Diagnosis of Small Bowel Crohn's Disease:
a Prospective Comparison of Capsule Endoscopy with Magnetic Resonance Imaging and Fluoroscopic Enteroclysis

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Keywords

Capsule endoscopy – Crohn disease – Small bowel endoscopy – Inflammatory bowel disease – Digestive system endoscopy

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Abbreviations

CD – Crohn’s disease; MRI – magnetic resonance imaging; CE – capsule endoscopy; n. s. – not statistically significant; SD – standard deviation; SBFT – barium contrast small bowel follow-through.

Meeting presentation (study presented in part)


Statement

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**Abstract**

**Background & Aims:** The diagnostic yield of capsule endoscopy (CE) as compared to magnetic resonance imaging (MRI) in small bowel Crohn's disease is not well-established. We prospectively investigated CE, MRI, and double-contrast fluoroscopy in patients with suspected small bowel Crohn's disease.

**Methods:** 52 consecutive patients (39 female, 13 male) were investigated by MRI, fluoroscopy and – if bowel obstruction could be excluded – by CE. In 25, Crohn's disease was newly suspected, while the diagnosis of Crohn's disease (non small bowel) had been previously established in 27.

**Results:** Small bowel Crohn's disease was diagnosed in 41 out of 52 patients (79%). CE was not accomplished in 14 patients due to bowel strictures. Of the remaining 27 patients, CE, MRI, and fluoroscopy detected small bowel Crohn's disease in 25 (93%), 21 (78%), and 7 (of 21; 33%) cases, respectively. CE was the only diagnostic tool in four patients. CE was slightly more sensitive than MRI (12 vs. 10 of 13 in suspected Crohn's disease and 13 vs. 11 of 14 in established Crohn's disease). MRI detected inflammatory conglomerates and enteric fistulae in 3 and 2 cases, respectively.

**Conclusion:** CE and MRI are complementary means in diagnosing small bowel Crohn's disease. CE is capable of detecting limited mucosal lesions that may be missed by MRI, but awareness of bowel obstruction is mandatory. In contrast, MRI is helpful to identify transmural Crohn's disease and extra-luminal lesions, and may exclude strictures.
Introduction

Diagnosis of inflammatory bowel disease is based on clinical presentation, endoscopy, histopathological findings, and various other imaging techniques.[1] While the investigation of the small bowel has been difficult for years, only recently have two methods been introduced which may overcome the considerable limitations of conventional fluoroscopy. Capsule endoscopy (CE) [2] offers direct visualization of the small bowel mucosa, and magnetic resonance imaging (MRI) enables accurate diagnosis of intestinal and extra-intestinal abdominal pathology.[3][4] In small bowel bleeding, the contribution of CE to the diagnostic yield is significant; indeed, its accuracy outperforms any other investigational method presently available.[5][6] Although its value in detecting small bowel Crohn’s disease is not as well established, CE has been shown to add diagnostic information, particularly in difficult to determine clinical cases.[7] On the other hand, bowel strictures may cause complications, such as ileus.

To date, published studies either have dealt with small and vaguely defined patient groups[8] or compared CE to obsolete imaging.[9] Prospective comparison of CE with MRI in Crohn’s disease is lacking. Therefore, this prospective study aimed at evaluating the efficacy and safety of CE in diagnosing small bowel Crohn’s disease in comparison to MRI and double-contrast small bowel fluoroscopy (enteroclysis).
**Methods**

**Selection of patients**

From May 1st, 2002, through December 15th, 2003, all patients were screened, who were admitted to our hospital for evaluating suspected or previously diagnosed but worsening Crohn’s disease. Crohn’s disease was suspected in the presence of suggestive clinical symptoms (diarrhea, abdominal pain, anorexia, weight loss, rectal bleeding) and biochemical signs of systemic inflammation. Differential diagnoses had been excluded by microbiological stool tests, endoscopy, abdominal ultrasound, and cross-sectional imaging.

Eighty-one such consecutive patients were identified. They underwent a basic diagnostic work-up at our clinic including abdominal ultrasound, upper endoscopy (optional in established Crohn’s disease if performed previously), and ileo-colonoscopy. Patients were asked to take part in the study if these tests did not establish a diagnosis other than Crohn's disease, or – in patients with previously established Crohn's disease – did not sufficiently explain the clinical situation. Moreover, patients were selected in whom the detection of small bowel involvement was thought to potentially affect treatment strategies.

Exclusion criteria were dysphagia, gastrointestinal obstruction and/or ileus, pregnancy, and the presence of an implanted electro-medical device (cardiac pacemaker, defibrillator), and patients under the age of 18 were excluded.

The study protocol was evaluated and approved by the ethics committee of the Medical Faculty of the Martin-Luther-University. Written informed consent was given by all patients.

**Imaging procedures**

**Capsule endoscopy**

The technique of CE has been described in detail elsewhere.[10] After an overnight fast, patients ingested 1500 to 2000 ml of a bowel purgative (Klean-Prep®, Norgine, Marburg, Germany). Simethicone (80mg of Espumisan® Emulsion, Berlin-Chemie, Germany) was given with a small amount of tap water (<20ml) about twenty minutes prior to capsule ingestion.[11] Patients were allowed to drink water after two hours but not to eat until four hours later and were encouraged to walk around if they were able to. Digital video films of the examinations were reviewed using the ‘Rapid Reader 2’-software (Rapid Reader®, Given Imaging, Yoqneam, Israel). Capsule excretion was reported by the patients themselves within 48 hours. Otherwise, capsule retention was suspected and a plain abdominal radiograph was obtained.

**Magnetic resonance imaging**

Patients fasted overnight and drank about 1500ml of a suspension of Klean-Prep® (Norgine, Marburg, Germany) one hour before the investigation. Butylscopolaminiumbromide (Buscopan®, Boehringer Pharma KG, Ingelheim, Germany; 40mg) was given intravenously, if no contraindications were present. Magnetom Vision and Symphonie scanners (1.5T, Siemens, Erlangen, Germany) were used to acquire the following sequences: T2-weighted (T2w) coronal and transversal half-Fourier turbo-spin echo sequence (HASTE; TR 4.4ms; TE 64.0ms; Slice 9/8mm), T2w transversal IRM (TR 1000ms, TE 62ms), abdominal and pelvic projections, moreover ‘thin-slice’ RARE (TR 11.9ms; TE 95ms; TD 0; Slice 64mm; ETL 240), and T1w Flash-2d coronal and transversal sequences (abdomen: TR 147.2/115ms; TE 2.3ms; Flip 70°; 8/5mm; pelvis: TR 191ms, TE 2.5ms 7mm) with fat saturation, in abdominal and pelvic projections. T1w images were obtained before and after the intravenous administration of 0.1mmol / kg bodyweight of gadolinium chelate (Magnevist®, Schering, Berlin, Germany).
Enteroclysis

Patients fasted overnight. Then they were nasally intubated with a duodenography catheter the tip of which was advanced to the proximal jejunum distal to the ligament of Treitz. Approximately 140-200ml of barium sulfate suspension was injected into the small bowel under fluoroscopy. Thereafter, methyl-cellulose solution was continuously injected to obtain double contrast images. Radiographs in the prone, supine and oblique positions were obtained.[12]

Sequence of investigations

To exclude bowel strictures, enteroclysis and/or MRI were performed prior to CE. Significant bowel stricture was defined as luminal narrowing to less than 12mm. CE was not performed in these cases. The examiners of CE, MRI, and enteroclysis were blinded to each others findings, but were aware of the patients’ history and laboratory data.

Outcomes

The primary event of interest was the detection of an inflammatory lesion of the small bowel. In addition, complications, patients’ acceptance of the diagnostic methods, and final diagnosis after twelve months follow-up were investigated.

In CE, the detection of aphthous mucosal lesions, irregularly shaped or fissural ulcers – occasionally associated with bleeding –, cobblestone appearance, luminal narrowing due to edema and / or fibrous scarring, and granularity with attenuated or lost vascular pattern resulted in the diagnosis of Crohn’s disease (figure 1). On the other hand, findings such as patchy mucosal erythema, edema, or a single regular ulceration were considered inconclusive.

MRI features indicative of active small bowel Crohn’s disease included thickening of the bowel wall (≥ 4mm) and enhancement of the bowel wall after application of intravenous contrast medium (figure 2). In contrast, weak enhancement of bowel loops without bowel wall thickening was interpreted as an nonspecific finding. All investigations were accomplished within ten days with the exception of one patient (six weeks).

Patient comfort during the imaging procedures was determined by use of a questionnaire which was to be completed within five days of the procedure. Patients were asked to grade “stress” on a scale of 0 (no stress at all) to 10 (unbearable stress) for each of the imaging procedures (MRI, CE, and enteroclysis).

None of the patients was on regular NSAID medication. In addition, all patients denied the occasional intake of NSAIDs during the study.

Statistical analysis

Continuous variables are expressed as means ± standard deviation (SD) and categorical variables as percentages. Categorical variables were compared with use of Fisher’s exact test. A p-value of less than 0.05 was considered statistically significant. To account for multiple testing of outcome data arising from individual patients, Bonferroni’s correction was used where appropriate, and significance was only asserted with p < 0.01 for an individual test. The Wilcoxon test was used for comparing patients’ acceptance of the investigations. Mc Nemar’s test was used to quantify interobserver agreement and chance corrected index (‘kappa statistics’) was given in this case. WinStat 3.1 © for MS ® Excel, Version 2003.1 (© Robert K. Fitch Software, Germany) software was applied.
Results

Patients

Eighty-one consecutive patients were screened for eligibility. In twenty-eight of these patients, either a definitive diagnosis was made by basic procedures, or it was determined that clinical management would not be affected by potential small bowel involvement. In one case, an urgent surgical intervention was necessary. Thus, fifty-two patients were enrolled (female: n = 39, male: n = 13, age 18 to 72 years [mean ±SD: 36.6 ±12.41 years in males and 39.7 ±16.0 years in females]; figure 3).

Twenty-five patients were newly suspected to have Crohn’s disease while a diagnosis of Crohn’s disease had been previously established in 27. The leading symptom at hospital admission was abdominal pain in 27 / 52 patients (51.9%), diarrhea in 19 (36.5%), and weight loss or perineal fistula with suspected Crohn’s disease in 3 patients each (5.8%). In patients with established Crohn’s disease the diagnosis had been made at an average of 8 years (range: 6 months to 23 years) previously. Sixteen of these patients had undergone bowel surgery 7 to 172 months before inclusion in the study (mean: 66.5 ±48.34 months). Surgical interventions comprised ileocoecal resection (n = 7), resection for stricture or strictureplasty (5), segmental resection for fistula (2), and partial colectomy (2).

Findings in patients with established Crohn’s disease

In patients with an acute flare of established Crohn’s disease, enteroclysis detected small bowel lesions in 16 of 27 cases (59.2%). No lesion was found in three cases. High grade bowel stricture was proven by enteroclysis in 12 cases. MRI detected inflammatory small bowel lesions in 22 of 27 patients (81.5%). One patient did not tolerate the procedure of enteroclysis, but MRI detected a high grade bowel stricture. Therefore, CE was not accomplished in thirteen patients due to bowel stricture. In the remaining fourteen, typical features of small bowel Crohn’s disease were detected in all but one patient (92.9%). In this patient only non-active, supposedly post-inflammatory ‘breaking’ of the mucosal folds was reported. In direct comparison, CE found slightly more inflammatory lesions than MRI; the difference was not statistically significant (p>0.05), (table 1).

Table 1:

<table>
<thead>
<tr>
<th>Established Crohn’s disease</th>
<th>Small bowel lesions detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsule endoscopy</td>
<td>13/14 92.9%</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>11/14 78.6%</td>
</tr>
</tbody>
</table>

Table 1. Capsule endoscopy vs. magnetic resonance imaging in patients with previously established diagnosis “Crohn’s disease” (p>0.05, kappa = 0.44).

CE was the exclusive diagnostic tool in two patients. In a 23 year old female, ileocolonoscopy showed normal colonic and ileal mucosa, and MRI detected some nonspecific contrast enhancement in pelvic small bowel without thickening of the bowel wall. CE demonstrated fissural and irregular ulcerous lesions, granularity and loss of vascularity of the middle small bowel, and the capsule was retained in a functionally stenotic area for about 30 minutes. Enteroclysis had been previously refused by the patient for radiation exposure. The second patient was a 32 year old male with weight loss of 10 kg. Both enteroclysis and MRI found a non-significant narrowing of the anastomosis that was present after segmental colectomy four years earlier. MRI suggested the luminal narrowing to be non-inflammatory in nature and showed minor contrast enhancement of proximal small bowel without wall
thickening. CE disclosed discontinuous aphthous disease of the entire small bowel. Anti-inflammatory therapy was initiated.

**Findings in patients with suspected Crohn’s disease**

Of twenty-five patients with suspected Crohn’s disease, the diagnosis was confirmed in 14 (56%) and rejected in 11 (44%); (table 2).

**Table 2:**

<table>
<thead>
<tr>
<th>n</th>
<th>Diagnosis in suspected Crohn’s disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Crohn’s disease</td>
</tr>
<tr>
<td>3</td>
<td>Irritable bowel syndrome</td>
</tr>
<tr>
<td>2</td>
<td>Infectious colitis</td>
</tr>
<tr>
<td>2</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>Indeterminate colitis</td>
</tr>
<tr>
<td>1</td>
<td>Ulcerative colitis</td>
</tr>
<tr>
<td>1</td>
<td>Intolerance to lactulose</td>
</tr>
<tr>
<td>1</td>
<td>Symptoms due to adhesions</td>
</tr>
</tbody>
</table>

**TABLE 2. PATIENTS WITH SUSPECTED CROHN’S DISEASE (N=25).**

Small bowel lesions were detected by enteroclysis in four of the 14 patients with final diagnosis Crohn’s disease (28.6%). No small bowel lesion was found in the remaining 12 patients. MRI detected small bowel pathology indicative of Crohn’s disease in 10 / 13 (77%) patients. Nonspecific contrast enhancement was reported in four patients with the final diagnosis Crohn’s disease (false-negative findings). Bowel wall thickening and some enhancement of the small bowel was regarded as indicative for Crohn’s disease in two cases, but endoscopy (including CE) detected no mucosal lesions (false-positive findings). No pathology was detected in the remaining patients who were diagnosed as not suffering from Crohn’s disease.

In CE, small bowel lesions were found in twelve of thirteen patients (92%) and in none of the patients with the diagnosis Crohn’s disease finally rejected. Patchy erythema in proximal and distal small bowel segments described by CE in another patient were regarded as nonspecific. In this patient, repeated colonoscopy disclosed ulcerous lesions suggesting active Crohn’s disease of terminal ileum and colon. Therefore, results in CE much like in MRI were regarded as false-negative (table 3).

**Table 3:**

<table>
<thead>
<tr>
<th>Suspected Crohn’s disease</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsule Endoscopy</td>
<td>12/13 (92%)</td>
<td>10/10 (100%)</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>10/13 (77%)</td>
<td>8/10 (80%)</td>
</tr>
</tbody>
</table>

**TABLE 3. PATIENTS WITH SUSPECTED SMALL BOWEL CROHN’S DISEASE: SENSITIVITY AND SPECIFICITY FOR ‘CROHN-LIKE’ SMALL BOWEL LESIONS IN DIRECT COMPARISON OF MRI TO CAPSULE ENDOSCOPY (P>0.05; KAPPA = 0.57).**

CE was the exclusive diagnostic tool in two patients. MRI showed discontinuous small bowel enhancement after application of contrast medium but no bowel wall thickening (nonspecific finding) in one case, while CE demonstrated multiple (> 40) aphthous ulcers of the upper and middle small bowel. In the other patient, MRI was also nonspecific but CE confirmed upper
small bowel ulcerations indicating Crohn's disease. In both patients, anti-inflammatory therapy was initiated and symptoms improved.

**Comparison of imaging methods**

Enteroclysis performed less sensitive than MRI (enteroclysis vs. MRI: p=0.011) and CE (enteroclysis vs. CE: p=0.002) in direct comparison of all patients investigated. CE was slightly more sensitive than MRI, but this marginal difference did not reach statistical significance. Details on the diagnostic yield of enteroclysis, MRI, and CE in small bowel Crohn's disease are given in table 4.

**Table 4:**

<table>
<thead>
<tr>
<th></th>
<th>Enteroclysis</th>
<th>MRI</th>
<th>Capsule endoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>established CD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Findings</td>
<td>16</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Normal</td>
<td>8</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Detection rate</td>
<td>67%</td>
<td>88%</td>
<td>93%</td>
</tr>
<tr>
<td>Drop-out</td>
<td>3</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td><strong>suspected CD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>True positive</td>
<td>4</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>False positive</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>True negative</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>False negative</td>
<td>6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>PPV</td>
<td>100%</td>
<td>83%</td>
<td>100%</td>
</tr>
<tr>
<td>NPV</td>
<td>50%</td>
<td>66%</td>
<td>92%</td>
</tr>
<tr>
<td>Drop-out</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

**TABLE 4.** PERFORMANCE OF INVESTIGATIONAL METHODS IN DETECTING SMALL BOWEL CROHN'S DISEASE (CD; MRI – MAGNETIC RESONANCE IMAGING) IN PATIENTS WITH PREVIOUSLY ESTABLISHED DIAGNOSIS CROHN'S DISEASE AND WITH SUSPECTED CROHN'S DISEASE.

**Follow-up data in patients with suspected Crohn's disease**

Follow-up data were available in 22 of 25 patients (88%) with suspected Crohn's disease while three were lost. Mean ±SD follow-up time was 14.5 ±6.5 months. The diagnosis of Crohn's disease remained unchanged in all cases. Diagnosis of ulcerative colitis (one patient) was revised to 'indeterminate colitis'. Other diagnoses were confirmed by follow-up.

**Procedure related events**

Procedure related events occurred in six patients (CE n = 1, MRI n = 3, and enteroclysis n = 2). Ingestion of the capsule was followed by colicky abdominal pain four hours later in one case. A plain abdominal radiograph showed the capsule in the right lower abdominal quadrant. CE imaging data disclosed inflammatory lesions in the upper small bowel and high-grade luminal narrowing in an inflamed region of the distal small bowel. The capsule was retained proximal of this bowel stricture, but did not cause complete obstruction or ileus. After i.v. corticosteroids were started, symptoms improved but did not resolve until about 72 hours later, when the capsule was excreted. Surgical intervention was not necessary –
neither during this hospital stay nor later in the course of follow-up. Abdominal ultrasound and enteroclysis had failed to detect this stricture. In two patients, acquisition of MRI data was incomplete due to claustrophobia; one patient refused MRI exam. Two patients did not tolerate placement of the transnasal tube for enteroclysis.

**Predicting stricturing disease**

In fourteen patients, significant bowel strictures were detected by MRI and/or enteroclysis. The concordance of MRI and enteroclysis in discovering strictures was high in retrospective analysis (kappa = 0.83). Eight of these patients had been operated three to fourteen years (mean ±SD = 6.2 ±4.1) earlier. In five of the eight, the stricture affected the anastomosis, while three had recurring stricturing disease at other locations. Prior surgery (8/14 vs. 6/38; p = 0.005), leading symptom ‘abdominal pain’ (13/14 vs. 14/38; p<0.001), and a previously established diagnosis of Crohn’s disease (13/14 vs. 14/38; p<0.001) were identified as prognostic factors.

**Patient comfort**

Twenty-two patients returned the questionnaire; all had been investigated by all three methods. MRI mean ±SD stress grade was 4.4 ±2.95 and was regarded less stressing than enteroclysis (stress grade = 5.6 ±2.38; p=0.02). CE (stress grade = 1.1 ±0.9) was found to be significantly less stress-associated than both MRI and enteroclysis (p<0.001, respectively; figure 4).
Discussion

To the best of our knowledge, the present study is the first to prospectively compare CE with MRI and double-contrast fluoroscopy (small bowel enteroclysis) in patients with supposed small bowel Crohn’s disease. While enteroclysis turned out to be the least sensitive modality, CE was only slightly more sensitive than MRI (12 vs. 10 of 13 in suspected Crohn’s disease and 13 vs. 11 of 14 in established Crohn’s disease), and this small difference did not achieve statistical significance. One would have to perform a trial on 93 (power 80%, alpha 0.05) or 120 patients (power 90%, alpha 0.05) with Crohn’s disease of the small bowel in order to statistically prove or disprove such a small advantage in sensitivity of 14% (92% vs. 78%). Even if such marginal superiority of CE could be established, it would most probably not alter diagnostic decision making in the individual patient as discussed below.

Methodological considerations

One of the problems inherent in diagnostic studies in small bowel Crohn’s disease is the lack of a non-surgical “gold standard” for comparisons. Assuming that the apparently most sensitive method should set the “standard” may be incorrect due to unrecognized false-positive results. For this reason, we used a combined diagnostic end point composed of all imaging methods including ileocolonoscopy as well as clinical and lab data and the evolution of the diagnosis during follow-up. Thus, our rating of CE, MRI and conventional fluoroscopic enteroclysis was as objective as possible.

Another potential source of error in such studies is the observation of nonspecific lesions even in healthy subjects which could be falsely diagnosed as indicative of Crohn’s disease. We tried to avoid this problem by defining as narrowly as possible the distinction between “nonspecific” and “diagnostic” for Crohn’s disease on the basis of our previous experience with CE and MRI, and of findings described in the literature. Furthermore, investigators were blinded for the results of the various competing imaging methods.

Finally, our present results were obtained in a highly preselected group of patients. However, there is no apparent reason to assume that the hierarchy of diagnostic efficacy of the three imaging methods investigated should be substantially altered in a population showing a smaller prevalence of Crohn’s disease. If anything, the specificity of positive results of all three methods, possibly most prominently for CE, would decrease if the number of subjects with nonspecific findings were to increase.

The results concerning enteroclysis in suspected Crohn’s disease might have been hampered by the fact that some patients refused this procedure – mainly due to fear of radiation. While this is correct theoretically, enteroclysis still performed less sensitive than MRI (enteroclysis vs. MRI: p=0.011) and CE (enteroclysis vs. CE: p=0.002) in the subgroup of patients in whom all three methods had been applied. Alike results have been reported [30]: In a trial of 84 patients the sensitivity was 85.4% and 95.2%, and the specificity was 76.9% and 92.6% for enteroclysis and MRI, respectively. Others found similar sensitivities for conventional enteroclysis and MR-enteroclysis in detecting small bowel Crohn’s disease.[29]

In addition, we believe that refusal to undergo imaging because of problems inherent in the examination itself should not be disregarded when calculating diagnostic efficacy.

Diagnostic value of CE, MRI and enteroclysis

In the pre-CE era, results of intraoperative endoscopy of the entire small bowel increased the number of findings over those known pre-operatively in 20 to 35% [13][14] and influenced surgical interventions in about 60% [15] of patients with Crohn’s disease requiring surgical intervention. Information on the comparative diagnostic efficacy of CE in Crohn’s disease is sparse to date. In the early more or less anecdotal reports, detection rates of CE are reported as 70% (12 of 17 Crohn lesions) [7] and 42.8% (9 of 21) [16] in patients with an unspecified but apparently non-diagnostic prior investigational work-up. The diagnostic yield of CE in explaining the symptoms of abdominal pain, diarrhea and weight loss was found to be higher (70%) than that of small bowel follow-through and enteric computed tomography.
Enteroclysis or small bowel follow-through have been standard radiological investigations to detect small bowel Crohn’s disease until now, but the preference for one or the other still depends on institutional standards. In a very recent study, CE was compared to barium contrast small bowel follow-through (SBFT) in 30 patients with a previously established diagnosis of Crohn’s disease. Although active small bowel Crohn’s disease was detected in a similar proportion of patients by both methods (CE: 21/30 patients; SBFT: 20/30), findings were inconsistent in 20 – 30% of patients: in six patients, CE found lesions that had escaped detection by SBFT, while SBFT was diagnostic in five patients in whom CE had failed. In a retrospective study of 40 patients with CE, 3 were found to have significant small bowel ulceration despite normal fluoroscopic enteroclysis. In the present study, the sensitivity of enteroclysis was found to be significantly inferior to both CE and MRI. Since radiation exposure is significant and diagnostic capability for extraluminal disease limited, fluoroscopic enteroclysis should be abandoned as a diagnostic tool for inflammatory bowel disease if modern MRI technique is available.

After completion of this study, a prospective comparison of CE to computed tomography enteroclysis in patients with an established diagnosis of Crohn’s disease was published. Small bowel lesions were detected by CE in 25 of 41 patients compared to only 12 of 41 with CT enteroclysis (p=0.004). Mucosal lesions escaped CT in 13 cases. In the present study MRI (78%) was far more sensitive in detecting Crohn lesions of the small bowel than CT enteroclysis in the above mentioned investigation (12 of 25: 48%). Although the patient groups in the two studies may not be compared directly, the lack of radiation exposure and greater diagnostic sensitivity strongly support the use of MRI rather than CT technology for investigating the small bowel in Crohn’s disease. Furthermore, MRI is widely applied in perianal fistulizing Crohn’s disease and detection of intestinal and extra-intestinal (abscesses, fistulae, mesenteric lymph nodes) manifestations of Crohn’s disease is feasible.

Not surprisingly, patients preferred CE to fluoroscopic enteroclysis. However, the use of CE as a first line diagnostic measure for small bowel Crohn’s disease is limited by potential capsule retention with the risk of “non-natural excretion”. While in some reports no side effects of CE were observed in an accumulated 58 cases, recent publications suggest capsule retention occurs in 5 to more than 10% of patients, even in those with only suspected disease. An even higher index of suspicion is warranted in patients with established Crohn’s disease: in the present study, strictures were detected in 48% of these patients. Therefore, CE should only be applied when strictures have been excluded by the most reliable method available, which, according to the present results, is MRI.

**Which examination to see what in clinical practice?**

In conclusion, CE is highly sensitive in diagnosing small bowel Crohn’s disease and well tolerated by the patients. It might even be slightly superior to MRI, but this potential advantage is relevant in a few cases in clinical practice only. Imaging of the small bowel in patients with suspected or established Crohn’s disease is indicated for the initial determination of the extent of bowel involvement, if a diagnosis cannot be made by upper endoscopy and ileocolonoscopy, and if demonstration or exclusion of small bowel involvement would affect medical or surgical therapy. In this situation, the first, most simple and quite helpful examination is abdominal ultrasound. As the next step, if questions of therapeutic relevance remain, MRI should be performed to provide clues to both intestinal and extraintestinal Crohn’s disease, although it might lack the superior sensitivity of CE in detecting minor lesions limited to the mucosa. Using this algorithm, CE will most probably be applicable to no more than 10% of the population in which the small bowel should be...
specifically visualized. In the present trial of 52 patients this applied to four, in whom CE was the only effective diagnostic measure.

**Acknowledgements**

The authors are greatly indebted to Ms. S. Behl for her biostatistical contribution, and to Ms. Chr. Zschorn and Mr. M. Neugebauer for technical support.
References
Figure 3. Flow-chart of the study group.

- **screening**
  - 81 patients
    - **established diagnosis "Crohn's disease"**
      - 39 patients
        - stricturing Crohn's disease
          - 7 patients
        - fistulizing Crohn's disease
          - 4 patients
        - urgent surgery
          - 1 patient
    - **suspected Crohn's disease**
      - 42 patients
        - Ulcerative Colitis
          - 10 patients
        - Other diagnoses
          - 7 patients

- **recruitment**
  - 52 patients
    - **established diagnosis Crohn's disease**
      - 27 patients
        - "drop-out" enteroclysis
          - n=1; patient denial
    - **suspected Crohn's disease**
      - 25 patients
        - "drop-out" enteroclysis
          - n=9; patient denial
Figure 4. Patients’ acceptance of the investigations: Psychical stress during the investigation on a scale from 0 (no stress) to 10 (unbearable stress); (N=22).
Diagnosis of small bowel Crohn's disease: a prospective comparison of capsule endoscopy with magnetic resonance imaging and fluoroscopic enteroclysis

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