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BRIEF ARTICLE

Comparison of high-resolution ultrasound and MR-enterography in patients with inflammatory bowel disease

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Abstract

AIM: To compare the results of high-resolution ultrasound (HR-US) and magnetic resonance enterography (MRE) examinations in patients with inflammatory bowel disease (IBD).

METHODS: The reports of 250 consecutive cases with known IBD, who had an MRE and HR-US examination, were retrospectively analyzed. Using a patient-based approach we evaluated morphological disease features such as affected bowel wall, stenosis, abscess and fistula. The comparison between the two modalities was based on the hypothesis, that any pathological change described in any imaging modality was a true finding, as no further standard of reference was available for complete assessment.

RESULTS: Two hundred and fifty examinations representing 207 different patients were evaluated. Both modalities assessed similar bowel wall changes in 65% of the examinations, with more US findings in 11% and more MRE findings in 15%. When the reports were analyzed with regard to "bowel wall inflammation", US reported more findings in 2%, while MRE reported more findings in 53%. Stenoses were assessed to be identical in 8%, while US found more in 3% and MRE in 29% ($P < 0.01$). For abscess detection, US showed more findings in 2% ($n = 4$) while MRE detected more in 6% ($n = 16$). US detected more fistulas in 1% ($n = 2$), while MRE detected more in 13% ($n = 32$) ($P < 0.001$). The most common reason for no detected pathology by US was a difficult to assess anatomical region (lesser pelvis, $n = 72$).

CONCLUSION: US can miss clinically relevant pathological changes in patients with IBD mostly due to difficulty in assessing certain anatomical regions.

Key words: Crohn's disease; Diagnosis; Inflammatory bowel disease; Magnetic resonance imaging; Ultrasound

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INTRODUCTION

Patients suffering from inflammatory bowel disease (IBD) need a complete bowel assessment for their primary diagnosis. In addition, follow-up examinations are necessary during deterioration of clinical symptoms or for therapy monitoring.

According to most recent national or international guidelines, high-resolution ultrasound (HR-US) should be the first-line diagnostic modality for disease assessment or follow up examinations[1,2]. If an IBD is assumed, several guidelines recommend a complete sectional imaging of the small bowel. Because of the lack of any ionizing radiation, a dedicated magnetic resonance imaging (MRI) examination of the small bowel is therefore recommended. Currently magnetic resonance (MR) enteroclysis with contrast application *via* a naso-jejunal tube as well as MR enterography (MRE), where the contrast is applied orally, are the methods of choice. Because of the expensive radiological equipment and the need for intravenously applied contrast media, MRE is an examination which is less available and more cost intensive compared to HR-US. On the other hand, US is more subjective and highly dependent on the experience of the examiner, but requires less expensive equipment.

The current literature shows excellent sensitivity of between 78% and 96% with specificity between 67% and 100% for HR-US in IBD[3]. On the other hand, MRE shows sensitivity of between 82% and 100% with specificity between 71% and 100%. Most studies were performed in an academic environment by specialists in their field. In our experience a total small bowel assessment by HR-US during daily routine is difficult to perform. Several segments of the bowel cannot be visualized by US because of residual air in the bowel, anatomical obstacles in the pelvic region or superposition of other bowel loops.

To assess the diagnostic and therapeutic impact of HR-US and MRE in patients with IBD in a day-to-day clinical setting, we decided to perform a retrospective study. By analyzing and comparing the written reports retrospectively, we intended to avoid the study bias sometimes caused by extremely motivated study examiners, and depict the report quality for both modalities under everyday circumstances.

In this study we compared and evaluated the results of HR-US and MRE examinations in patients suffering from IBD, with regard to clinically relevant disease features such as bowel wall affection, stenosis, fistula, abscess and indirect inflammation indicators such as local lymphadenopathy, mesenteric fat injection or enlarged local vessels.

MATERIALS AND METHODS

Patient selection

Using our radiological information system, we retrospectively searched for patients who underwent an MRE examination between October 1999 and January 2007 in our tertiary care medical center. After identifying 1582 MRE examinations during this period, we selected all patients in this group with histologically and clinically proven IBD, resulting in 801 MRE examinations. Based on these 801 cases we evaluated all patients who had a HR-US examination within a 14-d period before or after MRE. Based on this selection we chose 250 consecutive cases for further analysis.

MRE examination

MRE was performed using a 1.5-Tesla MRI unit (Magnetom Symphony and Magnetom Sonata, Siemens Healthcare, Erlangen, Germany) using a circular polarized 6-channel phased array body coil supplemented with a spine array coil. The dark lumen technique with an oral contrast of 1.5-2 L of water mixed with methylcellulose was applied. A coronal True-fast imaging with steady state precession sequence and an axial T2-weighted half-Fourier acquired single-shot turbo spin echo sequence were acquired. Subsequently, 0.1 mmol/kg body weight of Gd-DTPA (different vendors during the examination period) was injected intravenously. A fat-suppressed 3D gradient echo sequence and a fat-suppressed T1-weighted 2D gradient echo sequence with axial and coronal orientation were acquired with a delay of 70 s after the start of the contrast injection.

If the clinical examination or anamnesis suggested fistulas, additional sequences with 4 mm slice thickness (axial and coronal T2 short tau inversion recovery and T1-weighted sequences before and after Gd-DTPA iv) were acquired. The MRE examinations were evaluated by a board certified radiologist and an experienced resident, resulting in a written and electronically documented report based on a consensus decision.

HR-US

HR-US of the bowel was performed in our interdisciplinary ultrasound department by a resident in internal medicine, surgery or radiology or by a consultant in internal medicine. To evaluate the influence of the individual experience of the examiner on the examination results in ultrasound, we subdivided the examiners into groups with moderate and high experience. Examiners with high experience were board certified with more than 2000 documented ultrasound examinations per year.

For a clinical routine ultrasound examination of the bowel, a 3.5 MHz convex transducer was applied first. A high-resolution 5 to 10 MHz transducer was then used for bowel imaging. During the evaluation period we used several ultrasound devices: SonolineElegra (Siemens, Erlangen, Germany), Logiq 9 (General Electric, Solingen, Germany) or EUB-8500 (Hitachi, Tokyo, Japan). Ultrasound images were documented in soft prints as part of the patient record. An electronically documented report of the examination was available for all patients.

Data analysis

We retrospectively evaluated the electronically documented reports of MRE and US examinations without reviewing the original imaging data. The 250 cases were evaluated in a patient-based analysis with regard to the following categories: affected bowel wall, bowel stenosis, abscess, fistula, local lymphadenopathy and local fat injection or comb sign. The evaluation of these categories was based on the written report of each modality.

For MRE, the bowel wall was deemed affected when having a diameter of at least 3 mm and/or showing increased contrast uptake. For ultrasound examinations a bowel wall diameter larger than 3 mm was also considered as "thickened bowel". A thickened bowel wall larger than 3 mm without any data on contrast enhancement of vascularization is a very unspecific finding. For routine HR-US examinations of the bowel, an intravenous contrast application is currently not an established standard. Vascularization information based on Power Doppler imaging was integrated into the ultrasound findings. The mention of an "accentuated" or "slightly thickened" bowel wall in a written ultrasound report is not very specific. For our comparison we separately evaluated the assessment of the bowel wall of each modality regarding the terms "affected" or "inflamed", which represents a clear clinical statement, and "accentuated" and "slightly thickened", which is an unspecific statement without immediate clinical consequences.

For bowel stenosis in MRE and US the term "stenosis" as well as "narrowed bowel lumen" was considered as a positive finding. For the diagnosis of an abscess or a fistula the term had to be mentioned in the report. Local lymphadenopathy was not restricted to a certain size or amount of lymph nodes. In this study, the descriptive term "lymphadenopathy" as well as "enlarged" or "multiple" lymph nodes represented the diagnosis of local lymphadenopathy. The diagnosis of a local fat injection was made when terms such as "injected mesenteric fat" were used. The comb sign as an indirect inflammation criterion caused by enlarged vasa recta surrounding the affected bowel was diagnosed with the mention of "comb sign" or the finding of enlarged or accentuated local vessels[4].

In the patient-based analysis we focused on all cases with identified pathological findings in only one modality, which were not noted in the other modality report. Possible reasons for discrepant findings were analyzed and noted.

Statistical significance was calculated using the Chi-test by McNemar. *P*-values $\leqslant 0.05$ were considered statistically significant while *P* values $\leqslant 0.01$ were considered highly significant. Descriptive statistics were calculated using Excel (Office: Mac 2008, Version 12.2.5; Microsoft, Redmond, WA, USA). Significance levels were calculated using SPSS for Windows 16 (SPSS, Chicago, IL, USA).

RESULTS

We evaluated a total of 250 consecutive cases of patients with known IBD, where a MRE and a HR-US examination of the bowel were performed within 14 d. The 250 cases were based on 207 patients. The 207 patients had a mean age of 35.6 years (range 14-77 years; 55% female, 45% male). The evaluated patients suffered from Crohn's disease (CD; 84.5%, $n = 175$) or ulcerative colitis (UC; 15.5 %, $n = 32$).

Table 1 Contingency table of all evaluated 250 cases (patient based) *n* (%)

Any bowel wall changes (including unspecific changes such as "accentuated wall", *etc.*)	Ultrasound	
	Negative	Positive
Magnetic resonance enterography		
Negative	21 (8.4)	28 (11.2)
Positive	38 (15.2)	163 (65.2)

Negative findings means no bowel wall change found in the modality (magnetic resonance enterography or ultrasound) report.

In 69% of all evaluated cases ultrasound was performed before MRE, in 16% MRE and ultrasound were performed on the same day, while in 15% MRE was performed before ultrasound. On average, HR-US was performed 1.9 d before MRE. In 90% of all cases the time period between MRE and ultrasound was less than 7 d, in 72% both examinations were performed within 3 d.

During the evaluation period we found a total of 100 different examiners for high-resolution bowel ultrasound. Of these examiners, 13 were considered highly experienced (13%) while 87% had moderate experience in ultrasound. The highly experienced examiners performed 48% ($n = 119$) of all bowel examinations.

Affected bowel wall

In the 250 cases evaluated both modalities described no bowel wall pathology in 21 cases. In the remaining 229 cases, a total of 673 changes of the bowel wall were described with 439 changes described by MRE and 405 changes described by US. The described changes included subtle and unspecific findings such as "accentuated bowel wall" without any specific diagnostic statement. With regard to all bowel wall changes, there was no statistically significant difference between MRE and US (Table 1). MRE and ultrasound had similar results in 163 cases, while MRE detected more lesions in 38 cases and US found more affected bowel wall segments in 28 cases. When analyzing the 28 cases with more lesions found on US, we had no explanation for the negative MRE findings in 10 of the 28 cases. For 12 cases, possible explanations were subtle US findings describing a wall thickness of 3 mm as an accentuated bowel wall. In 6 patients the MRE report stated inferior image quality due to breathing and motion artifacts.

When analyzing the subgroup of 28 cases with more US findings with regard to the examiner's experience, 43% ($n = 12$) of the cases were examined by moderately experienced examiners (9 cases with possible explanations and 3 cases with no explanation), while 57% ($n = 16$) where

Table 2 Influence of the experience of the ultrasound examiner on diagnosis

Pathological changes	Ultrasound examiner with moderate experience (%)	Ultrasound examiner with high experience (%)
MRI found more lesions than ultrasound		
Stenosis (n = 72)	62	38
Abscess (n = 16)	46	46
Fistula (n = 32)	59	41
Ultrasound found more lesions than MRI		
Stenosis (n = 8)	0	100
Abscess (n = 4)	50	50
Fistula (n = 2)	0	100

The percentage indicates the ratio of moderate or experienced ultrasound examiners in this scenario. MRI: Magnetic resonance imaging.

Table 3 Contingency table of all evaluated 250 cases (patient based) *n* (%)

Statement "inflammation" or "bowel wall affection" in the report	Ultrasound	
	Negative	Positive
Magnetic resonance enterography		
Negative	83 (33.2)	6 (2.4)
Positive	132 (52.8)	29 (11.6)

Negative findings means no bowel wall affection or inflammation assessed based on the report (magnetic resonance enterography or ultrasound).

examined by the highly experienced group (9 cases with possible explanations and 7 cases with no explanation). Based on these data, there was no relevant tendency or statistical relevance regarding the examiner's experience (Table 2).

For the 38 cases with a superior MRE examination we had no explanation for the inferior US in 18 cases. For the remaining cases, restricted image quality was stated in 14 cases. Additionally, in 12 cases (in some cases more than one explanation for the same case was reported) the pathological changes were in anatomical areas with a difficult access by US (lesser pelvis, rectum). The 38 cases were performed by 13 highly experienced examiners and 25 moderately experienced examiners.

Different results emerged when analyzing diagnostic statements such as "inflammation" and "affected bowel wall" only (Table 3). Restricted to these terms, which represent a definite diagnostic statement with therapeutic consequences, we found only 29 cases with similar results. There were six cases, where US detected more lesions than MRE and 132 cases (53%) where MRE described inflamed and affected bowel wall without US findings.

Stenosis

In 170 of 250 cases (68%) there was a consensus between US and MRE, while in 80 cases (32%) the findings regarding a stenosis were different (Table 4). In 72 cases (29%) the MRE examination described a stenosis, while the US was negative. For 18 of 72 cases there was no explanation for the negative ultrasound findings. In 54 cases we found possible explanations. In 23 patients the stenosis was localized in an area which was difficult to assess by US. In 20 patients, the US image quality deteriorated due to residual bowel air. In 19 cases an explanation can be assumed because of a subtle finding in the MRE. The MRE findings were just reported as a "narrowing of the lumen" without mentioning the word "stenosis" or describing indirect signs such as "pre-stenotic dilatation".

The moderately experienced examiners performed 44 of the 72 cases with a superior MRE result, while the highly experienced examiners performed 28 of these examinations (Table 2). In 8 cases (3%) a stenosis was described in the US report having a negative MRE. The 8 cases with more US findings were examined only by highly experienced examiners.

Abscess

In the majority of all cases (221 cases, 88%) we did not find any abscesses (Table 4). In 16 cases (6%) MRE detected an abscess which was not described by US and in 4 cases (2%) US described an abscess not mentioned in the MRE report. These 4 cases were assessed by 2 moderately and 2 highly experienced examiners.

For the 16 cases with an abscess described by MRE and not by US there was no explanation in 1 case, where several abscesses with a diameter of 1 cm in the region of the cecum and terminal ileum were described in the MRE report. For 13 cases, a possible explanation was assumed to be difficult access mostly in the lesser pelvis, and for another 2 cases reduced image quality. Highly experienced examiners (n = 9) and moderately experienced examiners (n = 7) were equally distributed in these 16 cases.

Fistula

Two hundred and eleven of 250 cases (84%) showed no fistulas in either of the modalities (Table 4). In 5 cases (2%) both modalities detected a fistula in the same patient while US identified 2 fistulas (1%), which were not described in the MRE report. We identified 32 cases (13%) where MRE identified fistulas not described by US. The 2 cases with more US findings were performed by a highly experienced examiner.

Thirty two cases of fistula were detected by MRE which were not identified by US. In 24 cases a possible explanation was difficult access for US, while in 9 cases reduced image quality was stated in the US report. Nineteen moderately experienced and 13 highly experienced examiners performed these 32 examinations. There was no statistical significance in the examiners experience.

Local lymphadenopathy

Because the exact measured diameter was mentioned in just 4 cases for US and MRE we were unable to compare these data quantitatively. Based on both modalities, local lymphadenopathy was reported in 63 of 250 cases (25%). In 4 cases, MRE as well as US described enlarged or mul-

Table 4 Diagnostic performance of ultrasound and magnetic resonance enterography regarding bowel wall changes, diagnosis of bowel inflammation, stenosis, abscess, fistula and indirect inflammation signs such as local lymphadenopathy and fat injection or comb sign *n* (%)

	Bowel wall changes	Diagnosis "bowel wall inflammation"	Stenosis	Abscess	Fistula	Local lymph-adenopathy	Mesenteric fat injection/comb sign
US = MRE (no pathological change)	21 (8)	83 (33)	150 (60)	221 (84)	211 (88)	187 (75)	182 (73)
US = MRE (pathological change)	163 (65)	29 (12)	20 (8)	9 (4)	5 (2)	4 (2)	4 (2)
US > MRE	28 (11)	6 (2)	8 (3)	4 (2)	2 (1)	15 (6)	4 (2)
MRE > US	38 (15)	132 (53)	72 (29)	16 (6)	32 (13)	44 (18)	60 (24)

US: Ultrasound; MRE: Magnetic resonance enterography. In "US = MRE" the number (and percentage) of cases, when both modalities found the same amount of pathological features (patient based) are identical. For "US > MRE" the reports based on ultrasound described more pathological changes compared to the MRE, while for "MRE > US" more findings in the MRE reports were detected (because of truncation the percentage values in a column can exceed 100%).

Table 5 Possible explanations for misdiagnosis of all evaluated features (wall affection, stenosis, abscess, fistula, lymph nodes and indirect inflammation signs) for ultrasound and magnetic resonance enterography for all 250 evaluated cases

	HR-US	MRE
Reduced imaging quality (obesity, breathing artifacts, residual bowel gas, *etc.*)	25	7
Region difficult to access (lesser pelvis)	72	N/A
Subtle findings	15	31

Magnetic resonance enterography (MRE) missed most of the diagnoses made by ultrasound (US) because of subtle US findings (n = 31), while the most common reason for a misdiagnosis based on the US report was an anatomical region difficult to assess (n = 72). N/A: Not available.

tiple local lymph nodes, while lymphadenopathy was reported in 15 cases solely by US (6%) and in 44 cases solely by MRE (18%).

Local fat injection and comb sign

A total of 68 cases (27%) with signs of indirect inflammation such as local fat injection or comb sign were detected based on both modalities. In 4 cases, US and MRE identified these signs, while US described 4 additional cases (2%), which were not described by MRE. In the MRE reports, 60 cases (24%) with positive findings of indirect inflammatory signs were found, which were not described in the US report.

Reasons for discrepant findings

When analyzing all these results, when one modality described a pathological finding, which was not described by the other modality, we detected several circumstances and possible reasons for this misdiagnosis (Table 5). In most cases (n = 72) a possible reason for misdiagnosis was the anatomical region, which was difficult to access by US such as the lesser pelvis and peri-rectal tissue. In particular, the localization of fistulas in the pelvis is frequently an obstacle for abdominal US diagnosis. Other reasons were reduced image quality on US due to obesity or residual bowel air in 25 patients and inadequate bowel distension or breathing artifacts in 7 patients on MRE examination.

In most evaluations, a higher ratio of detected lesions by US was found for examiners with a higher level of experience, however, this influence was not demonstrated with any statistical significance (Table 2).

DISCUSSION

Our study retrospectively evaluated the results of reports based on MRE and HR-US examinations in 250 consecutive patients with known IBD.

By analyzing the bowel wall changes on a patient basis we obtained different results when evaluating different key words in the reports. When we evaluated all the terms regarding bowel wall changes including unspecific terms such as "accentuated bowel wall" or "wall thickening" we did not show statistically relevant differences between HR-US and MRE. In this scenario, the HR-US misses totaled 38 cases (15%) and the MRE misses totaled 28 cases (11%), which were described in the opposite modality, respectively. Assuming that MRE depicts the whole abdomen including the bowel wall quite objectively, one of the main reasons for these differences could be, that HR-US sometimes subjectively overestimates bowel wall thickening without giving exact measurements. In this study, we found this in at least 12 of the 28 cases, when US described a thickening without a correlation in MRE. A possible reason for this was a very subtle finding mentioning a wall thickness between 2 mm and 3 mm. In the MRE findings, there were no signs of inflammation such as increased contrast uptake or indirect inflammation features. Therefore, HR-US could theoretically sometimes show "false positive" results, especially when describing subtle findings such as "accentuated bowel walls". For diagnostic features such as "inflamed" or "affected" bowel wall there were statistically significant differences between HR-US and MRE. In this scenario, the US misses consisted of 132 cases (53%), while MRE misses consisted of just 6 cases (2%). Obviously MRE has some methodological advantages for decision making such as contrast media and better bowel distension because of the oral contrast application before the examination.

Comparing our results with other studies we found the same tendencies in a study by Potthast *et al*[5] carried out in 2002. This group retrospectively compared 46

patients undergoing MR enteroclysis with US and conventional enteroclysis, surgery or colonoscopy as a gold standard. For bowel wall changes they calculated 22% false negative results for US and 2.4% false negative results for MRE. Martínez *et al*[6] in their prospective study of 30 patients with CD published different results. They compared US and MRI with regard to the extension and transmural complications in CD. For localization of affected bowel wall, US was not statistically significantly superior to MRI having a sensitivity of 91%, while MRI detected changes with a sensitivity of 83%. There are several major limitations of this study. In addition to the small number of patients, the authors accepted a time period of up to 3 mo between the examinations and the standard of reference. Also their choice of the standard of reference is very questionable. In addition to surgery they accepted conventional barium studies and small bowel follow-through examinations as a standard of reference. In several studies these examinations showed a poorer sensitivity and accuracy than MRE[7].

A meta-analysis from 2008 on the diagnostic accuracy of studies based on US, MRI, scintigraphy, CT and PET imaging in IBD, did not reveal any statistically significant differences between the modalities[3]. The authors calculated that on a patient basis, US had a sensitivity of 90% (range 78%-96%) and MRE had a sensitivity of 93% (range 82%-100%).

It is not possible to compare our results directly using sensitivity values, because we did not have any standard of reference in our study and just compared the positive results from the two modalities performed in the same patient. Based on our data, MRE (11% missed cases) detected slightly more lesions than HR-US (15% missed cases). A certain problem in this study was the vagueness of the diagnostic statements with regard to the affection and inflammation of bowel wall segments. Because of the lack of bowel distension and intravenous contrast application in standard HR-US examinations it seems inherent to the system that US examinations were frequently describes as an unspecific bowel wall thickening without calling a finding an inflammation or affection. In our study, US reports missed 53% of the cases when evaluating for terms such as "inflammation" or "affection", while MRE just missed 2% in this scenario.

With regard to terms such as "lumen narrowing" and "stenosis" we found a highly significant difference between HR-US, which missed 29% of the described stenoses, and MRE, which missed just 3%. There was certainly a problem with the exact definition of stenosis for HR-US and MRE. US has the advantage of dynamic real-time imaging, which allows an assessment of peristalsis with consecutive appreciation of a functional stenosis *vs* lumen narrowing. In MRE reports, a lumen narrowing of more than 50% can be called a stenosis. MRE is not a real-time imaging modality using a standard MR protocol. The only way to identify a functional stenosis is to evaluate all MRI sequences along the time line, which are performed over 25 min. Theoretically, MRI could lead to an overstaging of lumen narrowing calling it a "stenosis" because of the lack of functional real-time image data. In 17 of the 72 cases with a stenosis diagnosed by MRE and not by US, the stenosis was not called functionally relevant in the MRE report, while US described a wall thickening in the same bowel segments. The localization of misdiagnosed stenoses by US was responsible for 23 of the 72 discrepant cases. These stenoses were especially located in the lesser pelvis, which is difficult to assess by transabdominal US. Our results are in contrast to the prospective results of 48 patients published by Schmidt *et al*[8] in 2003. In this study, conventional enteroclysis was considered the standard of reference with data acquisition between 1999 and 2000. They calculated a sensitivity of 56% for detecting stenosis when using US with a specificity of 97%, while MRI had a sensitivity of 44% with a specificity of 100%. On the other hand, the retrospectively performed comparison by Potthast *et al*[5] had a sensitivity of 58% for US with a false negative rate of 16%, while MRI had a sensitivity of 100% with a false negative rate of 2%. In our study, 6 (75%) of the 8 examinations with a superior US result were performed by a highly experienced examiner, while in the group of superior MRI results just 28 (39%) of the 72 examinations were performed by the highly experienced group.

For abscess diagnosis the differences between HR-US (16 missed abscesses) and MRE (4 missed abscesses) were statistically significant ($P < 0.05$). Considering the fact that all 4 abscesses diagnosed by US and not by MRE were most likely not present at the time of MRE examination ($n = 3$) due to treatment or a false positive US result ($n = 1$; probably hemorrhagic ovarian cyst), MRE seems to be the superior modality for detecting abscesses in the abdomen.

For 13 (81%) of the 16 cases with a missed abscess by HR-US, the localization of the abscess in the lesser pelvis and peri-rectal region, which is difficult to assess by US, was the most plausible reason. Our results were mirrored in the study by Potthast *et al*[5], which showed a sensitivity of 100% for MRI and 89% for US. Another study from the same hospital attributed MRI with a sensitivity of 83%, and US with a sensitivity of 67%[9].

For fistula detection, the differences between MRI, which missed 2 cases (1%), and HR-US, which missed 32 cases (13%), were highly significant. The localization of the fistula in the lesser pelvis and peri-rectal region was a possible explanation in 24 of the 32 cases. The experience of the examiners did not have any influence on the results. It should be noted that HR-US examinations were restricted to transabdominal US examinations. A HR-US examination performed transperineal or trans-rectally would most probably improve the results of US dramatically. When comparing dedicated US examinations such as endoscopic endorectal US to MRI, both modalities were found to have similar sensitivities and specificities[10-12]. The study by Potthast *et al*[5] supports our data,

showing a false negative rate of 26% for transabdominal US and 5% for MRI.

The mention of a local lymphadenopathy is an indirect unspecific sign of an inflammatory process. Maconi *et al*[13] found an unspecific lymphadenopathy in 25% of their patients (n = 240) with CD using US. They detected more enlarged lymph nodes in young patients and in patients with fistulas and abscesses. In our study, MRE missed 15 cases (6%) with lymphadenopathy while US missed 44 cases (18%). There was an identical tendency in the evaluation of local mesenteric fat injection and comb sign with a missed rate of 2% in MRI and 24% in HR-US.

One of the major restrictions of our study is the retrospective approach used as well as the long data acquisition period of 7 years using different equipment and different examination protocols. In addition there was no standard of reference for the evaluated parameters. The retrospective evaluation of consecutive patients was deliberately chosen to assess the actual quality of MRE and US without influencing the examiners using both modalities. The quality improvements in HR-US over time were accompanied by improvements in MR imaging and protocols. However, basically identical protocols (fast T2 weighted sequences as well as gradient echo sequences after contrast application) were used during the evaluation time period. Having a standard of reference for all features evaluated in this study was extremely difficult. For small bowel assessment, MRI together with multidetector CT is already considered an accepted standard of reference with superior sensitivity and specificity compared to conventional enteroclysis and follow-through examinations[2,3]. When considering surgery as the standard of reference this would reduce the number of patients included in the study dramatically. Therefore, we considered a pathological finding mentioned in one report as a real finding, which was also to be described in the other modality. The analysis of 32 of 250 examinations, which were performed in patients with UC makes the patients evaluated more inhomogeneous, but does not influence our results significantly. On the other hand, we intended to analyze a realistic scenario in patients suffering from IBD.

In the recent literature, there are no major studies evaluating the diagnostic quality of HR-US and MRI with regard to bowel wall affections as well as transmural complications such as abscesses or fistulas. In our study, MR imaging was superior to US for all evaluated features. The difference was statistically significant for the diagnosis and detection of an abscess and highly significant for stenosis and fistula evaluation.

In conclusion, transabdominal HR-US can miss a certain number of pathological changes in patients with IBD. The localization of the pathological lesions in anatomical regions, which are difficult to assess by US, such as the lesser pelvis or the peri-rectal region, is one of the most frequent reasons for a missing a diagnosis. When the clinical suspicion of bowel affection or complications is mentioned, an MRI examination should be performed after an US examination without relevant findings.

COMMENTS

Background

Patients suffering from inflammatory bowel disease (IBD) require a complete bowel assessment for primary diagnosis or follow-up, when their symptoms are increasing. Guidelines recommend high-resolution ultrasound (HR-US) or magnetic resonance imaging (MRI) as imaging modalities.

Research frontiers

Ultrasound and MRI are diagnostic modalities without ionizing radiation. In this study, the authors compared the findings of MRI as well as ultrasound examinations in the same patients. They evaluated the limitations of ultrasound imaging for whole bowel assessment in patients with IBD.

Innovations and breakthroughs

Currently there are no major studies comparing state of the art MRI with ultrasound in bowel imaging for IBD. Our study shows, that relevant complications such as fistulas, stenoses or abscesses are often missed when using ultrasound imaging only.

Applications

By understanding the limitations of ultrasound imaging due to difficult to assess anatomical areas, algorithms for IBD imaging can be improved.

Peer review

This is an interesting retrospective manuscript on the comparison of HR-US and magnetic resonance enterography in a high number of patients with IBD. The comparison of competing imaging methods is of high clinical relevance therefore the topic of the manuscript is of clinical importance.

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