Magnetic resonance imaging in Crohn's disease
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Magnetic Resonance Imaging compared to ileocolonoscopy in evaluating disease severity in Crohn’s disease

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ABSTRACT

**Background & aims:** Abdominal magnetic resonance imaging (MRI) has shown promising results in the detection of Crohn’s disease-related lesions. The purpose of this study was to assess the value of MRI in measuring disease activity in Crohn’s disease patients in comparison to ileocolonoscopy.

**Methods:** 31 patients undergoing ileocolonoscopy because of suspicion of relapsing Crohn’s disease underwent MRI using water as intraluminal contrast medium. At endoscopy, disease severity was graded (4-point scale) and the Crohn’s Disease Endoscopic Index of Severity (CDEIS) was determined. Two radiologists independently interpreted the MRI. Radiological grading (4-point scale) was compared with endoscopic grading of disease severity and CDEIS (overall, for all segments). Wall thickness and enhancement were compared to CDEIS. Patient experience and preference were determined.

**Results:** In respectively 14 and 14 patients (radiologist 1), and 16 and 11 patients (radiologist 2) an exact match or one level of difference in grading was scored with the endoscopist. Correlation between severity rated at MRI and CDEIS was moderate to strong with \( r=0.61 \) \((P<0.001)\) for observer 1 and \( r=0.63 \) \((P<0.001)\) for observer 2. Per segment, the best correlation was seen in the terminal ileum \( (r=0.63 \ P<0.001, \text{for both observers}) \). Wall thickness correlated moderately to strongly with CDEIS \( (r=0.57, \ P<0.001 \text{ and } r=0.50, \ P<0.001 \text{ for observer 1 and 2}), \) while enhancement correlated weakly to moderately \( \text{respectively } r=0.45, \ P<0.001 \text{ and } r=0.42, \ P<0.001 \). Patients experienced more pain during endoscopy and all patients except two preferred MRI to endoscopy.

**Conclusion:** MRI can correctly identify disease severity in Crohn’s disease patients and is a patient friendly alternative to ileocolonoscopy.
INTRODUCTION

Crohn's disease (CD) is a chronic inflammatory bowel disease that often requires endoscopic and/or radiological assessment. However, the most frequently used techniques (i.e. ileocolonoscopy and barium enteroclysis) are hampered by the facts that patient acceptance is relatively low, the procedures are associated with increased morbidity, and combined evaluation of the small and large bowel is not possible (1). Furthermore, in CD patients intubation of the terminal ileum during endoscopy is often not achieved due to inflammation and/or stenosis, necessitating barium enteroclysis. The latter technique requires ionizing radiation, and only prominent intraluminal changes secondary to inflammation can be visualized (e.g. stenoses, cobblestoning).

In recent years, several studies have been performed using magnetic resonance imaging (MRI) for evaluation in CD (2-13) as this is a noninvasive, patient-friendly imaging technique that allows evaluation of the large bowel, small bowel and extra-intestinal abdomen. These studies have shown that the presence of certain MRI signs, such as increased wall thickness and increased enhancement, is associated with disease activity (4, 9), and inflamed bowel segments can be identified (2, 6, 10). However, before MRI can be implemented in daily clinical practice, validation of this technique for determining disease severity and localization is required. Few prospective studies have been performed in adult CD patients correlating MRI grading and endoscopic grading of disease activity (4,7,8,11-13). However, only two of these studies were performed in CD patients only, showing contradictory results (12,13).

The primary aim of this study was to evaluate the value of MRI in determining disease severity compared with ileocolonoscopic grading and the Crohn’s Disease Endoscopic Index of Severity (CDEIS) in CD patients. The secondary aim was to determine patient experience of MRI and ileocolonoscopy and preference for one of these two modalities.

MATERIALS AND METHODS

Study population

Patients scheduled for ileocolonoscopy because of clinical suspicion of relapsing CD were included in this study. Exclusion criteria were: age below 18 years, suspicion of bowel obstruction or perforation, administration of another contrast medium within 36 hours before the MRI, the inability to ingest at least 1000ml of water, the inability to hold breath for 25 seconds, and contraindications for MRI (including claustrophobia and pregnancy). The MRI was planned within two weeks of the ileocolonoscopy. Patients were excluded from the study if treatment was started or changed in the period between the MRI and ileocolonoscopy, or if symptoms markedly worsened or improved in this period. The institutional review board of the hospital approved the study and all patients gave written informed consent.
Patient preparation

Patients fasted for four hours prior to MR scanning. No gastroduodenal intubation was performed. Starting two hours prior to imaging patients were instructed to drink at least 200 ml of tap water every half hour (the final volume therefore was at least 1000ml) to facilitate identification of the bowel lumen and subsequent measurements. Before scanning an intravenous cannula was placed. Blood was drawn to determine the hematocrit to calculate the Crohn’s Disease Activity Index (CDAI). On the MRI-scanning table patients were checked for an abdominal mass as this is part of the CDAI score, by a physician (JF) not involved in reading MR examinations.

MR imaging protocol

The MRI sequences were performed on a 1.5 T scanner (Siemens Vision, Erlangen, Germany). A series of breath-hold sequences were performed before intravenous contrast injection: coronal HASTE (TE 87ms, slice thickness 5mm, matrix 240*256, FOV 400mm), coronal and transversal True FISP (TR/TE 4.8/2.3ms, flip angle 55°, slice thickness 5mm, matrix 256*256 (coronal) or 160*256 (axial), FOV 400 mm*400mm (coronal), 400mm*250mm (axial), coronal out-of-phase FLASH (TR/TE=160/2.3ms, flip 80°, slice thickness 5mm, matrix 128*256, FOV 400mm) and coronal T1 weighted GRE (TR/TE 149/4.1, flip 80°, slice thickness 5mm, matrix 172*256, FOV 400mm) sequences. If a series did not encompass the whole abdomen, multiple breath-hold sequences were used until the whole abdomen was visualised. After these series 20 mg of butylscopolaminebromide (Buscopan; Boehringer-Ingelheim, Ingelheim, Germany) or 1 mg of glucagon hydrochloride (Glucagen; Novo-Nordisk, Bagsvaerd, Denmark), and 0.2 ml/kg bodyweight of a gadolinium containing contrast agent: dimegluminegadopentetate 0.5 mmol/ml (Magnevist; Schering, Berlin, Germany) were administered intravenously. Seventy seconds after the administration of the intravenous contrast agent coronal (parameters as in T1 pre-contrast) and transversal fat saturated T1- weighted series (TR/TE 159/4.1, flip 80°, slice thickness 4mm, matrix 107*256, FOV 400) were performed. The total imaging time was about 20 to 25 minutes depending on the size of the patient.

Image evaluation

All images were independently evaluated by two abdominal radiologists (JS and CYN) to determine 1) per-patient grading of disease severity (a total grading and an endoscopy based grading), 2) segmental grading, 3) segmental wall thickness and segmental enhancement. The radiologists, each having more than 10 years of clinical experience, were blinded for all clinical findings. The first radiologist (JS) also analyzed image quality (4-point scale) and the amount of small bowel distension (4-point scale, per segment: duodenum, jejunum, ileum, terminal ileum). For segmental analysis, the bowel was divided in jejunum, ileum, terminal ileum, ascending colon, transverse colon, descending colon including the sigmoid, and the anorectum.
Maximum bowel wall thickness (mm) was measured using calipers. Maximum bowel wall enhancement was graded subjectively on the post contrast images on a 7-point scale (hypointense compared to spleen, isointense to spleen, in-between spleen and liver, isointense to liver, in-between liver and renal cortex, isointense to renal cortex, hyperintense to renal cortex). The bowel segments were also evaluated for stenosis (low-grade, high-grade, high-grade with prestenotic dilatation), target signs (layered enhancement) and the presence of cobblestoning. Extra-intestinal findings such as the presence of fistulas, abscesses, mesenterial lymphadenopathy (small axis >1cm), and fibrofatty proliferation were scored.

Severity of inflammation was subjectively graded per patient and per segment using a 4-point scale (no/mild/moderate/severe disease). The per-patient grading (\( \text{MRI}_{\text{total}} \)) was based on all CD related findings, including extra-intestinal findings and small bowel pathology not visible at ileocolonoscopy. In addition, the radiologists also determined a modified grading of severity per patient that was only based on bowel wall abnormalities (i.e. wall thickness, wall enhancement, stenosis) and was only based on segments also visualized at ileocolonoscopy (\( \text{MRI}_{\text{end based}} \)).

**Ileocolonoscopy**

Ileocolonoscopic grading and CDEIS were used as primary reference standard, CDAI was used as secondary reference parameter.

Patients ingested 4L of polyethylene glycol electrolyte solution (KleanPrep; Helsinn Birex Pharmaceuticals, Dublin, Ireland) for bowel cleansing on the evening before and/or the day of the endoscopy. The ileocolonoscopy was performed with a standard colonoscope (CF-Q160AL; Olympus, Tokyo, Japan) by either a gastroenterologist or a senior resident in gastroenterology under direct supervision of a gastroenterologist. The performing endoscopist was aware of the patient history. During endoscopy, 29 patients received a standard dose of sedatives: 5mg of midazolam (Dormicum; Roche, Basel, Switzerland) and analgesics: 0.05mg of fentanyl (Fentanyl-Janssen; Janssen Pharmaceuticals, Beerse, Belgium). The endoscopy was recorded on videotape. At ileocolonoscopy the CDEIS was determined by the performing endoscopist. To determine a CDEIS per segment, the CDEIS was calculated as if this was the only segment that could be evaluated. Scoring a CDEIS per segment was performed to enable more accurate matching between MRI and endoscopy per segment. The endoscopist also graded the severity of disease per patient (no, mild, moderate or severe disease).

A second observer, an experienced gastroenterologist, scored the same parameters (CDEIS and severity of disease) after viewing the videotaped ileocolonoscopy. Like the radiologist, he was not aware of the patient’s clinical background. In four patients, the ileocolonoscopy could not be recorded due to technical problems with the video recorder. The expert gastroenterologist therefore reviewed 27 patients. The scores of the expert gastroenterologist were used to evaluate inter-observer variability for the endoscopic scores (i.e. grading of disease severity and CDEIS).
In 23 patients C-reactive protein (CRP) was determined as part of their clinical evaluation.

Patient questionnaires
In the week prior to MR-scanning all patients kept a symptom diary to determine their CDAI. Standardized questionnaires were used to score the burden of both examinations. Prior to MR scanning patients were asked how burdensome the drinking of water and fasting prior to scanning had been (5-point Likert scale; not, little, somewhat, rather, severe). After MRI they were asked how much pain, embarrassment and discomfort they had experienced (5-point Likert scale). Similar questions were asked about the preparation for the ileocolonoscopy and the examination itself. After patients had undergone both examinations, the patients were asked which technique they would prefer for their next examination using a 7-point Likert scale, assuming both techniques would give equal information about disease severity. They were also asked to rank the four elements of this study (MRI, ileocolonoscopy, and both bowel preparations) from the most to the least burdening.

Statistical analysis
Interobserver variability for MRI\textsubscript{total} and for endoscopic grading of disease activity was expressed by calculating weighted kappa values (Fleiss-Cohen). Limits of agreement were calculated for maximum wall thickness. For calculating interobserver correlation of wall thickness, of maximum enhancement and of CDEIS, Spearman correlation coefficients (two-sided) were used. Weighted kappa values were calculated to determine agreement between MRI\textsubscript{end based} and grading at endoscopy. Spearman correlation coefficients were determined between the MRI\textsubscript{end based} and CDEIS, between the per-segment MR grading and CDEIS, between maximum wall thickness and endoscopic grading, maximum enhancement and endoscopic grading, MRI\textsubscript{total} and CDAI, and between MRI\textsubscript{total} and CRP. Correlation coefficient values were interpreted as follows: 0.0 not correlated, 0.2 weakly correlated, 0.5 moderately correlated, 0.8 strongly correlated, 1.0 perfectly correlated (14).

Differences in patient experience (pain, embarrassment, discomfort) between MRI and ileocolonoscopy were tested for statistical significance using Wilcoxon rank sum test; differences in preference were tested using the Fisher exact test after dichotomizing the parameter (preference for MRI versus preference for ileocolonoscopy). \(P\) values <0.05 were considered significant.

RESULTS
From February 27\textsuperscript{th} 2002 to January 29\textsuperscript{th} 2003, 31 patients were included in this study. Baseline characteristics are shown in Table 1. In five patients it was not possible to fully
Table 1. Demographic characteristics and severity indices of the study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>31</td>
</tr>
<tr>
<td>Male/female</td>
<td>22/9</td>
</tr>
<tr>
<td>Age in years: mean ± sd</td>
<td>36 ± 12</td>
</tr>
<tr>
<td>(range)</td>
<td>(18-60)</td>
</tr>
<tr>
<td>Disease history: ileoocoecal resection</td>
<td>4</td>
</tr>
<tr>
<td>Endoscopical grading (no, mild, moderate severe)</td>
<td>10/8/6/7</td>
</tr>
<tr>
<td>CDEIS: mean ± sd, median (range)</td>
<td>4.0 ± 4.4, 3.0 (0-16.1)</td>
</tr>
<tr>
<td>CDAI: mean ± sd, median (range)</td>
<td>163 ± 79, 167 (0-293)</td>
</tr>
<tr>
<td>CRP (n=21): mean ± sd, median (range)</td>
<td>46 ± 77, 23.0 (3-355)</td>
</tr>
</tbody>
</table>

sd = standard deviation

inspect the colon. In one patient the scope could only be introduced as far as the splenic flexure, in three patients as far as the hepatic flexure and in one patient as far as the cecum. Previously four patients had undergone an ileocecal resection (in two patients this also included the ascending colon); in these patients the neoterminal ileum was scored as terminal ileum. In one other patient the descending colon and sigmoid were removed. Consequently, 142 segments could be evaluated at ileocolonoscopy.

MRI quality findings

In all patients image quality was sufficient. The quality of MR scans was rated as diagnostic without artifacts in 17 patients, diagnostic with minor artifacts in 13 patients and diagnostic with many artifacts in one patient. The most commonly seen artifacts were motion artifacts due to bowel peristalsis (n=8) and breathing artifacts (n=6). In 35 of 124 small bowel segments no bowel distension was seen, in eight out of 31 patients no distension was seen in the terminal ileum.

Interobserver variability

The MRI_total and MRI_end based showed kappa values of 0.49 (0.24-0.73) and 0.56 (0.33-0.78). The segmental maximum wall thickness correlated moderately-strongly (r=0.58; P<0.001, n=214) between both MR observers. Limits of agreement showed a mean difference of 0.9mm (±1.96 * 1.8mm, range 0 to 9mm). Maximum enhancement readings correlated weakly to moderately between the two observers (r=0.44, P<0.001). The grading of disease between the endoscopist and the expert gastroenterologist showed a weighted kappa of 0.68 (0.49-0.86). A strong correlation was found between the CDEIS determined by the endoscopist and CDEIS determined by the expert gastroenterologist (r=0.80, P<0.001, n=27).
Agreement between MRI and endoscopic grading

Comparison between MR grading from observer 1 and endoscopic grading is shown in Table 2 (weighted kappa: 0.59, 95% CI 0.38-0.80). Differences in overall degree of inflammation in the three patients with two levels of difference in grading were respectively caused by: 1) the absence of enhancement at MR and the overlooking of a fistula; 2) MR showed stenosis and severe inflammation whereas only mild inflammation was seen on endoscopy; 3) MR showed severe enhancement in the colon whereas the endoscopist rated disease activity as remission. When the MRI_total was compared with ileocolonoscopy one additional discrepancy of two levels was observed. This was in a patient in whom the terminal ileum, which was shown to be abnormal at MRI, could not be intubated at ileocolonoscopy.

For the second observer the weighted kappa for the second MRI observer was 0.68 (95% CI 0.48 to 0.87; Table 2). In one patient the discrepancy of two levels could be explained by the identification of a stenosis at MRI, in one other patient the severity of a stenosis in the terminal ileum was rated higher at MRI. In the third patient the rectum showed strong enhancement, whereas it was rated in remission at ileocolonoscopy, the MRI of the fourth patient was normal according to observer 2, whereas endoscopy showed inflammation in the terminal ileum. These four patients were different than those of observer 1. When the MRI_total of this observer was compared with ileocolonoscopy, the same additional discrepancy was seen as in observer 1.

Table 2. Comparison of grading of Crohn’s disease activity by MRI (MRIend based) and endoscopy

<table>
<thead>
<tr>
<th>MRI</th>
<th>Ileocolonoscopy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remission</td>
<td>Mild</td>
</tr>
<tr>
<td>Remission</td>
<td>6/5</td>
<td>0/2</td>
</tr>
<tr>
<td>Mild</td>
<td>3/4</td>
<td>4/3</td>
</tr>
<tr>
<td>Moderate</td>
<td>1/1</td>
<td>3/1</td>
</tr>
<tr>
<td>Severe</td>
<td>0/0</td>
<td>1/2</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>

Scoring by the first MRI observer is shown left of the slash, the second observer right of the slash. Discrepancies of more than one grade between MR grading and grading at ileocolonoscopy are in bold.

Correlation between MRI and CDEIS

The MRI_end based correlated significantly with the CDEIS, showing moderate to strong correlation of $r=0.61$ for observer 1 ($P<0.001$) and $r=0.63$ ($P<0.001$) for observer 2 as is shown in Figure 1. When analyzed per segment, the best correlation was seen between MR grading and CDEIS in the terminal ileum, both observers showing correlation coefficients of $r=0.63$ ($P<0.001$). Combined evaluation of all 142 segments showed correlation coefficients for observer 1 of $r=0.59$ ($P<0.001$) and $r=0.53$ ($P<0.001$) for observer 2.
Correlation of individual MRI parameters compared to endoscopic grading
When maximum wall thickness per segment was compared with the CDEIS, moderate to strong correlations were seen (respectively $r=0.57$ ($P<0.001$) for observer 1 and $r=0.50$ ($P<0.001$) for observer 2). Maximum enhancement measurements correlated weakly to moderately with the CDEIS (correlation coefficients of 0.45 ($P<0.001$) for observer 1 and 0.42 ($P<0.001$) for observer 2).

Correlation between MRI findings and CDAI
With one exception, the other reference parameters (CDAI and CRP) did not correlate significantly with the MRItotal and MRIend based of observer 1 and 2, and also did not correlate significantly with the grading and CDEIS of the endoscopist and gastroenterologist. Only the MRItotal of observer 1 showed a weak to moderate, but significant correlation ($r=0.38$, $P=0.034$) with the CDAI.

Stenosis and other bowel wall abnormalities
In eight patients, a stenosis of the terminal ileum was found at ileocolonoscopy. The first observer correctly identified 6 of these 8 stenoses (Figure 2). Moreover, three additional stenoses were identified by this observer. Two of these were seen in bowel segments that could not be evaluated at ileocolonoscopy (one was confirmed at barium enteroclysis).
The second observer correctly identified 7 of 8 stenoses seen at ileocolonoscopy while he identified six additional stenoses of the terminal ileum. Two of these were located in the terminal ileum, which could not be evaluated at ileocolonoscopy. One of the latter two was confirmed at barium enteroclysis. In two other patients, both scored as low grade stenosis, the terminal ileum was inflamed, but not stenotic at ileocolonoscopy. Neither of the observers identified a stenosis in the rectum seen by the endoscopist.

Target signs were seen in 12 segments, all except one were severely inflamed segments at endoscopy. The typical cobblestone-pattern was not seen in any of the patients at MR. In one patient with severe inflammation of the jejunum on MRI, this was confirmed by videocapsule endoscopy. In other patients with inflammation of the jejunum a stenosis precluded the use of video capsule endoscopy.

Figure 2. A 41 year old female patient with Crohn’s disease of the neoterminal ileum.

- a. Axial post contrast T1-weighted MRI showing wall thickening, stenosis and increased enhancement.
- b. Neoterminal ileum at endoscopy showing ulceration and stenosis
- c. Neoterminal ileum showing cobblestoning and stenosis at conventional barium enteroclysis
- d. Resected neoterminal ileum showing thickened bowel wall with cobblestoning. C = coecum, I = neoterminal ileum
Extra-intestinal findings related to Crohn’s disease
In one patient an ileorectal fistula was identified at ileocolonoscopy that was missed by both radiologists, but was marked as an adhesion by observer 1. Fistulas, all originating in the rectum, were seen in four patients on MRI but were missed on endoscopic evaluation. In four patients abscesses were seen at MRI; one of the right lower abdominal cavity, two perirectal abscesses and one of the abdominal wall after a caesarian section. Lymphadenopathy was found in three patients only, all with moderate to severe overall disease activity. Fibrofatty proliferation was found in four patients and not associated with increased disease activity at ileocolonoscopy.

Other pathology
In seven patients findings unrelated to CD were reported at MRI. One aortic aneurism that was subsequently operated upon, one avascular necrosis of the femoral head (probably related to corticosteroid therapy), one stenosis of the left iliac artery (thrombus), one vertebral disk degeneration (L3-L4), a hemangioma in the liver, one enlarged spleen and one renal cyst.

Patient questionnaires
All 31 patients completed the questionnaire. Patients rated the bowel preparation prior to the MRI as less burdening than the bowel preparation prior to the ileocolonoscopy ($P<0.001$) (Figure 3). Pain (Figure 3), embarrassment and discomfort experienced during both examinations also showed statistically significant results in favor of MRI ($P$-values respectively $P<0.001$, $P=0.001$, $P<0.001$). As a result, 29 patients would ($P<0.001$) prefer

Figure 3. Ratings from patients on the burden of bowel preparation (left side) and pain during the examinations itself (right side)
DISCUSSION

This study demonstrates that the radiological grading (MRI\textsubscript{end based}) of disease severity showed moderate to good agreement when compared with the endoscopic grading and correlated moderately to strongly when compared to the CDEIS. Additional advantages of MRI are the possibility to identify inflammatory activity and stenoses in all bowel segments, including small bowel segments, and to detect extra-intestinal findings. Moreover, patients prefer MRI to ileocolonoscopy for their next examination since both the bowel preparation and the examination itself are less burdensome.

Although agreement between MRI\textsubscript{end based} grading and endoscopical grading showed kappa values of only 0.59 and 0.68, a comparable kappa value (0.68) was calculated between grading by the endoscopist and the expert gastroenterologist, meaning that if clinical decisions would be based on the endoscopic grading of disease severity, MRI is a valuable alternative. However, correlation coefficients of MRI\textsubscript{end based} compared to the CDEIS (0.61 observer 1, 0.63 observer 2) were lower than the interobserver correlation for the CDEIS (0.80). Calculation of interobserver variability between the gastroenterologist and endoscopist was performed to determine the consistency of endoscopic scoring. This served the purpose of providing a frame of reference for the agreement and correlation coefficients between radiological and endoscopic scoring.

The interobserver agreement of MRI was moderate. This could be due to the fact that this is a relatively novel technique and no standardized scoring system has been developed yet. Introduction of a validated system to grade severity could drastically improve reproducibility.

When analyzed per segment correlation coefficients between MRI\textsubscript{end based} and CDEIS were slightly lower than when analyzed per patient. The main cause was enhancement of segments adjacent to endoscopically proven inflamed segments. These segments did not show inflammatory activity on colonoscopy whereas they showed enhancement at MR.

The secondary reference standard used in this study, i.e. CDAI, is a clinical disease activity index that is used in large clinical trials comparing pre and post therapy CDAI values for determining effect of medication. The low correlation coefficients between MR grading and CDAI in this study were probably caused by subjective elements in this index. This hypothesis is supported by the fact that the CDEIS did not correlate with the CDAI either (r=0.33, \( P=0.07 \)), and is in line with earlier research showing low correlation coefficients between CDEIS and both CDAI and CRP (15, 16). CRP, which was used as biological
disease activity marker, did not correlate with either endoscopic or MRI findings. The main problem when comparing endoscopic and MRI findings with CRP was the fact that some patients with low CRP values showed moderate to severe inflammation on both MRI and endoscopy. This discrepancy is often encountered in daily clinical practice. In contrast, few patients with high CRP values did not show abnormalities at endoscopy. All of these patients showed inflammatory activity on MRI, either in segments that could not be visualized at endoscopy or extraintestinally. MR imaging therefore has the benefit of assessing disease activity outside the range of endoscopy.

Besides overall grading and the segmental grading, bowel wall thickness showed good correlation coefficients (r=0.50-0.57). The correlation coefficients between enhancement and CDEIS were lower (r=0.42-0.45) than between wall thickness and CDEIS. Similarly, the interobserver agreement of enhancement (r=0.44) was lower than the interobserver agreement of wall thickness (r=0.58). In the study by Shoenut et al (4), the MR parameter with the highest correlation coefficient with endoscopic grading was percentage of contrast enhancement (r=0.74) whereas bowel wall thickness only showed a moderate correlation (r=0.42). These discrepant results between the current study and the study by Shoenut could be explained by the fact that Shoenut only correlated the most diseased segment with the per-patient endoscopy outcomes and the fact that different methods were used to determine bowel wall thickness and enhancement in these studies. In the aforementioned study bowel wall thickness was divided in three crude categories (i.e. <0.5, 0.5-1 and >1cm), whereas in our study wall thickness was measured in millimeters, allowing more precise correlation. Enhancement was calculated in the study by Shoenut by calculating an enhancement ratio. Although his results were good, in theory technical problems such as field inhomogeneity, proximity of the studied tissue to the coil and nonlinearity of MR values hamper these calculations. To our knowledge, no other studies have been performed comparing enhancement ratios with endoscopy outcomes.

To our knowledge only seven studies (2,4,7,8,11-13) have been performed that evaluated whether severity of CD in an adult population could accurately be assessed on MRI using endoscopy as gold standard. However, the study by Low et al (2), one of the largest studies (n=28), was a retrospective study that used an overall score based on different examinations as gold standard. Four other studies were performed in both CD patients and patients with ulcerative colitis and used both one radiological as well as one endoscopic scoring system of inflammation for the whole group of patients. Moreover, MR disease activity in these studies was based on parameter cut-off values that were seemingly arbitrarily chosen. In the study by Shoenut disease activity (mild, moderate, severe) was based only on the most diseased segment whereas in the study by Ajaj et al only the large bowel and not the terminal ileum was evaluated (7). Two studies solely focusing on patients with CD (12, 13), showed contradictory results; whereas Schreyer et al. stated that MRI is not suited to correctly assess mild inflammation (13), Narin et al. (n=18) stated that MRI overestimates disease activity (12).
Studies on the value of Computed Tomography in CD have been performed. Although the spatial resolution is better than in MR, the ionizing radiation that is needed for scanning precludes it from being a valuable alternative to ileocolonoscopy for follow-up in CD. In the current study water was used as intraluminal contrast medium; although water is a patient friendly contrast medium, early resorption has been described (17, 18), possibly causing inadequate distension of the terminal ileum. However, even in inadequately distended segments it was possible to delineate the bowel wall and measure wall thickness. Theoretically, better bowel distension by use of fibers (19) or hyperosmolar fluids (20) might facilitate identification of thickened and/or pathologically enhancing bowel wall, leading to even better results. Further studies comparing different oral contrast agents need to be undertaken.

In conclusion, MRI of the small bowel and colon is a patient-friendly technique that abstains from using ionizing radiation and is able to determine disease activity adequately. Moreover, if these positive results for colon and terminal ileum also are applicable to the entire small bowel, this technique could theoretically serve as a one-stop shop technique for the evaluation of both luminal activity and extraintestinal pathology in CD.

REFERENCES


