Turk J Gastroenterol 2006; 17 (3): 191-197

Detection of colonic masses with MR colonography

Kolon kitlelerinin tespitinde MR kolonografi

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Background/aims: *Magnetic resonance colonography based on magnetic resonance imaging is a relatively new diagnostic modality for diagnosing colon pathology. The aim of this study was to evaluate its performance in detecting colorectal masses.* ***Methods:*** *Thirty-three patients (20 male, 13 female; age range 28-85 years; mean age 78.7) suspected of having colonic lesions because of rectal bleeding, positive fecal occult blood test results or altered bowel habits underwent magnetic resonance colonography and subsequent conventional colonoscopy. All patients underwent standard bowel preparation 24 h before magnetic resonance colonography. Patients were placed in a supine position on the magnetic resonance table. After placement of a rectal tube, the colon was filled with of a mixture of 1000-1800 ml 0.9% NaCl solution and 15-20 ml 0.5 mmol/L gadopentetate dimeglumine solution. Once colonic distension was achieved, 3D GRE magnetic resonance colonography and complementary Magnetic resonance images were taken in all cases.* ***Results:*** *Sensitivity of magnetic resonance colonography for colorectal masses was 90% and specificity was 100%. Percentage of correct diagnosis of magnetic resonance colonography was 94.3%. Magnetic resonance colonography was well tolerated without sedation or analgesia.* ***Conclusions:*** *Magnetic resonance colonography is a new technique for imaging of the colon. Magnetic resonance colonography has potential advantages of multiplanar capabilities and of being a less-invasive imaging technique; it can be implemented in daily practice and has a role in accurately staging colorectal cancers. In symptomatic patients, this new technique shows promising results for the detection and imaging of colorectal masses.*

Key words: MR colonography, colorectal mass, conventional colonoscopy

Amaç: *Manyetik rezonansla görüntüleme temeline dayanan manyetik rezonans kolonografi kolon patolojilerinin teşhisinde yeni diagnostik bir metoddur. Bu çalışmada amacımız kolorektal kitlelerinin tanısında manyetik rezonansla kolonografinin tanısal etkinliğini değerlendirmektir.* ***Yöntem:*** *Klinikte, rektal kanama, gaitada gizli kan pozitifliği veya barsak alışkanlığında değişiklik gibi nedenlerle kolon patolojisinden şüphelenilen 33 olguya (20 erkek, 13 kadın; 28-85 yaşları arasında; yaş ortalaması 78,7) manyetik rezonans kolonografi ve konvansiyonel kolonoskopi yapıldı. Tüm olgulara uygun barsak temizliği yaptırıldı. Olgular manyetik rezonans masasına supin pozisyonunda yerleştirildi. 1000-1800 ml % 0,9 NaCl içerisine 15-20 ml 0,5 mmol gadopentetate dimeglumine ilave edilerek elde edilen karışım rektal lavman yoluyla verildi. Tüm olgularda kolon distansiyonu sonrası 3B GRE manyetik rezonans kolonografi ve tamamlayıcı manyetik rezonans imajları elde edildi.* ***Bulgular:*** *Manyetik rezonans kolonografinin kolorektal kitlelerde sensivitesi % 90 ve spesifitesi % 100 bulundu. Sedasyon ve analjezik gerekmeksizin iyi tolere edilen manyetik rezonansla kolonografinin tanıda doğruluk oranı % 94.3'tür.* ***Sonuç:*** *Manyetik rezonansla kolonografi kolonun görüntülenmesinde yeni bir tekniktir. Manyetik rezonans kolonografinin multiplanar görüntüleme yapabilmesi, az invaziv olması, kolorektal kanserlerin doğru evrelendirilmesinde etkin bir rolünün olması ve günlük kullanımda uygulanabilir olması gibi avantajları vardır. Manyetik rezonans kolonografi semptomatik hastalarda kolorektal kitlelerin görüntülenmesinde ve tespit edilmesinde umut vaat eden yeni bir tekniktir.*

Anahtar kelimeler: MR kolonografi, kolorektal kitle, konvansiyonel kolonoskopi

INTRODUCTION

Colorectal cancer is the third most common cancer and the second leading cause of cancer-related deaths in western countries. Most colorectal cancer evolves from preexisting adenomatous polyps. The incidence of colorectal cancer could be considerably reduced if polyps and small tumors were detected and eliminated prior to their malignant degeneration (1-3).

There is a continued search for a colorectal cancer screening test that is cost-effective, safe, and acceptable to patients. Current methods used to screen for colorectal polyps and colonic cancer

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Manuscript received: 14.06.2005 **Accepted:** 12.07.2006

include fecal occult blood testing, sigmoidoscopy, colonoscopy and double-contrast barium enema examination. The effectiveness of each modality as a screening tool remains controversial, and each method has inherent limitations.

Magnetic resonance colonography (MRC) is a new radiologic technique for examination of colorectal masses. Selective three-dimensional (3D) imaging of the colon was first described in 1994 by Vining et al. (4) as a method using spiral computed tomography (CT) to provide a computer-simulated endoluminal perspective of the air- distended colon. Three years later, MR angiography was transferred to 3D imaging of the colon and the technique of MRC was described. Analogous to MR angiography, the colon, rather like a vessel, is filled with paramagnetic contrast. Due to the 3D nature of the dataset and selective imaging of the contrast filling, MRC allowed for different image postprocesses and in particular virtual colonoscopy. The examination is usually performed in the prepared colon using a MR technique in either supine or prone positions. By using advanced imaging software (axial and multiplanar 2-dimensional reformatted and 3-dimensional view), images of the colon are reviewed to provide a thorough and noninvasive evaluation of the entire colorectum. Recent studies indicate MRC likely will be competitive with other full structural examinations of the colorectum (5, 6).

Magnetic resonance colonography may have a role in accurately staging colorectal cancers, in particular if combined with state of the art MR imaging of the liver. As with staging, MRC can also be used for evaluating postoperative surveillance (7). MRC based on MR imaging is a relatively new diagnostic modality for diagnosing colon pathologies. The aim of this study was to evaluate the effectiveness of MRC in detecting colorectal masses.

MATERIALS AND METHODS

Thirty-three patients (20 men, 13 women; age range 28-85 years; mean age 78.7 years) suspected of having colonic lesions because of rectal bleeding, positive fecal occult blood test results or altered bowel habits underwent MRC and subsequent conventional colonoscopy (CC). All patients underwent standard bowel preparation 24 h before MRC. MRC was performed on a 1.5 T MR system (Edge, Picker, USA). No sedative or analgesic agents were used. Patients were placed in a supine position on the MR table. After placement of a rectal tube, the colon was filled with 1000-1800 ml of mixture 0.9% NaCl solution and 15-20 ml of 0.5 mmol/L gadopentetate dimeglumine solution. When the contrast material reached the cecum, the 3D colon imaging data were acquired using a T1-weighted 3D Gradient-Echo Sequence (GRE) (TE: 2.49 ms, TR: 6 ms, Flip angle: 10, Thickness: 2.5 mm, FOV: 40-43 cm, Matrix: 128x192). Once colonic distension was achieved, 3D GRE MRC and complementary MR images were taken in all cases. Further, axial spin-echo (SE) T1-weighted (TE: 10 ms, TR: 130 ms, Flip angle: 90, Thickness: 8 mm, FOV: 40-43 cm, Matrix: 192x256), and axial Fat-saturation SE T1-weighted (TE: 20 ms, TR: 749 ms, Flip angle: 90, Thickness: 7 mm, FOV: 40-43 cm, Matrix: 192x256) sequences were performed in some patients.

Three-dimensional MR data sets were analyzed in the multiplanar reformation and evaluated by two experienced radiologists unaware of the findings of the CC. Each radiologist recorded the location and the size of colorectal masses. If their interpretation on MRC images differed, consensus was achieved by reviewing and discussing the controversial images.

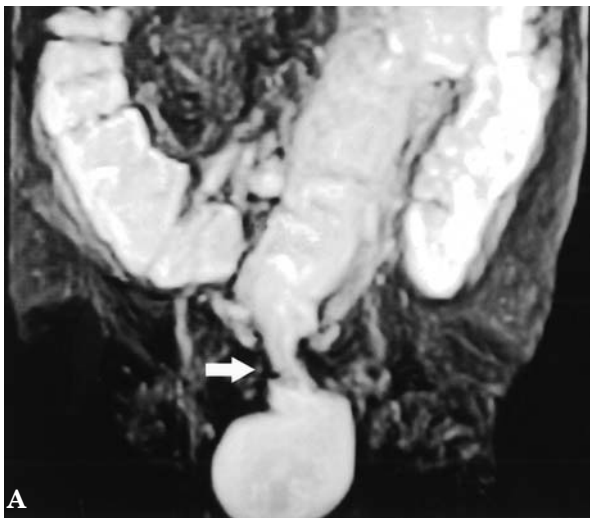
Standard colonoscopy and histopathologic examination were accepted as the references, so sensitivity, specificity and correct diagnosis ratio of MRC in detecting colorectal masses were evaluated.

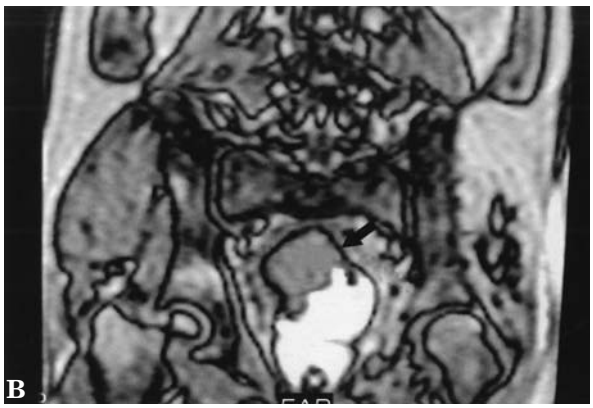
Each MRC examination lasted about 20 minutes. MRC was tolerated well by all patients. There were no postprocedural complications after MRC.

RESULTS

A total of 33 patients suspected of having colonic lesions underwent MRC. In 18 patients, colonic lesions were identified by MRC. MRC was normal in 15 patients. On the basis of MRC, 15 colon carcinoma (83.3%), 2 invasions of rectum (11%), and 1 recurrent colon tumor (5.5%) were determined, and these lesions were confirmed with CC and histopathologic examination.

Magnetic resonance colonography identified colorectal cancer in 15 patients. Malignant tumors of colon were located in rectum (n=6) (Figure 1), in rectosigmoid region (n=3), in cecum (n=2) (Figure 2), in ascending colon (n=1) (Figure 3) and in sigmoid colon (n=3) (Figure 4). Malignant tumors of colon appeared on MRC as a tumor mass projecting into the lumen of the colon or as asymmetrical or circumferential thickening of bowel wall with deformation and narrowing of the lumen.





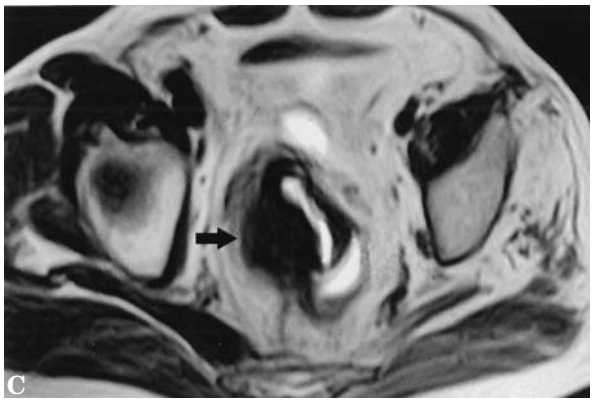
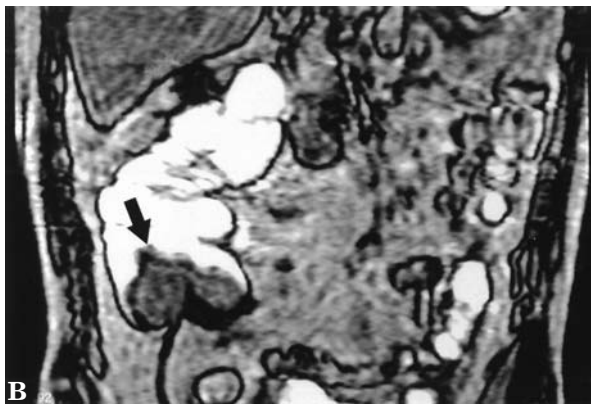


Figure 1. A 63-year-old man with rectum carcinoma. **A)** MR colonography MIP image, luminal narrowing (arrow) at the proximal part of rectum, **B)** MR colonography raw data coronal image; luminal narrowing is due to annular thickening of rectum wall (arrow), **C)** Axial T1-weighted image shows asymmetric wall thickening at rectum. There is also invasion to the fatty tissue arround the mass



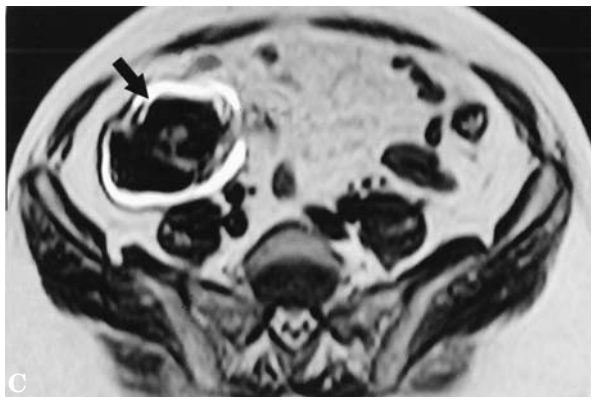


Figure 2. A 70-year-old man with cecum carcinoma. **A)** MR colonography MIP image, **B)** MR colonography raw data coronal image, and **C)** Axial plane T1-weighted image show hypointense mass with lobulated contour in the cecum lumen (arrows)

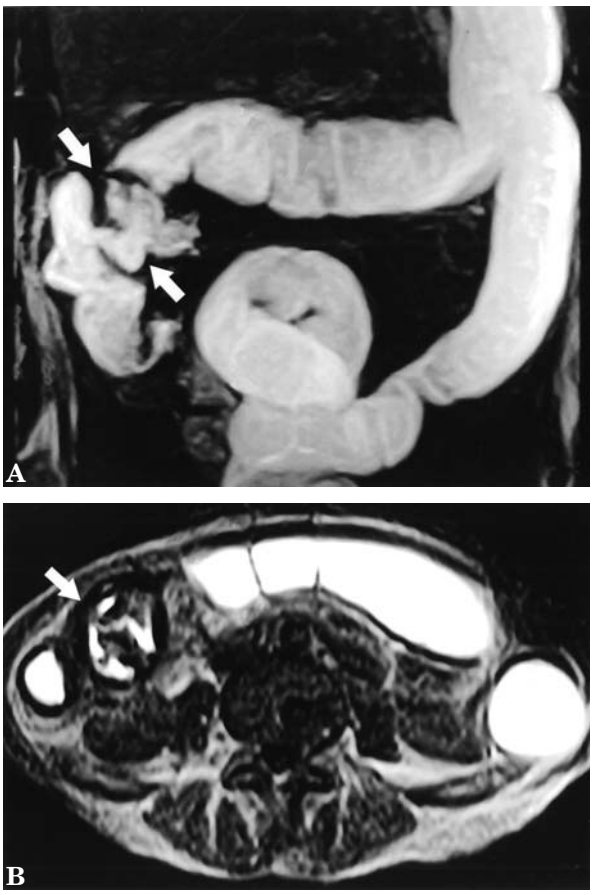


Figure 3. A 59-year-old woman with cecum and ascending colon carcinoma. **A)** MR colonography MIP image shows asymmetrical, irregular wall thickening at the cecum and ascending colon segments (arrows). **B)** T1-weighted axial plane image shows asymmetrical wall thickening at the cecum (arrow)

Fifteen patients with primary colon tumors underwent CC. A complete CC was achieved in 12 patients. In three patients, CC could not be evaluated completely due to occlusive carcinoma. However, MRC was performed for complete examination of the colon in these patients. Results of MRC were compared with colonoscopy, histopathologic examination and surgery results. All patients with colon tumors were correctly identified on MRC. Twelve adenocarcinomas, two mucinous adenocarcinomas and one tubulovillous adenoma (carcinoma in sutu) were confirmed by histopathologic examination. In two of them, additional (one more) colonic lesions (polyp) were determined. Polyps detected by CC were not diagnosed with MRC (3 mm in 1 patient and 7 mm in the other). In one of them the MR examination was performed insufficiently because of technical reasons. In the other patient, the small polyp was not identified from the adjacent mass. These polyps were excised during CC and they were described as hyperplastic polyps on histopathologic examination.

Magnetic resonance colonography identified invasion to rectum in two patients. In one, bladder cancer invasion to rectum was determined, and MRC presented the invasion. MRC also showed presence of rectovesical fistula due to bladder cancer. In the other patient, invasion to rectum due to prostate cancer was determined.

Sensitivity of MRC for colon pathologies was 90% and specificity was 100%. Percentage of correct diagnosis of MRC was 94.3%. MRC was well tolerated without sedation or analgesia and no complications were observed.

Magnetic resonance colonography identified 16 extracolonic lesions in 9 of 33 patients. These lesions

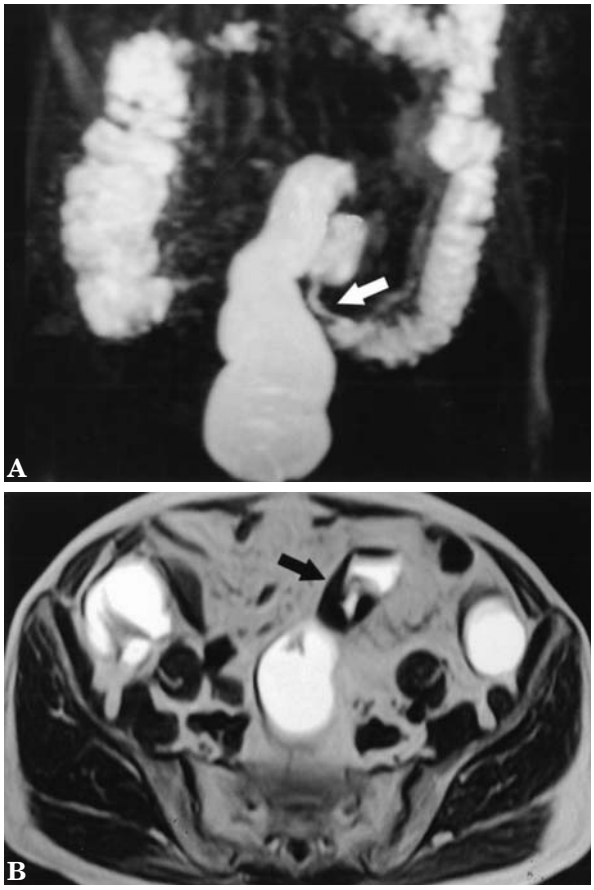


Figure 4. A 77-year-old man with sigmoid carcinoma. **A)** MR colonography MIP image shows asymmetrical, annular wall thickening at the sigmoid colon segment (arrow). **B)** T1- weighted axial image shows asymmetrical, irregular wall thickening at the sigmoid colon (arrow)

were liver metastases, hydatid cyst of liver, simple cyst of liver, mesenteric cyst, gallbladder carcinoma, duodenum carcinoma, renal cyst, gastric tumor, multiple lymphadenopathy and pleural effusion.

DISCUSSION

Colorectal cancer is the second leading cause of cancer-related death. Most colorectal cancer evolves from adenomatous polyps, and screening for colorectal polyps with subsequent polypectomy has been shown to constitute an effective approach for decreasing its incidence (1, 2). However, as evidenced by disappointing participation in colorectal screening and the continuing high incidence of colorectal cancer, new screening strategies may prove beneficial. To prove effective in reducing mortality from colorectal cancer, new screening methods must demonstrate a high diagnostic accuracy at a low cost, and prove safe and highly acceptable to patients (8).

Computed tomography and MR colonography techniques have been introduced recently as potential methods for colorectal screening. CT and MR colonography have several advantages over existing colorectal cancer screening methods. Fecal occult blood testing has a sensitivity of less than 10% for adenomatous polyps and a sensitivity of less than 15% for the detection of polyps under 2 cm in size (9).

In contrast, the promise of colonography is to detect malignant and premalignant polyps with a sensitivity rivaling colonoscopy. Flexible sigmoidoscopy allows examination of only the distal 60 cm of the colon, which limits evaluation to the descending colon, sigmoid, and rectum; inherently, lesions are missed in more than one-half of subjects who have advanced colonic adenoma located proximal to the splenic flexure but who do not have a distal index polyp (10, 11). Colonography, in contrast, images the entire colorectum and may be able to further decrease mortality by detecting more right-sided lesions.

Investigators in retrospective evaluations of double-contrast barium enema examination for the detection of colorectal cancer have found sensitivities of 71-95% (12). However, investigators in prospective studies of double-contrast barium enema examination for colorectal cancer detection report sensitivities as low as 50-75% in asymptomatic patients with positive fecal occult blood test results (13).

A recent study (14) in which double-contrast barium enema examination was compared with colonoscopy for colonic surveillance after polypectomy found a poor detection rate of 48% for polyps 10 mm and larger, as well as a poor overall detection rate of only 39% for adenomas. Unlike barium enema, MRC does not have the disadvantage of superimposition, and can examine lesions as well as pericolonic tissue.

In most centers, colonoscopy has emerged as the principal means of examining the colon. Although standard colonoscopy is a total colonic examination that allows lesion biopsy and resection, it fails to demonstrate the entire colon in up to 5% of cases examined by an experienced gastroenterologist (15), and up to 20% of all adenomas are missed (16). Furthermore, there is a risk of complications associated with diagnostic and therapeutic colonoscopy, including perforation (0.1%), major hemorrhage (0.3%), and death (0.0033%) (8, 16). Moreover, colonoscopy is limited by poor patient acceptance, which is the most important variable for a screening test (17, 18). Rex et al. (19) have shown that even when offered free of charge, most patients refused to undergo the test for primary colorectal cancer screening. The rapid examination without the use of sedation, intervention or compression is well tolerated by patients compared with other full colonic examinations such as barium enema radiography or CC.

The CT and MR colonography techniques have recently been introduced as potential methods for colorectal screening, and combine volumetric imaging with sophisticated image processing. While there is general consensus that the most accurate name for the CT- and MR-based colon imaging is colonography, there remains no clear consensus on numerous issues ranging from patient preparation to data analysis techniques.

In addition, technical innovations, such as the introduction of multislice CT and faster gradients in MR, continue to shape the evolution of these developing technologies (20-22).

Currently, MRC requires patients to undergo a standard colonoscopic bowel cleansing regimen the day before the exam. For cleansing we used a combination of bisacodyl and polyethylene glycol (20, 21).

Bowel cleansing is identified as an important factor that influences the acceptance of and compliance with colonography. Therefore, fecal tagging has been proposed as a method to replace the standard bowel cleansing and render the examination more attractive. Thus, analogous to fecal tagging in CT colonography, ingestion of oral contrast has been proposed in MRC to adapt the signal of stool to the signal of the enema. The need for colonic cleansing could be eliminated if stool were to acquire a signal intensity different from polyps and identical to the enema used to fill and distend the colon. In principle, there are two approaches to this concept of fecal tagging: dark polyps surrounded by bright stool and a bright enema, and bright polyps surrounded by dark stool and a dark enema. The first approach has been evaluated with some success. Gadolinium (Gd)-DOTA was administered as an oral contrast agent with meals preceding MRC based on the administration of a Gd-based enema. The high cost of Gd-based contrast has limited the clinical utility of this technique. In the second approach, patients are provided with barium as an oral fecal tagging agent to render stool dark, and barium for the enema is used to distend the colon during MRC. The colonic wall and polyps arising from it can be made visible after intravenous administration of Gd-based extracellular contrast. This method provides sufficient contrast between the darkened colonic lumen and the brightly enhanced colonic wall to permit virtual endoscopic rendering (21, 23-25).

As with the double-contrast barium enema, MRC requires an optimally distended colon to maximize colorectal mass detection. In principle, a liquid or gaseous enema can be used for this purpose. Alternative to the positive enema usually employed in MRC, a negative contrast agent such as water or air can be used to distend the colon. According to the different enemas (paramagnetic, water, air), there are three protocols for MRC currently under investigation. The bright lumen MRC and the dark lumen MRC performed with either water or with air. The bright lumen or the dark lumen MRC includes many sequences (e.g. 2D-GRE, 3D-GRE, 2D-HASTE, 3D-HASTE, TrueFISP) (21, 26, 27).

We performed bright lumen MRC. The colon was filled with dilute paramagnetic contrast, and non-slice selective 3D GRE sequence, covering colorectum in the coronal plane, and complementary axial plane MR images were taken in all cases.

Magnetic resonance colonography was compared with CT colonography which has been improved significantly with the introduction of multi-slice technology. The advantages of MRC over CT colonography include the lack of ionizing radiation, superior soft tissue contrast, possible better distention of colon due to the liquid filling, the selective imaging of the colon without superposition of the small bowel, and lack of sensitivity to IV contrast. The disadvantages of MRC include lower spatial resolution, high susceptibility to motion artifacts, and longer examination time (20, 21, 28).

In colorectal cancer screening, MRC can play an important role in patients who have undergone incomplete endoscopic colonoscopy. Common reasons for incomplete colonoscopy are redundant bowel loops and occlusive carcinoma. MRC can achieve complete examination of the colon in these patients. In patients with occlusive carcinoma, evaluation of the proximal colon is necessary to exclude a secondary neoplasia, which occurs in 5% of these cases (29).

Luboldt et al. (30) performed MRC in 132 patients referred for CC. MRC had a sensitivity of 93% and specificity of 99%. A similar study by Pappalardo et al. (31) compared MRC with CC in 70 patients. All patients who underwent MRC had satisfactory studies, and MRC achieved a diagnostic accuracy similar to that of CC (sensitivity 96%, specificity 93%).

Conventional colonoscopy is generally reserved for patients with positive results of screening tests or those with a higher-than-average risk of colorectal cancer. This invasive technique is used for problem solving and interventions. It is not reimbursed for routine screening. In the search for an adequate screening method, MRC can emerge. It possesses unique advantages over existing screening tests in that it is a quick and less-invasive technique, requires no sedations or analgesics during investigation, demonstrates lower percentage of perforation complication, and can evaluate all colon segments. Due to multisectional imaging availability, intramural and extraintestinal spread of colonic lesions, metastasis and additional lesions can be evaluated easily. It has the potential to be highly accurate and reproducible and is highly acceptable to the patient.

In conclusion, MRC achieved a diagnostic accuracy similar to CC in detecting colon lesions. MRC is a fundamentally new imaging technique with the potential of altering current clinical approaches to the detection of colorectal neoplasms.

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