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ORIGINAL ARTICLE

The Role of Magnetic Resonance Enterography for Detection and Differentiation of Pediatric Inflammatory Bowel Diseases

Pediatrik İnflamatuar Bağırsak Hastalıklarının Tanısında ve Ayrımında Manyetik Rezonans Enterografinin Rolü

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ABSTRACT

Background/Aıms: Inflammatory bowel diseases (IBD) are of two types: Crohn's disease (CD) and ulcerative colitis (UC). The differential diagnosis of these two diseases is important because their treatment strategies are different. The present study aimed to evaluate the Magnetic Resonance Enterography (MRE) findings of pediatric patients who were clinically diagnosed with CD or UC.
Materıal And Method: The patients under the age of 18, who underwent MRE examination, were retrospectively screened. Fifty five of those patients, who were clinically diagnosed with CD or UC, were included in the study. Bowel wall thickening, mesenteric fat tissue changes and complications were evaluated, and the findings were recorded. The sensitivity and specificity of MRE in the diagnosis of CD and UC in IBD patients were calculated.
Results: Three of the patients clinically diagnosed with CD (7.3%) and six patients who had UC (42.9%) had involvement from the rectum to the proximal colonic segments (continuous lesions). Of those diagnosed with CD, 11 (26.8%) had skip lesions. In patients with IBD, the sensitivity of MRE for the diagnosis of CD was 56.1% and the specifity was 100%. The sensitivity of MRE for the diagnosis of UC was 42.9% and the specificity was 90.2%.
Conclusıon: MRE is helpful to identify the signs and complications of inflammatory bowel diseases. Although MRE has low sensitivity to differentiate between CD or UC in pediatric patients, it may help with its high specificity rates.

Keywords: Crohn's Disease; Inflammatory Bowel Diseases; Magnetic Resonance Enterography; Ulcerative Colitis.

ÖZ

Amaç: İnflamatuar barsak hastalıkları Crohn hastalığı ve ülseratif kolit olarak ikiye ayrılır. Tedavi stratejileri farklı olduğundan ayrımları önemlidir. Bu çalışmada klinik olarak Crohn hastalığı veya ülseratif kolit tanısı alan pediatrik hastaların Manyetik Rezonans Enterografi (MRE) bulgularının değerlendirilmesi amaçlanmıştır.
Gereç Ve Yöntem: Onsekiz yaş altı MRE incelemesi bulunan hastalar retrosepektif olarak tarandı. Bu hastalardan Crohn hastalığı veya ülseratif kolit tanısı bulunan 55 hasta çalışmaya dahil edildi. Barsak duvar kalınlaşması, mezenterik yağ doku değişiklikleri ve hastalık komplikasyonları değerlendirildi, bulgular kaydedildi. İnflamatuar barsak hastalığı tanısı bulunan hastalarda, MRE'nin Chron veya ülseratif kolit tanısındaki sensitivite ve spesifiteleri hesaplandı.
Bulgular: Chron hastalığı tanısı bulunan 3 hastada (%7.3) and ülseratif kolit tanısı bulunan 6 hastada (%42.9) rektumdan proksimal kolonik segmentlere uzanan tutulum mevcuttu. Crohn tanısı bulunan 11 hastada (%26.8) atlayıcı lezyonlar vardı. İnflamatuar hastalığı tanısı bulunan hastlarda MRE'nin Crohn hastalarında sensititivtesi %56.1 ve spesifistesi %100, ülseratif kolit hastalarında sensitivitesi %42.9 ve spesifitesi %90.2 olarak hesaplandı.
Sonuç: MRE inflamatuar barsak hastalıklarının bulgularının ve komplikasyonlarının tanımlanmasında yardımcıdır. Crohn hastalığı ile ülseratif kolit ayrımında MRE'nin sensititivtesi düşük olmakla birlikte yüksek spesifiste oranları ile tanıda yardımcı olabilir.

Anahtar Kelimeler: Crohn hastalığı; İnflamatuar barsak hastalığı; Manyetik Rezonans Enterografi; Ülseratif Kolit.

Introduction

Inflammatory bowel diseases (IBD) are of two types: Crohn's disease (CD) and ulcerative colitis (UC). The clinical and histopathological findings of the two conditions are different. The differential diagnosis of these two diseases is important because their treatment strategies are different. Diagnosis is made based on clinical history, physical examination, laboratory findings, endoscopic findings, histologic evaluation and radiologic imaging. While the upper gastrointestinal tract and colon structures are evaluated by endoscopy, magnetic resonance imaging (MRI) is recommended for the evaluation of the small intestine (1). About 20-30% of IBD are diagnosed before the age of 20. IBD that begins in childhood tends to have more widespread involvement, higher disease activity, and a more complicated course (2). Although the disease peaks in late adolescence, up to 4% of pediatric IBDs are diagnosed in early childhood (3). Crohn's disease can involve any part of the gastrointestinal system, but terminal ileum involvement is the most common. In UC, on the other hand, there is mucosal inflammation limited to the rectum and colon (3). Magnetic resonance enterography (MRE), which is used in combination with endoscopy and histopathological analysis, helps in the diagnosis and management of the disease (4). The present study aimed to evaluate the MRE findings

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of pediatric patients who were clinically diagnosed with CD or UC. The sensitivity and specificity of MRE in differentiating CD and UC were evaluated.

Material and Methods

The study was approved by the local ethics committee.

The patients under the age of 18 who underwent MRE examination between 2015 and 2022 were retrospectively screened. Of these patients, 55 patients who were clinically diagnosed with CD or UC were included in the study. When a patient had more than one MRE examination, the first examination was evaluated.

For MRE scan, patients were asked to fast for five hours before the examination. Water and lactulose (Duphalac, 667 mg/mL) were used to ensure intestinal distention before the examination. One hour before the examination, the patients were started to be given a solution prepared with 1000 cc of water and 100 cc of Duphalac. Just before the examination, an ampoule of hyoscine-N-butylbromide (Buscopan) was administered as slow infusion IV to reduce the artifacts due to peristalsis. During the examination, 0.1 mmol/kg gadoterate meglumine was used.

Examinations were carried out using a 1.5 T MRI scanner (Philips Ingenia; Best, the Netherlands and Siemens Avanto; Erlangen, Germany). Evaluations were made on coronal T2A SSTSE (Philips) or HASTE (Siemens), coronal and axial BTFE (Philips) or True FISP (Siemens), coronal pre-contrast mDIXON (Philips) or VIBE (Siemens), coronal and axial post-contrast mDIXON (Philips) or VIBE (Siemens) images. MRE examinations were evaluated by a pediatric radiologist with seven years of MRE experience. A blind evaluation was made on MRE examinations in which the radiologist did not have information about the clinical diagnosis while making the evaluation.

To find out whether there was wall thickening in jejunal-proximal ileal loops, terminal ileum, cecum, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum were evaluated separately for each segment. A wall thickness of more than 3 mm was accepted as a positive finding (5). The wall thickening in the terminal ileum was considered to be the long segment if it concerned a 5 cm or more segment and the short segment if it concerned the shorter segment (6). The number and percentages of bowel segments involved in patients with CD and UC were calculated.

Then, mesenteric findings (mesenteric fibrofatty proliferation, perienteric inflammation, reactive free fluid, comb sign, and mesenteric lymph node enlargement) and complications (presence of stricture, fistula, and abscess) were evaluated and the findings were recorded. The short diameters of the mesenteric lymph nodes greater than 5 mm were also evaluated as enlarged lymph nodes (7). According to the CD and UC diagnoses, the frequency of these findings was calculated.

The presence of wall thickening starting from the rectum and continuing towards the proximal was considered a continuous lesion. When there was a normal segment between the segments with wall thickening in the intestinal loops, it was considered a skip lesion. Examinations with skipped lesions and continuous lesions were recorded. The frequencies of the continuous lesion and skip lesion were calculated for CD and UC.

The presence of at least one of the findings of comb sign, abscess, enteroenteric fistula, skip lesion, wall thickening in the jejunal-proximal ileal loops, long segment wall thickening in the terminal ileum and mesenteric fibrofatty proliferation in MRE was defined as CD. The presence of a continuous lesion on colonic segments in MRE was defined as UC. The sensitivity and specificity of MRE in the diagnosis of UC and CD were calculated.

Statistical Analyses

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) ver. 23 (SPSS Inc., Chicago, IL, USA). Descriptive statistics, frequency, and percentage values of MRE findings were calculated. Minimum, maximum, percentage, and n values were used as descriptive statistics. The relationship between MRE findings was evaluated by Chi-square and Fisher's exact test. $p < 0.05$ was considered significant.

Results

The study included 55 pediatric patients (25 females and 30 males). The age distribution of the patients was between 8 and 17 years and the median age was 14. The number of patients who were clinically diagnosed as CD was 41 (74.5%), and the number of patients who were clinically diagnosed as UC was 14 (25.5%). The distribution of patients according to clinical diagnosis and gender is given in Table 1.

Crohn's disease was more common in boys while UC was more common in girls. The relationship between the gender and the type of IBD was statistically significant ($p < 0.05$). There was no significant difference between the type of IBD and age ($p > 0.05$). The number and percentage of intestinal loops in which wall thickening was detected in MRE based on clinical diagnosis are given in Table 2.

The number and percentage of extraluminal findings detected by MRE are given in Table 3 (Fig. 1,2,3).

Short segment involvement only in the terminal ileum was present in one of the CD and UC patients who were diagnosed based on clinical data (Fig.4). MRE findings were completely normal in 12 patients (29.3%) of CD and 8 patients of UC (57.1%). In other words, MRE findings were completely normal in 20 of 55 patients (36.4%) with IBD. In 63.6% of the patients, bowel wall thickening was observed in any segment of the intestinal loops. There was only short segment involvement in the terminal ileum in two of the CD patients.

Jejunal-proximal ileal wall thickening was not observed in UC patients. One of the patients with UC had short segment terminal ileum involvement plus bowel wall thickening in the entire colon (Fig. 4). Long segment

terminal ileum involvement was not present in UC patients. Six UC patients had rectum, sigmoid colon, and descending colon involvement. Eight of IBD patients (3 with CD and 5 with UC) had only colonic involvement (14.5%).

In two of the CD patients, wall thickening of the jejunal-proximal ileal loops was observed, while the terminal ileum was normal (Fig. 5). The colonic involvement was observed in only one of them. Three of CD patients (7.3%) and six of UC patients (42.9%) had involvement of colon from rectum to proximal segments (continuous lesions) (Fig 6). Of those diagnosed with CD, 11 (26.8%) had skip lesions, while UC patients had none.

The sensitivity of MRE in the diagnosis of CD was 56.1% and the specificity was found as100%, in cases who showed at least one of these findings: comb sign (Fig.1), abscess (Fig. 2), enteroenteric fistula (Fig. 2), skip lesion (Fig. 7), wall thickening in the jejunal-proximal ileal loops, terminal ileal long segment wall thickening, and mesenteric fibrofatty proliferation (Fig. 1).

The sensitivity of MRE in the diagnosis of UC in cases with continuous lesions was 42.9% and specificity was 90.2%.

The most common MRE finding in UC patients was bowel wall thickening (6 patients, 42.9%). The stricture was observed in 2 of these patients.

The numbers and percentages of patients with terminal ileum, small bowel, and colonic wall thickening due to IBD were given in Table 4.

In CD and UC patients, the relationship between bowel wall thickening and other findings in MRE are given in Table 5 and Table 6, respectively.

Table 1. The distribution of patients according to clinical diagnosis and gender

Diagnosis	Female n (%)	Male n (%)	Total n (%)
Crohn disease	15 (36.6)	26 (63.4)	41 (100)
Ulcerative colitis	10 (71.4)	4 (28.6)	14 (100)
Total	25 (45.5)	30 (54.5)	55 (100)

Table 2. The number and percentage of intestinal loops in which wall thickening was detected in MRE based on clinical diagnosis

Segment with wall thickening	Crohn disease n (%)	Ulcerative colitis n (%)
Jejunal-proximal ileal	9 (22)	0
Terminal ileum (short segment)	5 (12.2)	1 (7.1)
Terminal ileum (long segment)	19 (46.3)	0
Cecum	13 (31.7)	1 (7.1)
Ascending colon	8 (19.5)	2 (14.3)
Transverse colon	5 (12.2)	3 (21.4)
Descending colon	8 (19.5)	6 (42.9)
Sigmoid colon	8 (19.5)	6 (42.9)
Rectum	6 (14.6)	6 (42.9)

Table 3. The numbers and percentages of extraluminal findings detected in MRE examination based on clinical diagnosis

Extraluminal finding	Crohn disease n (%)	Ulcerative colitis n (%)
Abscess	4 (9.8)	0
Enteroenteric fistula	4 (9.8)	0
Free fluid	11 (26.8)	1 (7.1)
Perienteric inflammation	14 (34.1)	2 (14.3)
Stricture	8 (19.5)	2 (14.3)
Mesenteric fibrofatty proliferation	10 (24.4)	0
Mesenteric lymph node enlargement	17 (41.5)	1 (7.1)
Comb sign	6 (14.6)	0

Table 4. The numbers and percentages of patients with terminal ileum, small bowel and colonic wall thickening according to clinical diagnosis

	Crohn disease n (%)	Ulcerative colitis n (%)
Terminal ileum	24 (58.5)	1 (7.1)
Small intestine	26 (63.4)	1 (7.1)
Colon	17 (41.5)	6 (42.9)

Table 5. The relationship between bowel wall thickening and other findings in MRE, in CD patients

MRE finding	n (%)	p
Stricture	8 (27.6)	0.079
Perienteric inflammation	14 (48.3)	0.003
Mesenteric fibrofatty proliferation	10 (34.5)	0.021
Mesenteric lymph node enlargement	17 (58.6)	<0.01
Comb sign	6 (20.7)	0.106
Abscess	4 (13.8)	0.302
Enteroenteric Fistula	4 (13.8)	0.302
Skip lesion	11 (37.9)	0.018

Table 6. The relationship between bowel wall thickening and other findings in MRE, in UC patients

MRE finding	n (%)	p
Stricture	2 (33.3)	0.165
Perienteric inflammation	2 (33.3)	0.165
Continue	6 (100)	<0.001
Mesenteric lymph node enlargement	1 (16.7)	0.429

Discussion

The role of the radiological imaging in the diagnosis of IBD is important in the pediatric age group because endoscopic examinations mostly require anesthesia which makes the process more labourous and worrisome for the parents and children. MRE is helpful not only in showing inflammation in the intestinal wall but also in showing extraluminal and extraintestinal findings. MRE comes to the fore in pediatric patients because it does not involve ionizing radiation, it has

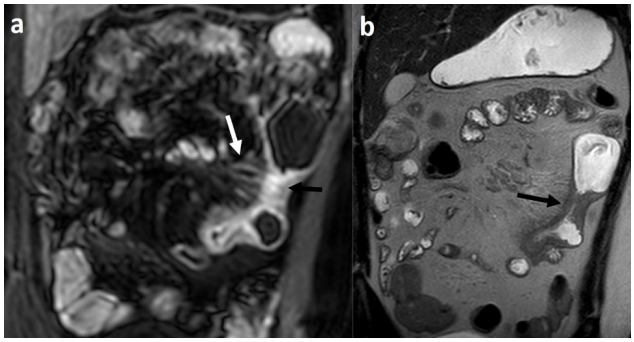

Figure 1: A 17-year-old boy with known Crohn's disease. Coronal contrast-enhanced T1-weighted with fat suppression image (a) and coronal SSTSE T2-weighted image (b) show focal wall thickening in the small bowel loop and stricture (black arrow). The bowel proximal to the stricture is dilated. The white arrow shows the ectasia of the vasa recta with the characteristic "comb sign". Mesenteric fibrofatty proliferation is seen in figure (b).

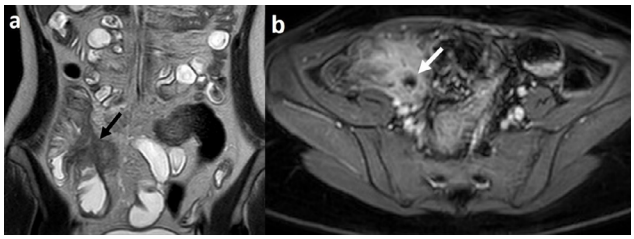

Figure 2: A 16-year-old girl with known Crohn's disease. Coronal SSTSE T2-weighted image (a) shows an enteric fistula (black arrow) and axial contrast-enhanced T1-weighted with fat suppression image shows an abscess formation with peripheral enhancement (white arrow).

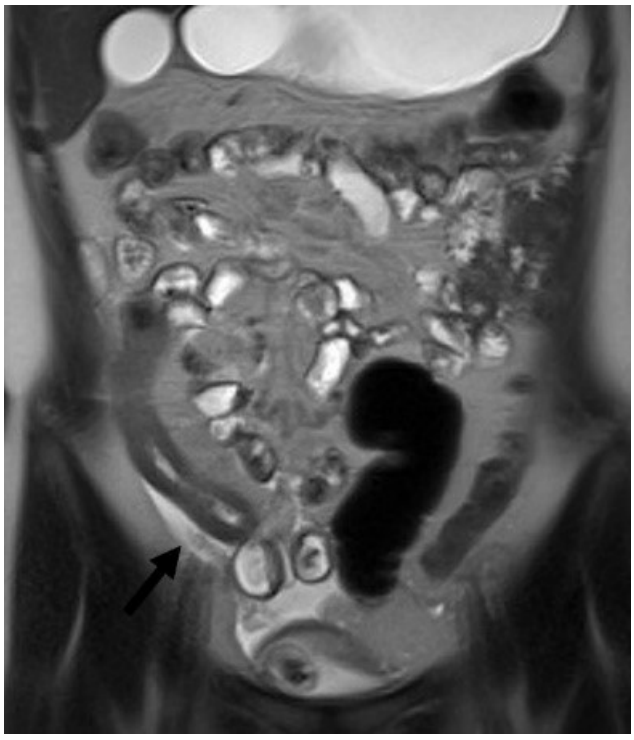

Figure 3: A 15-year-old girl with known Crohn's disease. Coronal HASTE image shows free fluid (arrow) and wall thickening of the terminal ileum.

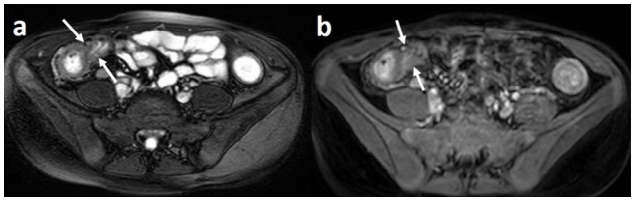

Figure 4: A 16-year-old girl with known ulcerative colitis. Axial balanced FFE (BTFFE) image (a) and axial contrast-enhanced T1-weighted with fat suppression image (b) show short segment wall thickening in the terminal ileum (white arrows). Coronal SSTSE T2-weighted image (c) shows wall thickening in ascending and descending colon (black arrows).

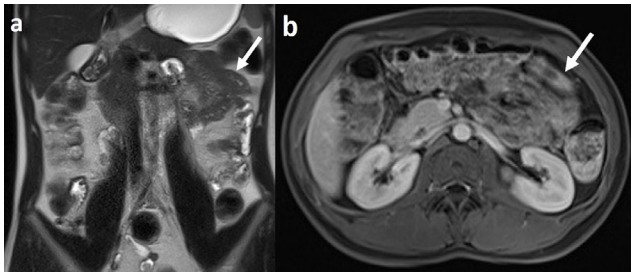

Figure 5: A 15-year-old boy with known Crohn's disease. Coronal HASTE image (a) and axial contrast-enhanced T1-weighted with fat suppression image (b) show wall thickening of the jejunal loops (arrows).

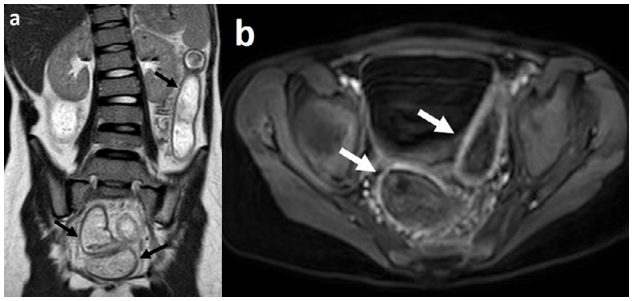

Figure 6: A 10-year-old girl with known ulcerative colitis. Coronal SSTSE T2-weighted image (a) and axial contrast-enhanced T1-weighted with fat suppression image (b) show continuous lesions. Wall thickening (black arrows) in the rectum, sigmoid colon, and descending colon and enhancement (white arrows) are shown.

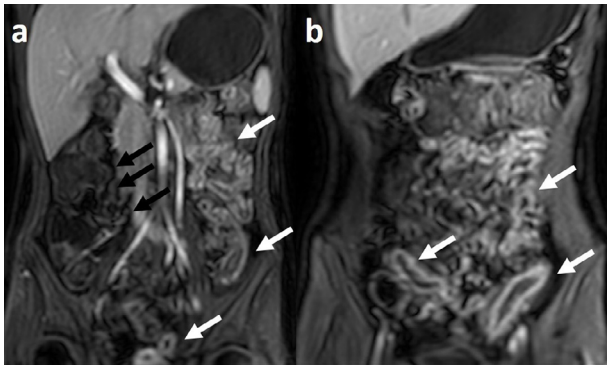

Figure 7: A 14-year-old girl with known Crohn's disease. Coronal contrast-enhanced T1-weighted with fat suppression images show skip lesions. Wall thickening in the rectum, sigmoid colon, terminal ileum, and jejunal loops (white arrows) are shown. In figure (a), black arrows show normal bowel wall thickness

excellent soft tissue contrast, and allows multiphase and multiplanar imaging. The long scanning time and the need for sedation or anesthesia in pediatric patients are its disadvantages (8).

In the present study, pediatric patients under the age of 18 years, who were clinically diagnosed with CD or UC and who had MRE examinations, were screened. Common and distinct MRE findings of CD and UC patients were evaluated. The weaknesses and the strengths of MRE in differentiation of IBDs that were diagnosed on clinical work-up were discussed.

In terms of the disease frequencies, 74.5% of the patients with IBD had CD and 25.5% had UC in the present study which were similar to the literature (9). In our study, the 55% of the patients were males. In the study of Heyman et al. which defined IBD characteristics in 1370 pediatric patients, 54% of the patients were male (10). The results were very similiar based on the gender distribution. There was male predominance in CD and female predominance in UC patients. In the literature, although there is male predominance in CD, there is no gender difference in pediatric UC patients (11).

While CD can develop anywhere along the gastrointestinal tract starting from the mouth to the anus, only colonic involvement occurs in UC (2). In our study, only one of the UC patients had short segment terminal ileum involvement as well as the wall thickening in all colonic segments consistent with pancolitis. Small bowel involvement was not observed in other UC patients. We believe that the short-segment wall thickening in the terminal ileum was related to backwash ileitis. In their study, Najarian et al. showed ileal inflammation histopathologically in 16% of pediatric patients with UC, and also reported a significant relationship between ileal inflammation and pancolitis (12).

In the present study, 36.4% of patients with IBD did not have wall thickening in any segment of the gastrointestinal tract. In the literature, it is stated that mild disease activity may not be revealed by MRE (1). The reason why we could not show IBD findings in some patients may be due to short segment and mucosal involvement or due to technical issues such as collapsed bowel loops or MRI artefacts.

In our study, 17 (41.5%) of CD patients had colonic wall thickening, and of those patients 3 had only colonic involvement (7.3%). The tendency of CD to involve only the colon is more frequent in pediatric patients (13). In a study composed of pediatric CD patients, colon involvement was observed in 80%, while 27% had isolated colon involvement (14). The percentage of CD patients with colonic involvement was found lower in our study compared to the literature, because some of the CD patients with negative radiologic signs in MRE may have colonic involvement although it can not be shown by MRE.

In the study of Podgorska et al., involving pediatric CD patients with MRE, 52.5% had wall thickening in the small intestine, 12.5% in the colon, and 5% in both the small intestine and colon while mural changes were not observed in 40% (15). In our study, these rates were 63.4%, 41.5%, 34.1% and 29.3%, respectively. While the age groups and the number of patients were similar between the studies of Podgorska et al. and ours, the wall thickening in the colon was more in the present study. The difference may be related to the timing of the examination. It is not known whether the imaging was performed during the active inflammation phase in their study. Podgorska et al. stated that MRE is not an appropriate examination for an optimal evaluation of colon since sufficient distension could not be achieved in colon loops. This may be another reason why the colonic involvement rates were different between the studies.

In IBD, strictures secondary to inflammation or fibrosis may develope (16). The strictures are common in CD and rare in UC (17). In the present study, stricture was observed in 19.5% of patients with CD and 14.3% of patients with UC. Onay et al. evaluated the MRE findings in adult patients with CD, and reported that 76% of them had stenosis and approximately 70% of the patients develope fibrotic strictures within 10 years (18). In our study, the stricture rate was much lower, because our patients were in the pediatric age group.

Inflammation can involve the entire intestinal wall and extend beyond the wall in CD, causing complications such as fistulas, abscesses, and strictures. In UC, on the other hand, inflammation is limited to the mucosal layer and the complications develop less frequently (19). In our study, none of the patients with UC had abscess or enteroenteric fistula. The patients with CD had both complications at a rate of 9.8%. As mentioned earlier, the stricture frequency was also higher in CD.

In IBD, several changes can be observed in mesenteric fat tissue. These are mesenteric fibrofatty proliferation, comb sign, mesenteric lymph node enlargement, peri-enteric inflammation, and the presence of free fluid (20). Of these, mesenteric fibrofatty proliferation and comb sign are the findings that mostly indicate CD (6). In our study, these findings were not observed in any patient with UC. Mesenteric lymph node enlargement, peri-enteric inflammation, and free fluid, which are signs of active inflammation, were also more common in CD patients. The inflammation in UC is mostly limited to the intestinal mucosa. This may be the reason why we did not observe those findings in UC.

In their study dealing with the adult CD patients, Onay et al. found the rate of enteroenteric fistula as 9%, which is similar to our study. In the same study, mesenteric fibrofatty proliferation was observed in 36%, perienteric inflammation in 18%, and mesenteric lymph node enlargement in 76%, while in our study these rates were 24.4%, 34.1%, and 41.5%, respectively (20). The mesenteric fat tissue is less in children than adults. This can make the evaluation of mesenteric fat more challenging and can obscure the mesenteric findings in pediatric patients. By this fact, we can explain why these findings involving the mesentery were observed less in our study.

In terms of the strength of MRE in differentiating CD and UC, the sensitivity (56.1% and 42.9% respectively) was low and the specificity was high for both diseases (100% and 90.2%, respectively). Low sensitivity may be related to the high number of patients having completely normal MRE findings.

The relationship between bowel wall thickening and peri-enteric inflammation and between bowel wall thickening and mesenteric lymph node enlargement were statistically significant in CD. There was no significant relationship between bowel wall thickening and peri-enteric inflammation and between bowel wall thickening and mesenteric lymph node enlargement in UC. This finding may be associated with the fact that UC is a mucosal disease while CD has transmural involvement and inflammation may exceed intestinal serosa (21).

In the present study, we evaluated the MRE of IBD patients who were diagnosed based on clinical and laboratory findings. The MRE was negative in 36.4% of IBD patients. This shows that MRE alone is not sufficient in the diagnosis of IBD. However, the presence of positive findings in 63.6% of patients shows us that it can be helpful in the diagnosis with suspected IBD.

Our study had some limitations. First, perianal MRI, which may help in the diagnosis of CD by imaging findings, could also be included in the study. Second, in our study, first MRE of the patients found in our hospital's database was evaluated. We did not know whether the patients were followed up at another center, nor were they newly diagnosed or on follow-up. Third, diffusion-weighted imaging (DWI) sequences were not included in our MRE protocol. Restricted diffusion in the intestinal wall can be considered as a sign of active inflammation (22). By using DWI, the sensitivity of the study could have been increased. Fourth, the technical issues such as insufficient dilatation of the intestinal loops, especially in the jejunal and proximal ileal segments, made the evaluation difficult. Fifth, there were artifacts due to peristalsis. Sixth, since all of the patients had IBD, we could not assess the sensitivity and specificity of MRE in the diagnosis of IBD.

In conclusion, MRE is a dedicated study which does not contain ionizing radiation and helps in showing intestinal loops noninvasively. It is beneficial in showing inflammation in the intestinal wall, also extraluminal and extraintestinal findings to identify active inflammatory, perforating, fistulating, and fibrostenotic subgroups. Although MRE has a low sensitivity to differentiate CD and UC in pediatric IBD patients, it may help with its high specificity rates. It has a significant role in diagnosis and treatment planning.

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