Original Article

A Comparative Study of Magnetic Resonance Imaging and Colonoscopy in Evaluation of Colorectal Diseases

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Abstract

Introduction: Colorectal disease, especially carcinoma, is an important cause of morbidity and mortality in modern era. With rising incidence of colorectal diseases and due to limitations of conventional flexible fiber-optic colonoscopy (gold standard tool), imaging plays a significant role in evaluation of these patients. Recent technical advancements coupled with noninvasive and radiation-free nature has made magnetic resonance imaging (MRI) an acceptable screening tool in colorectal diseases. Hence, we planned this study to evaluate role of MRI in colorectal diseases in our tertiary care, medical college, hospital. **Materials and Methods:** Forty-four patients with signs and symptoms of colorectal disease were evaluated by 1.5 Testa MRI followed by conventional, flexible, fiber-optic colonoscopy on the same day after obtaining approval from the institutional ethics committee and after obtaining written informed consent using strict criteria. Bowel preparation was done using polyethylene glycol. Data from MRI and colonoscopy were recorded in predesigned pro forma and compared with the final diagnosis. Appropriate statistical methods and tools were used to evaluate the results. **Results:** Majority of the patients in the study were in the age group of 21–40 years with male predominance. Altered bowel habit followed by bleeding per rectum was the most common presentations. Both MRI and colonoscopy overdiagnosed the lesions as malignant with higher errors by MRI. MRI was very effective in the detection of growth, strictures, diverticulosis, mucosal thickening/edema, and extracolonic manifestation but failed in detecting small polyps and ulcers. MRI had high sensitivity and negative predictive value (NPV) of 100% with an accuracy of more than 70%. **Conclusions:** Although conventional colonoscopy is considered as a gold standard tool in the diagnosis of colorectal diseases, it has several limitations including its invasive nature and low yield as a screening tool. Hence, MRI with its noninvasive and radiation-free nature along with its high sensitivity and NPV for malignant lesions should be considered over colonoscopy as well as computed tomography in evaluation of colorectal diseases.

Keywords: Colonoscopy, colorectal diseases, magnetic resonance imaging

Introduction

Computed tomography (CT) is a frequently used imaging modality for evaluation of colorectal disease, but magnetic resonance imaging (MRI) offers some definite advantages such as lack of radiation and better soft-tissue delineation. Recent advancements in MRI sequences have shown promising results in colorectal diseases, hence MRI has been added as a screening tool in the management of colorectal diseases.[1] MRI of colorectal region with bowel preparation and bowel distension is often referred to as magnetic resonance colonography.[1]

Till date, conventional flexible fiber-optic colonoscopy is considered to be the gold standard not only for the diagnosis of cancer of colon and rectum including its precursors but also for a variety of benign conditions.[2] Since colonoscopy is invasive and the incidence of detecting any significant lesion on colonoscopy screening is very low (0.5%–1.0%), a noninvasive alternative is the need of hour.[3]

Colonoscopy is not only associated with patient discomfort and poor compliance often requiring sedation but also carries the risk of perforation. In addition, it is incomplete in nearly one -fifth of patients secondary to adhesions, stenosis, long bowel

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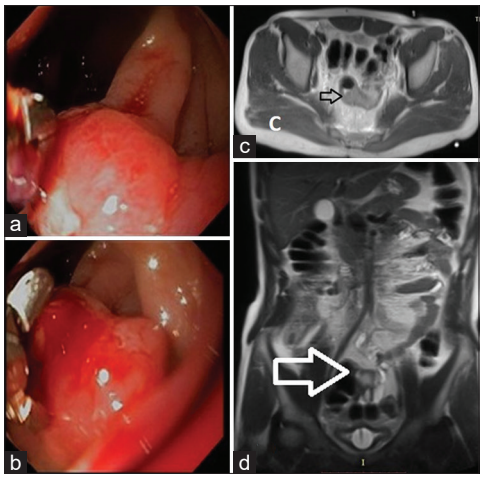

Figure 1: Growth on colonoscopy before (a) and after taking biopsy (b) with T2 weighted axial (c) and T2-weighted coronal (d) dark lumen magnetic resonance imaging showing sigmoid colon mass (arrows) in the same patient

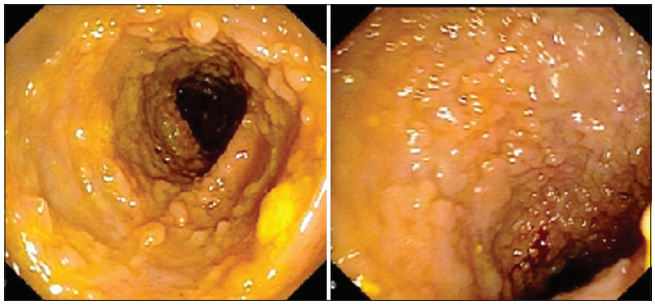

Figure 3: Colonoscopy demonstrating early ulcerative colitis with pseudopolyps not demonstrated on magnetic resonance colonography

Figure 5: T2-weighted coronal magnetic resonance imaging demonstrating multiple liver metastases in a patient with colonic malignancy that cannot be detected on colonoscopy

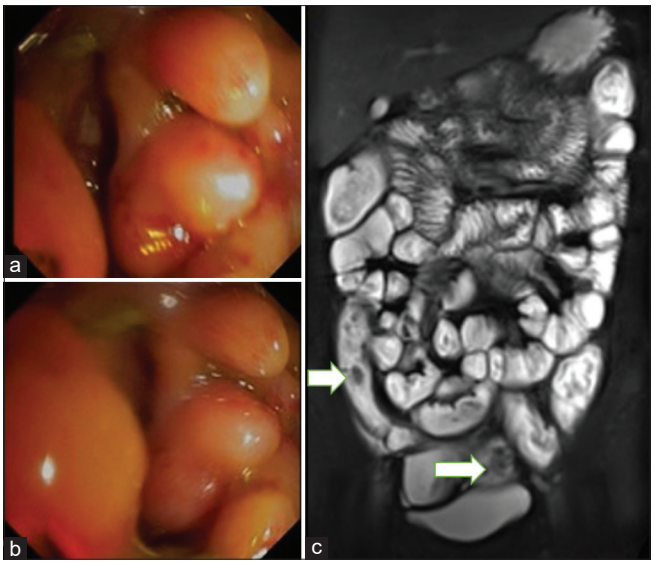

Figure 2: Colonoscopy demonstrated multiple polypoidal lesions (a and b) well demonstrated on bright lumen magnetic resonance imaging, T2-weighted coronal fat-suppressed image (c) as multiple intraluminal filling defects (arrows)

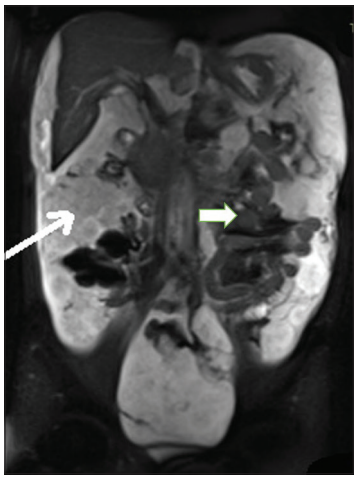

Figure 4: T2-weighted magnetic resonance imaging image demonstrating pseudomyxoma peritonei and mesenteric lymphadenopathy (arrows)

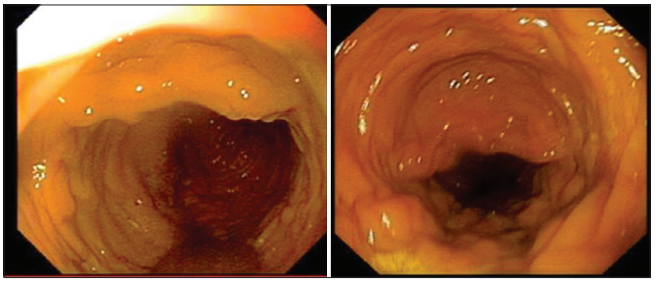

Figure 6: Colonoscopy demonstrating growth at junction of sigmoid with descending colon without demonstrable growth on magnetic resonance imaging is a patient with nonspecific colitis on histopathological examination

stricture, and inadequate bowel preparation.[4] Being operator dependent, approximately one-fifth of polyps and one-quarter adenoma (1–5 mm) may be missed on colonoscopy.[5] Absolute contraindications of colonoscopy include perforation, peritonitis, fulminant colitis, acute diverticulitis, etc., while relative contraindications include heavy bleeding per rectum,

cardiorespiratory instability, inadequate bowel preparation, an unconscious or uncooperative patient, imaging plays a crucial role in all of them.[6] Complications of colonoscopy include bacteremia, perforation, hemorrhage, serosal lacerations, abdominal distention, vasovagal reflex, impaction of scope in hernia, and rarely, pneumatosis cystoides intestinalis.[7]

Various disadvantages of colonoscopy coupled with recent MRI developments in the form of faster imaging sequences, high-resolution surface coils, deep learning systems, and computer-aided polyp detection systems together with ability to perform colonography without risk of radiation or contrast agents have helped in making MRI a well-recognized screening tool in colorectal diseases.[8,9] Although both CT and MRI have similar indications and advantages over conventional colonoscopy in colorectal region, MRI offers the additional advantage of not only being radiation free but also avoiding risk associated with iodinated contrast agents.[10,11]

Hence, this present study is targeted to compare and evaluate the advantages and disadvantages of MRI in colorectal diseases over flexible colonoscopy with the following aim and objectives.

Aim

- Comparison of MRI and colonoscopy in evaluation of colorectal diseases.

Objectives

- To assess the role of MRI in evaluation of colorectal diseases
- To compare the role of MRI with colonoscopy in evaluating various colorectal diseases.

Materials and Methods

This observational and comparative study was performed on 44 patients in our institution over a period of 15 months following approval from the institutional ethics committee and after obtaining written, informed consent using the following criteria.

Inclusion criteria

- Patients with clinical suspicion of colorectal pathologies.

Exclusion criteria

1. Patients with contraindication to MRI
2. Patients with contraindication to colonoscopy.

Following entry of patient demographic details in predesigned pro forma, a patient was enrolled for MRI abdomen on a 1.5 Tesla MR scanner. Bowel preparation to make the colorectal region free of fecal matter prior to MRI examination was achieved using polyethylene glycol administered during the prior evening. A patient was advised a liquid diet on a day prior to examination. Intravenous injection of 20 mg hyoscine butylbromide was used 30 min prior to examination to reduce the peristalsis-induced artifacts. The colon was distended by instilling optimal amount of lukewarm water through peroral route. MRI protocol included T1- and T2-weighted images (axial and coronal), fat-suppressed T1- and T2-weighted images (axial and coronal), diffusion-weighted images, and if required, postcontrast T1GRE images in supine position. Sagittal and prone images were used whenever required.

Following MRI examination, a patient underwent colonoscopy on the same day using Olympus 160AL video colonoscope. Biopsy was taken whenever indicated.

The findings of both MRI and colonoscopy were recorded in the predesigned pro forma and compared with the final clinicopathological diagnosis. Appropriate statistical methods and tools were applied to compare the findings. For statistical purposes, $P < 0.05$ was considered statistically significant.

Observations and Results [Figures 1-6]

Majority of the patients (12/44) in our study were in the age group of 21–30 years followed by 31–40 years (11/44) with a median age of 40 years and a mean age of 43.6 years. Male predominance (35/44) was noted in our study with a male-to-female ratio of nearly 4:1.

Table 1 shows that altered bowel habit was the most common clinical indication for evaluation of patients in our study followed by bleeding per rectum.

In our study, adequate bowel preparation could be achieved in only 25% of the patients (11/44) with poor preparation in nearly 61.4% (27/44). In less than two-third of the patients (61.4%, 27/44), colonoscopy was complete up to cecum and/or terminal ileum. In 45.5% of the patients, biopsy was taken during colonoscopy for tissue diagnosis.

Extracolonic findings on MRI were noted in nearly 70.5% (31/44) of the patients in our study, with the most common pathology being lymphadenopathy [Table 2]. In at least 54.3% (17/31) of the patients with extracolonic findings, the final management was affected.

In our study, both colonoscopy and MRI overdiagnosed patients for malignancy with higher errors in MRI [Table 3].

Approximately 16% (7/44) of the patients in our study had malignant disease whereas internal hemorrhoids were the most common benign cause. Tables 4-6 reveal that the comparison of MRI with colonoscopy in detection of growth, stricture, and diverticulum in colorectal region is not only statistically

Table 1: Distribution of patients based on clinical features

Clinical features	Frequency, *n* (%)
Altered bowel habits	27 (61.36)
Pain abdomen	2 (4.55)
Bleeding PR	13 (29.55)
Perianal pain	2 (4.55)
Chronic diarrhea	1 (2.27)
Intestinal obstruction	2 (4.55)
Anemia	1 (2.27)

PR: Per rectum

significant but also has a significant degree of agreement, maximum with diverticular detection.

Tables 7 and 8 show that the comparison of MRI with colonoscopy for differentiating mucosal thickening from edema and for detection of internal hemorrhoids is not only significant but also has a good agreement as well.

Table 2: Distribution of extraluminal pathologies on magnetic resonance imaging

Extraluminal	Frequency, *n* (%)
Lymphadenopathy*	9 (29.03)
Renal cyst	5 (16.12)
Distant metastasis*	4 (12.9)
Ascites*	3 (9.6)
Ureteric/renal calculus	2 (6.4)
Hydroureteronephrosis	2 (6.4)
Pleural effusion	1 (3.2)
Inguinal hernia	1 (3.2)
Pseudomyxoma peritonei (malignant)*	1 (3.2)
Splenic abscess/infarct	1 (3.2)
Hip prosthesis	1 (3.2)
Caudate lobe hypertrophy	1 (3.2)
Total	31 (100)

Table 3: Distribution of colonoscopy and magnetic resonance imaging based on benign versus malignant diagnosis

	Frequency, *n* (%)		
	Colonoscopy diagnosis	MRI diagnosis	Final diagnosis
Benign	34 (77.27)	24 (54.55)	37 (84.09)
Malignant	10 (22.73)	20 (45.45)	7 (15.91)
Total	44 (100.00)	44 (100.00)	44 (100.00)

MRI: Magnetic resonance imaging

The sensitivity of MRI for diagnosing malignancy in our study was 100% against 85% of colonoscopy with a lower positive predictive value (PPV) of 35% versus 60%. However, MRI had a negative predictive value (NPV) of 100% with an accuracy of 70.45% compared to 88.64% in colonoscopy.

Discussion

In our study, majority of the patients (23/44) were from the age group of 21–40 years with a mean age of 43.61 years and a median age of 40 years. Karthikeyan[12] in his study had a median age of 47 years. Ajaj *et al*.[13] found in their study had a mean age of 60 years. This difference in mean/median age is probably due to different study populations or demography-related differences in colorectal disease.

In our study, males outnumbered females with a male-to-female ratio of 4:1. Karthikeyan[12] had a male-to-female ratio of 2:1 probably due to different study populations (metropolis-based study). Ajaj *et al*.[13] had more slightly more females than males signifying better reach of women for health-care facilities in the Western world.

Altered bowel habit (61.36%) and bleeding per rectum were the two most common clinical features in our study population. Bleeding per rectum was the most common feature in the study by Karthikeyan[12] whereas Ajaj *et al*.[13] reported pain abdomen to be the most common clinical feature. Both the above authors did not include altered bowel habits as a clinical feature.

Out of total 44 patients, only 11 (25%) had adequate bowel preparation and majority (n = 27, 61.36%) had poor bowel preparation, especially those with obstructive growth. The adequacy of bowel preparation has a direct positive correlation to the completeness of colonoscopy. Both Karthikeyan[12] and Ajaj *et al*.[13] did not study this parameter in their studies.

Colonoscopy is considered complete if terminal ileum or cecum can be reached. However, in nearly 50%, colonoscopy

Table 4: Comparison of magnetic resonance imaging and colonoscopy based on detection of growth

Growth colonoscopy	Growth MRI		Total, *n* (%)	*P*	κ
	No (*n*=39), *n* (%)	Yes (*n*=5), *n* (%)			
No	36 (81.82)	0	36 (81.82)	<0.0001	0.732
Yes	3 (6.82)	5 (11.36)	8 (18.18)		
Total	39 (88.64)	5 (11.36)	44 (100.00)		

MRI: Magnetic resonance imaging

Table 5: Comparison of magnetic resonance imaging and colonoscopy based on detection of stricture

Stricture colonoscopy	Stricture MRI		Total, *n* (%)	*P*	κ
	No (*n*=42), *n* (%)	Yes (*n*=2), *n* (%)			
No	40 (90.91)	1 (2.27)	41 (93.18)	0.013	0.365
Yes	2 (4.55)	1 (2.27)	3 (6.82)		
Total	42 (95.45)	2 (4.55)	44 (100.00)		

MRI: Magnetic resonance imaging

Table 6: Comparison of magnetic resonance imaging and colonoscopy based on detection of diverticulum

Diverticulum colonoscopy	Diverticulum MRI		Total, *n* (%)	*P*	κ
	No (*n*=43), *n* (%)	Yes (*n*=1), *n* (%)			
No	43 (97.73)	0	43 (97.73)	<0.0001	1.000
Yes	0	1 (2.27)	1 (2.27)		
Total	43 (97.73)	1 (2.27)	44 (100.00)		

MRI: Magnetic resonance imaging

Table 7: Comparison of magnetic resonance imaging and colonoscopy based on detection of mucosal thickening/edema

Mucosal thickening/ edema colonoscopy	Mucosal thickening/edema MRI		Total, *n* (%)	*P*	κ
	No (*n*=31), *n* (%)	Yes (*n*=13), *n* (%)			
No	27 (61.36)	3 (6.82)	30 (68.18)	<0.0001	0.626
Yes	4 (9.09)	10 (22.73)	14 (31.82)		
Total	31 (70.45)	13 (29.55)	44 (100.00)		

MRI: Magnetic resonance imaging

Table 8: Comparison of magnetic resonance imaging and colonoscopy based on detection of hemorrhoids

Hemorrhoid colonoscopy	Hemorrhoids MRI		Total, *n* (%)	*P*	κ
	No (*n*=39), *n* (%)	Yes (*n*=5), *n* (%)			
No	34 (77.27)	0	34 (77.27)	<0.0001	0.607
Yes	5 (11.36)	5 (11.36)	10 (22.73)		
Total	39 (88.64)	5 (11.36)	44 (100.00)		

MRI: Magnetic resonance imaging

is incomplete secondary to inadequate bowel preparation, uncooperative patient, and obstructing mass/stricture. In our study, colonoscopy was complete in 61% of the cases (*n* = 27). Dafnis *et al*.[4] reported nearly 80% colonoscopies as complete whereas Karthikeyan[12] reported 70% complete. Ajaj *et al*.[13] reported only 9/122 as incomplete colonoscopies.

The reasons for lesser number of complete colonoscopies in our study may be due to a greater number of inadequate bowel preparations, lesser use of sedation, and less experience of gastroenterologist.

Extraluminal pathologies are purely MRI findings that are not picked up colonoscopy being the limitation of latter. The most common extraluminal pathology identified in our study was lymphadenopathy (*n* = 9, 29.03%) followed by cortical renal cyst (*n* = 5, 16.12%) and distant metastasis (*n* = 4, 12.9%). Excluding renal cortical cyst, both lymphadenopathy and distant metastases affect the management of colorectal disease. Karthikeyan[12] also reported almost similar extraluminal pathologies in his study. Ajaj *et al*.[13] reported renal cyst to be the most common extracolonic finding.

On colonoscopy, the diagnosis of malignant lesion was made in ten cases (22.73%), with the rest being labeled as a benign lesion. On MRI, the diagnosis of malignant lesion was made in twenty cases (54.55), with the rest being labeled as a benign lesion. Common final diagnosis was normal study (*n* = 11, 23.91%) followed by internal hemorrhoids (*n* = 10, 21.73%). Final diagnosis of malignancy was made in seven cases (15.91%), hence both colonoscopy and MRI overdiagnosed lesions as being malignant.

Lesion biopsy was decisive in five cases of colonic malignancy. In two cases, biopsy was not taken: one each due to low suspicion and extraluminal nature of lesion, hence in two out of seven malignant lesions colonoscopy failed to make the final that could be reached by MRI. In the study by Karthikeyan,[12] repeat biopsy in two cases of inflammatory pathology, turned out malignant. In our study, repeat biopsy was not considered.

In our study, colonoscopy detected three small polyps whereas MRI could not detect any polyp. This finding is similar to the studies by Karthikeyan[12] and Ajaj *et al*.[13] where all polyps <5 mm detected on conventional colonoscopy were not detected on MRI.

In our study, MRI was as accurate as colonoscopy in the diagnosis of diverticulosis. This accuracy is also similar to accuracy noted in the studies performed by Karthikeyan[12] and Ajaj *et al*.[13]

In our study, MRI could correctly diagnose mucosal thickening/edema in 10/14 patients (71.4%) and falsely diagnosed 3/30 (10%) negative cases. These findings are similar to the study by Karthikeyan.[12]

In our study, MRI could rule out internal hemorrhoids in 34/34 patients but could make the diagnosis in 5/10 patients. This parameter was not included in previous studies.

The sensitivity of MRI for diagnosing malignancy in our study was 100% against 85% of colonoscopy with a lower PPV of 35% versus 60%. However, MRI had a NPV of 100% with an accuracy of 70.45% compared to 88.64% in colonoscopy. Karthikeyan[12] considered colonoscopy as a gold standard and compared MRI diagnosis with colonoscopy in contrast to our study where we compared both MRI and colonoscopy with the final diagnosis Hence, our results are different from Karthikeyan[12] with MRI sensitivity, PPV, NPV, and accuracy of 53%, 83%, 32%, and 65%, respectively. However, the sensitivity in our study was similar to that of Haykir *et al*.[14] (96.4%) though with a lower specificity of 64.86% in our study versus 100% in their study.

Limitations

- Small sample size due to time-bound nature of the study
- Single-center study
- The study was done in a 1.5 Tesla MR scanner
- Higher number of inadequately prepared bowels
- No second-look colonoscopy or repeat biopsy was included in our study.

Conclusions

- Colorectal disease is most common in the third and fourth decades with male predominance
- The most common presentation of colorectal disease is altered bowel habit followed by bleeding per rectum
- Inadequate bowel preparation is the major limitation in evaluation of colorectum
- The most frequent extraluminal pathologies on MRI are lymphadenopathy, renal cyst, and distant metastasis
- MRI overdiagnosis lesions as malignant
- MRI effectively detects growth, stricture, diverticulosis, and mucosal thickening/edema while effectively rules out internal hemorrhoids
- MRI is highly insensitive for small polyps (<5 mm) and ulcers
- MRI is highly sensitive but moderately specific and accurate when compared with final diagnosis. In many cases, it is superior to colonoscopy. Hence, clinicopathological diagnosis should be considered as a gold standard
- MRI is the modality of choice of staging colorectal cancers with an advantage of detecting synchronous malignancy along with extracolonic spread.

Summary

Although conventionally fiber-optic flexible colonoscopy is considered as a gold standard method of evaluating colorectal diseases, it is limited by its invasive nature, operator dependence, dependency on bowel preparation, high frequency of incomplete examination, and low yield. MRI is now considered as a major screening tool in evaluating colorectal diseases due to its obvious and definite advantages over colonoscopy and CT.

MRI is quite accurate in diagnosis of colonic mass, stricture, mucosal thickening, and diverticulum in addition to detection of extracolonic pathologies that may affect the final diagnosis and management. In fact, MRI used in conjunction with colonoscopy has a very high accuracy in detection of malignant lesions.

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Conflicts of interest

There are no conflicts of interest.

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