. However, only 40% of patients having risk for colorectal cancer undergo screening. Bowel cleansing and discomfort of the procedures lead to poor patient acceptance. Unfortunately, this causes low screening rates for colonoscopy (1).

Table 1. Artifact levels according to colon segments

Colon Segments	Artifact levels
	Mean±SD
Cecum	1.36±0.49
Ascending colon	1.36±0.49
Transverse colon	1.21±0.41
Descending colon	1.26±0.44
Sigmoid colon	1.18±0.45
Rectum	1.1±0.31

Table 2. Distention levels in colon segments

Colon Segments	Distention levels
Cecum	3.77±1.44
Ascending colon	4±1.17
Transverse colon	4.31±0.86
Descending colon	4.31±0.98
Sigmoid colon	4.46±0.97
Rectum	4.85±0.67

The search for a more acceptable imaging screening examination for colorectal cancer has led to the development of virtual colonoscopy, which includes both CT colonography and MR colonography. From the late 1990s, more studies have been published about CT colonography than on MR colonography. The first one appears to be more suitable for colorectal screening than MR colonography because of the ease and speed of performing it, as well as the increased spatial resolution, decreased cost, and wider availability of CT colonography. The main advantage of MR colonography over CT colonography is the lack of ionizing radiation. A prone-supine CT colonography causes an approximately 0.14% lifetime cancer risk due to radiation exposure for a 50-year-old person (the age at which colorectal screening is recommended) (24). MR colonography is becoming a valuable method, as it is safe and non-invasive and does not include ionizing radiation. The main purpose of MRC is to detect polypoid lesions and tumors of the colon.

The most commonly used techniques are dark lumen and white lumen techniques. In the dark lumen technique, water, air, or carbon dioxide is used in order to provide colon distention. Oral polyethylene glycol solution has been recently added to these techniques. In the white lumen technique, a 1.5-2-L volume of gadolinium-containing enema is given via perioral or rectal route with 100-150 cm of hydrostatic pressure. So, the lumen shines with positive contrast medium and is discriminated from the lesions (25). The diagnostic performance of bright-lumen MR colonography was assessed widely, using conventional colonoscopy as the standard reference. Luboldt et al. (20) performed MR colonography in 127 patients who had been referred for conventional colonoscopy. The authors were able to identify 26

Table 3. Distribution of the lesions according to cases

	Age	Presence of the lesion on MR	Presence of the lesion on endoscopy	Histologic type	Size
Case 1	52	+	+	Tubulovillous adenoma	10 mm
Case 2	47	+	+	Colitis-lymphoid hyperplasia	17x14 mm
Case 3	54	+	+	Granular cell tumor	12x12 mm
Case 4	75	+	+	Adenocarcinoma	20 mm
Case 5.1	68	+	+	Intraepithelial carcinoma	25x15 mm
Case 5.2		+	+	Intraepithelial carcinoma	30x20 mm
Case 5.3		-	+	Unknown	8 mm
Case 5.4		+	+	multiple diverticula	-
Case 6.1	58	-	+	Tubular adenoma	7 mm
Case 6.2		+	+	Tubular adenoma	8 mm
Case 6.3		-	+	Tubulovillous adenoma	10 mm
Case 6.4		+	+	Tubulovillous adenoma	30x20 mm
Case 7	52	+	+	Hyperplastic polyp	7 mm
Case 8	44	-	+	Hyperplastic polyp	5 mm
Case 9.1	48	+	+	Tubular adenoma	10 mm
Case 9.2		-	+	Tubulovillous adenoma	10 mm
Case 10	60	-	+	Tubular adenoma	3 mm
Case 11	60	+	+	Adenocarcinoma	65 mm
Case 12	27	+	+	Juvenile polyp	20 mm
Case 13	63	+	+	Multiple diverticula	-
Case 14.1	64	+	+	Hyperplastic polyp	10 mm
Case 14.2		-	+	Hyperplastic polyp	3 mm

of 29 large (>10 mm) polyps or masses (90%) and 19 of 31 medium-sized (6-10 mm) polyps (61%), whereas only 9 of 129 small (<6 mm) polyps (7%) were identified. Overall, MR colonography had a sensitivity of 93% and a specificity of 99% for polyp detection. In an MRC study of Florie et al. (26) conducted through administering lactulose and gadolinium-containing oral contrast medium beginning from 48 hours prior to the study, the sensitivity was 77% in lesions 10 mm and above. The majority of studies in the past decade has focused on the role of dark-lumen MR colonography. Ajaj et al. (21) evaluated 122 patients undergoing 3D T1-weighted spoiled GRE dark lumen MR colonography and subsequent conventional colonoscopy. They identified all 9 colorectal cancers and polyps 10 mm or larger, 16 of 18 medium-sized polyps (89%), and no polyps less than 5 mm in size. In the study of Keeling et al. (27), they used room air to provide intraluminal contrasting in the dark lumen technique and obtained 66.7% sensitivity when all lesions were evaluated. In that study, sensitivity was 100% in lesions ≥6 mm. In the study of Hartman et al. (22) conducted with dark lumen technique by using tap water, the sensitivity was 84.2% for the polyps measuring 6-9 mm and 100% for the polyps 10 mm and above. In the study of Gomez et al. (28) comparing water- and air-based distention methods, they observed that the air-based method led to more artifacts. Bakır B. et al. (29) used oral polyethylene glycol solution in order to obtain colon distention. Sensitivity was 88% for lesions 10 mm and above and 67% for lesions between 6-9 mm. None of the lesions below 5 mm could be detected in that study. In 2005, Lauenstein et al. (30) compared polyp detection rates for dark lumen and bright lumen MR colonography in 37 patients. Dark lumen MR colonography with water distention was performed with 3D pre- and postcontrast T1-weighted spoiled GRE sequences, and bright lumen MR colonography was performed with true-fast imaging with steady-state precession sequence. Dark lumen MR colonography helped detect all medium-sized and large polyps but did not depict 4 small polyps less than 5 mm, resulting in an overall sensitivity of 79%. Still, the performance of dark lumen MR colonography was better than that of bright lumen MR colonography, which failed to depict 2 additional small polyps, resulting in an overall sensitivity of 68%.

In our study, we preferred to perform the dark lumen technique through administering tap water into the colon, as it is cheap and easily available. We could see none of the lesions

Table 4. Number of tumors and polyps detected on MRI and colonoscopy according to colon segments

Colon Segment	Tumor (n:6)	Polyp (n:13)
Cecum	2	-
Ascending colon	-	1
Transverse colon	-	2
Descending colon	-	1
Sigmoid colon	2	6
Rectum	2	3

Table 5. Lesion detection sensitivity according to the sizes of MRC examination

MRC for detection of lesions					
	Total	True positive	False negative	False positive	Sensitivity (%)
≤5 mm	3	0	3	0	0
6-9 mm	4	2	2	0	50
≥10 mm	13	11	2	0	84.6
All lesions	20	13	7	0	65

MRC: magnetic resonance colonography

Table 6. Distribution of histologic type according to lesion sizes

Lesion size	≤5 mm	6-9 mm	≥10 mm	Total
Adenocarcinoma	1		1	2
Unknown		1		1
Granular cell tumor			1	1
Hyperplastic polyp	2	1	1	4
Intraepithelial carcinoma			2	2
Juvenile polyp			1	1
Colitis-lymphoid hyperplasia			1	1
Tubular adenoma	1	2	1	4
Tubulovillous adenoma			4	4

Table 7. Lesion detection sensitivity of different sequences

Lesion detection sensitivity of different sequences				
	Total	True positive	False negative	Sensitivity (%)
Coronal T1 pre-contrast	20	9	11	45
Coronal T1 post-contrast	20	12	8	60
Coronal true FISP	20	13	7	65
When all sequences were evaluated together	20	13	7	65

FISP: fast imaging with steady-state precession

below 5 mm. Two of these lesions were hyperplastic polyps, and one was a tubular adenoma. When we evaluated the reasons for the low detectability of lesions 5 mm and below, we can state that discrimination from haustrations is difficult, and it may be confused with residual feces. This seems acceptable, given that the possibility of colorectal cancer development is very low for polyps below 5 mm, because the main purpose of colorectal cancer screening is to detect polyps 10 mm and above (31). Sensitivity was 50% for lesions measuring 6-9 mm. The polyp measuring 8 mm and the histopathology of which is not known, which could not be detected in the descending colon in case 5.3, was detected on conventional colonoscopy. The artifact level of the descending colon was 2, and the distention level was 3; this was low. Lesion detection is quite difficult when artifacts in the segments that are not well distended and residual feces is added. In case 6.1, a tubular adenoma measuring 7 mm in the ascending colon could not be detected. The reason for this was artifacts in the segment, with an artifact level of 2 and distention level of 4. Sensitivity was 84.6% for lesions 10 mm and above. In case 6.3, a tubulovillous adenoma located in the descending colon could not be detected on MRC. The artifact level of the segment was 2 and distention level was 3 and moderate. In case 9.2, a tubulovillous adenoma measuring 10 mm and located in the rectum could not be seen on MRC. The lesion could not be observed, although its artifact level was 1 and distention level was 5. The reason for this may be the lesion's being covered with haustra.

When compared with previous studies, we saw that we could obtain lower sensitivity values in our study. One of the reasons for this was that the populations selected in other studies included patients, but we performed this study in a screening group. We consider that larger studies must be done with more cases.

The main sequences used for dark lumen MR colonography are pre- and postcontrast T1-weighted spoiled GRE sequences with fat suppression. T2-weighted fat-saturated single-shot images obtained in both the coronal and axial planes are added to help to demonstrate other entities of bowel wall diseases. When we evaluated the detected lesions on the basis of sequences, it was seen that the most successful sequences were T1A post-contrast sequences, with a sensitivity ratio of 60%, and true FISP sequences, with a sensitivity ratio of 65%, and the T1A pre-contrast sequence had a lower sensitivity, with a ratio of 45%. Fewer artifacts are observed in true FISP sequences compared to other sequences. In post-contrast T1A sequences, contrast enhancement facilitates discrimination of the lesion from haustrations.

Magnetic Resonance colonography has advantages in the imaging follow-up of patients with symptomatic inflammatory bowel disease (IBD), since a large proportion of these patients are young and often require repeat imaging. Ajaj et al. (32) studied MRC to evaluate inflammatory diseases of the large bowel. MRC correctly identified 68 of 73 histopathology and colonoscopically proven diseased segments of 23 patients with IBD. Similarly, characterization of inflammatory disease proved correct in all 68 segments that were considered diseased on MRI-

characterized, clinically relevant IBD of the large bowel, with sensitivity and specificity values of 87% and 100%.

Uncompleted conventional colonoscopy is not a rare condition. This ratio was reported to vary between 5%-56%, even in experienced hands. The most important reason for this is severe abdominal pain related with the procedure, and it is a condition that develops together with elongated sigmoid colon or not being able to reach the right colon and cecum due to the operator. Uncompleted conventional colonoscopy rates reach up to 50% in inflammatory bowel disease or colorectal cancer cases. Ajaj et al. (33) elevated number of evaluated segments from 87 to 206 in 37 cases for which conventional colonoscopy could not be completed. In our study, there were no cases for which conventional colonoscopy could not be completed. MRC may be used for detection of colorectal lesions found concurrently in colorectal cancer cases. In the study of Achiam et al. (34), a total of 12 synchronized lesions composed of cancers and polyps were detected in 46 cases with colorectal cancer. We did not aim to seek synchronized lesions, as we preferred patients in the screening group. It also provides very valuable data in preoperative tumor localization and staging. It provides significant advantages with the data about colon wall thickness, extracolonic structures and lesions, pericolonic soft tissue invasion, and lymph node involvement in tumors.

It is a deal that the detection of extracolonic findings on MR colonography may not be always clinically important, and these incidental findings may result in further investigations and additional costs. But, if it is an important finding, like an early-stage tumoral lesion, this will provide early treatment of the disease and decrease treatment cost. Further investigations should be made to detect the cost-effectiveness of this process (24). In the study of Ajaj et al. (35) conducted using dark lumen technique, they screened extracolonic organ findings and detected 510 extracolonic findings in 260 out of 375 cases; 12% of these findings carried prognostic and therapeutic value. In our study, a total of 43 extracolonic findings were detected in 28 cases when extracolonic MR findings of 38 cases were analyzed. Sixteen findings (37%) were carrying prognostic and therapeutic value, and 27 findings (63%) had no prognostic value.

Unfortunately, using gadolinium-based contrast material brings additional cost and risk for the development of nephrogenic systemic fibrosis, causing serious renal impairment. The patients in the screening group (>50 years of age) have a greater risk than the younger ones. It is not needed generally for CT colonography.

With the integration of 3.0-T MR colonography, parallel imaging (an evolving data acquisition and reconstruction technique that makes use of coil arrays to encode and detect multiple data points simultaneously), fecal tagging (a concept based on altering the signal intensity of feces by adding contrast material to patients' meals in the days prior to MR colonography) (28), fecal cracking (a novel concept that is based on the administration of stool softeners, both orally and rectally, which leads to hydration of stool and thus a decrease in the signal intensity of stool in T1-weighted imaging) (24), and nanoparticle-based MRC (an experimental method using solid lipid nanoparticles (SLNs) synthesized with loading gadolinium-DTPA to construct Gd-SLNs as an MR T1 contrast agent) (36) methods into research and clinical settings, MRC gives us the hope of becoming a method that has higher detection ratios and easier clinical use.

CONCLUSION

In conclusion, MRC is a good alternative to other colorectal cancer screening methods, as it is non-invasive, has high sensitivity in colorectal lesions measuring 1 cm and above, enables assessment of extracolonic findings, and do not include ionizing radiation. Sensitivity may be increased by developing methods, like providing a good colonic cleaning and distention and reducing respiratory artifacts through good breath-holding. Future investigations by developing large-scale studies will likely lead to wider acceptance of this method to detect colonic pathologies, including perhaps their use in colon cancer screening programs.

Ethics Committee Approval: Ethics committee approval was received for this study from of Bakırköy Dr. Sadi Konuk Training and Research Hospital Ethical Commitee.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author contributions: Concept - M.B.A., S.B.; Design - M.B.A., S.B.; Supervision - M.B.A.; Resource - A.A.; Materials - M.B.A., A.A.; Data Collection&/or Processing - M.B.A., A.A.; Analysis&/or Interpretation - M.B.A., S.B.; Literature Search - M.B.A., A.A.; Writing - M.B.A., S.B.; Critical Reviews - S.B.

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