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Original Article

Capsule Endoscopy Complements Magnetic Resonance Enterography and Endoscopy in Evaluating Small Bowel Crohn's Disease

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Abstract

Aims: Wireless capsule endoscopy (WCE) and magnetic resonance enterography (MRE) are increasingly utilized to evaluate the small bowel (SB) in Crohn's disease (CD). The primary aims were to compare the ability of WCE and MRE to detect SB inflammation in children with newly diagnosed CD, and in the terminal ileum (TI) to compare them to ileo-colonoscopy. Secondary aims were to compare diagnostic accuracy of WCE and MRE and changes in Paris classification after each study.
Methods: Patients (10 to 17 years of age) requiring ileo-colonoscopy for suspected CD were invited to participate. Only patients with endoscopic/histologic evidence of CD underwent MRE and WCE. SB inflammation and extent were documented and comparative analyses performed.
Results: Of 38 initially recruited subjects, 20 completed the study. WCE and MRE were similarly sensitive in identifying active TI inflammation (16 [80%] versus 12 [60%]) and any SB inflammation (17 [85%] versus 16 [80%]). However, WCE detected more extensive SB disease than MRE with active inflammation throughout the SB in 15 [75%] versus 1 [5%] patient ($P < 0.001$). Moreover, WCE was more likely to detect proximal SB disease (jejunum and ileum) compared to MRE (85% versus 50%, $P = 0.04$). Overall, the Paris classification changed in 65% and 85% of patients following MRE and WCE, respectively.
Conclusions: WCE is as sensitive as MRE for identifying active TI inflammation, but appears more sensitive in identifying more proximal SB inflammation. In the absence of concern regarding stricturing or extra-luminal disease WCE can be considered for the evaluation of suspected SB CD.

Keywords: *Crohn disease; Endoscopy; Imaging; Paediatrics*

What Is the Current Knowledge?

1. Paediatric onset Crohn's disease (CD) is more aggressive and dynamic than adult onset disease
2. Accumulating evidence suggests that mucosal healing in CD leads to better outcomes
3. Repeated sensitive accurate small bowel assessment is required for effective disease assessment and management
4. WCE is superior to MRE in identifying SB inflammation other than TI inflammation
5. WCE can detect superficial mucosal ulcerations missed on MRE

What Is New?

1. The distribution of SB inflammation is more extensive when characterized by WCE
2. Lewis score in the TI correlated with bowel wall thickening and bowel wall enhancement on MRE
3. Although CT and endoscopy have demonstrated a phenomenon called 'endoscopic skipping of the TI' evaluation of WCE and MRE data confirmed that active mucosal inflammation was at, or near, the ileo-cecal valve.

INTRODUCTION

Crohn's disease (CD) is a chronic relapsing-remitting disease, however, an increasing body of literature suggests that the natural history of CD is modifiable through early therapeutic intervention and maintenance of disease remission (1–5). Paediatric CD exhibits a more extensive and aggressive phenotype than adults (1,6). In particular, children exhibit a high prevalence of small bowel (SB) disease, with an associated higher likelihood of fibrostenotic and penetrating disease requiring surgical intervention (1,6). Hence, accurate evaluation of SB inflammation early in the disease course is crucial.

Unfortunately, SB evaluation remains challenging in paediatric CD patients. Poor correlation among clinical, laboratory and endoscopic evaluations necessitates the use of multiple investigations for disease evaluation (7,8). Furthermore, standard endoscopy, laboratory investigations and fecal testing do not visualize, or are not specific for SB CD. Therefore, imaging studies, the least invasive way to evaluate the SB, are required. Fluoroscopic studies and computerized tomography image the SB, but nonionizing modalities are preferred in children (9–11). Ultrasound can demonstrate high levels of sensitivity and specificity for SB CD, but can be time consuming, challenging to reproduce, requires committed, well-trained sonographers and high-resolution equipment (11). Consequently, wireless capsule endoscopy (WCE) and magnetic resonance enterography (MRE) are increasingly utilized to evaluate SB CD.

MRE effectively evaluates transmural lesions and provides accurate assessment of stricturing and penetrating disease (12,13). However, MRE can miss superficial ulcerations and diagnostic accuracy is affected by imaging artifact due to motion, bowel peristalsis and intake of oral contrast. A recent study in adult patients with established or suspected CD, reported WCE to be superior to MRE for detecting superficial and proximal SB lesions (14). Moreover, a systematic review and meta-analysis of prospective paediatric and adult studies in patients with suspected and, or established CD, reported a similar diagnostic yield for SB disease, although WCE was superior for proximal SB disease (15). Conversely, a paediatric study using the MRE global score [MEGS] for quantitative evaluation of the entire digestive tract, reported similar detection rates with both modalities (16). Consequently, the superior diagnostic accuracy of WCE for SB CD remains unclear and the most effective approach for diagnosing SB CD remains to be established.

The primary study objectives were to compare diagnostic yield of MRE and WCE for the assessment of SB inflammation in children with newly diagnosed CD and in the terminal ileum (TI), to compare their performance with ileo-colonoscopy. Secondary objectives were to compare the diagnostic accuracy of both modalities and change in Paris classification after each examination.

MATERIALS AND METHODS

Study Subjects

From September 2010 to December 2014, consecutive paediatric patients 10 to 17 years of age, attending the British Colombia Children's Hospital (BCCH) gastroenterology clinic and, requiring ileo-colonoscopy and gastroscopy for evaluation of suspected CD were prospectively recruited. Parents (or legal guardians) provided informed consent. Following endoscopy, participants with endoscopic/histologic evidence of CD who underwent MRE and WCE to evaluate for SB inflammation were included in analysis. The Pediatric Crohn's Disease Activity Index (PCDAI) was calculated based on clinical and laboratory parameters (17). Clinical response was defined as a decrease in the PCDAI of ≥ 15 points from baseline, a physician global assessment (PGA) of mild disease or remission a PCDAI≤ 10 and a PGA of inactive disease. Exclusionary criteria included ulcerative colitis or infectious colitis, a contraindication to MRE (metal foreign body), severe renal insufficiency, contrast allergy, claustrophobia or suspected high-grade SB stricture. The lower age limit of 10 years was based on the likelihood of being able to orally ingest the capsule. Patients unable to swallow the capsule were excluded, as an additional endoscopy for capsule placement was not considered ethically justifiable. To minimize the potential for changes in mucosal disease in the interval between investigations, patients initiated on corticosteroids, or biologic therapy were excluded. Treatment was otherwise left to the discretion of the primary

physician, and patients were allowed to start other standard therapies including a -5-ASA compound or exclusive enteral nutrition following ileo-colonoscopy. Treatment optimization occurred after the imaging studies. Ethical approval was obtained from the Clinical Research Ethics Board of the University of British Columbia, and the BCCH and Women's Research Review Committee. An REB concern was the inclusion of children with obvious and extensive small bowel disease detected on MRE and the potential for WCE impaction. Consequently, a requirement of the REB was that the result of the MRE be available to investigators prior to patient participation in the WCE part of the study. As a result, only cases with mild or no small bowel mucosal disease on MRE were included. Moreover, the capsule was only taken orally with no option for endoscopic placement further increasing the length of time to recruit.

Ileo-colonoscopy

Endoscopy was performed in the BCCH OR following propanol sedation administered by the attending anaesthetist. Endoscopic activity was defined by K.J. and Z.H. (from TI images and performing endoscopist's findings) using the Simple Endoscopic Score – Crohn's Disease (SES-CD); which includes presence and size of ulcers, extent of ulcerated surface, extent of affected surface and presence/number of narrowing(s) and whether this can be passed in up to five segments (rectum, sigmoid and left colon, transverse colon, right colon and terminal ileum). A maximum accumulative score for all segments is 56, with maximum score of 12 per segment. Activity score thresholds for remission are 0 to 2, mild disease 3 to 6, moderate 7 to 15 and severe ≥ 16 (18).

Magnetic Resonance Enterography

MRE was performed as soon as possible after ileo-colonoscopy to reduce the likelihood of significant changes in mucosal findings (procedure and sequence protocol outlined in Supplementary Table 1). Radiologists, TS and DJ blinded to ileo-colonoscopy results, performed image analysis independently. Activity at three defined SB segments (TI [distal 10 cm], ileum [distal half of the remainder of the SB] and jejunum [proximal half of the remainder]) (19) was determined by presence/absence of the following five variables: bowel wall thickening, bowel wall enhancement, fibro-fatty proliferation, hyperemia/vascular engorgement and proximal dilation. T1- and T2-weighted images were evaluated. Each finding was given a score of 1 (maximum score/segment was 5 and maximum total score was 15). A segment score ≥2 was considered evidence of active disease. Similar scoring systems have been utilized elsewhere (20,21). Where discrepancy occurred between readers, a consensus agreement was reached to facilitate comparative analysis with endoscopic and WCE findings.

Wireless Capsule Endoscopy

WCE was performed as soon as possible after ileo-colonoscopy and MRE. All patients swallowed a SB2 Pillcam except one (SB3 capsule due to local practice change) capsule (Given Imaging, Yokneam, Israel). The examination was incomplete if the capsule failed to reach the cecum within the battery life, or before removal of the recorder. Gastroenterologists DP and RE blinded to the other data evaluated the WCE images independently. Disease severity was scored using the Lewis score (22), and mean reader's scores were used for comparative analyses. The final tertile of SB transit time was considered the TI. A score ≥135 was considered active disease. The change in Paris classification based on MRE and WCE was determined and compared between the two modalities.

Statistical Analysis

A sample size of 45 patients was estimated, based on a retrospective analysis of data in the BCCH GI division IBD database, to show a precision (95% confidence limit) of 11.5% with a sensitivity of 80% or greater which would be adequate to determine whether WCE is clinically useful as a supplementary diagnostic tool. Descriptive statistics are presented as frequencies and percentages or medians ± interquartile range (IQR) where appropriate. Mann–Whitney *U* and Chi Square tests were used for intergroup comparisons. Cohen's kappa coefficient (κ) was used to assess (i) agreement between radiologists and gastroenterologists for MRE and WCE findings, respectively and, (ii) agreement among ileo-colonoscopy, MRE and WCE in identifying active TI inflammation based on the mucosal changes defined by SES-CD, MRE criteria defined above (≥2 findings), and those included in the Lewis score. The marginal proportions of patients with active mucosal inflammation identified by each modality were investigated using an exact McNemar's test. Analyses were performed using R (Version 3.5.1).

RESULTS

Demographic Features

Thirty-eight children with suspected CD were recruited. Patient characteristics are described in Table 1 and individual data are presented in Supplementary Table 2. Reasons for exclusion and disease characteristics for the 18 patients excluded are presented in Supplementary Table 3. There were no statistical differences between included and excluded groups among evaluated parameters. No patients used nonsteroidal anti-inflammatory medications.

Ileo-colonoscopy Findings

Macroscopic TI inflammation was reported in 12 of 18 (67%) patients, however TI intubation was unsuccessful in two patients due to IC valve swelling, and poor bowel preparation (no biopsies of TI taken). The median SES-CD for the TI was 3 of 12 (IQR 1 to 4).

MRE Findings

The median time between endoscopy and MRE was 13 days (7 to 29). Radiologically active TI inflammation (≥2 findings) was present in 12 of 20 (60%) patients, and in the SB (including TI) in 16 of 20 (80%) patients (Table 2). In patients with active inflammation (based on the criteria defined in the methods section, ≥ 2 findings), the median MRE score was 2 of 5 (2 to 3) in the TI and 3 of 15 (2 to 5) in the SB. Penetrating disease was detected in 1 patient. Inter-rater agreement between radiologists on MRE scores as well as inflammatory features is detailed in Supplementary Table 4. Discrepancies were predominantly related to disease location rather than radiological findings.

Table 1. Demographic, symptom and laboratory characteristics of the patient cohort

Patient characteristics	
Suspected CD	20 (100%)
Male/Female	13 (65%)/7 (35%)
Caucasian/Asian Ethnicity	14 (70%)/6 (30%)
Age (Median, IQR)	14.0 (13.2–15.8)
BMI	18.1 (16.8–19.9)
First-degree relative with IBD	7 (35%)
Symptoms	
Abdominal pain	14 (70%)
Weight loss	10 (50%)
Diarrhea	5 (20%)
Bloody stools	6 (30%)
Nausea	3 (15%)
Lethargy	4 (20%)
Nocturnal symptoms	2 (10%)
Extra-intestinal manifestations	
Myalgias	1 (5%)
Fever	1 (5%)
Arthralgias	2 (10%)
Oral ulcerations	2 (10%)
Number of symptoms (Median, IQR)	3 (2–5)
Duration of symptoms (Months, Median, IQR)	10.5 (3–24)
Laboratory Investigations	
Hemoglobin (Median, IQR)	110g/L (103–126)
WBC (Median, IQR)	8.6×10^9/mL (7.0–10.6)
Platelets (Median, IQR)	373×10^9/mL (296–445)
ESR (Median, IQR)	22 mm/h (14–44.5)
CRP (Median, IQR)	18 mg/L (10–42)
Albumin (Median, IQR)	38g/L (35–41)
Paediatric Crohn's Disease Activity Index (Median, IQR)	20 (15–31)

BMI, Body mass index; CD, Crohn's disease; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; IBD, Inflammatory bowel Disease; IQR, Interquartile range.

WCE Findings

The median time between MRE and WCE was 5 days (2 to 13) and between endoscopy and WCE was 21 days (14 to 37). Bowel preparation was excellent in all but two patients (Median ICCE score = 0 [0-0]) (23). Active TI inflammation (Lewis score ≥ 135) was identified in 16 of 20 (80%) patients, and in the SB (including TI) in 17 of 20 (85%) patients (Table 2). Inter-rater agreement between gastroenterologists on Lewis score assessments and presence/absence of inflammatory features is detailed in Supplementary Table 4.

No clinically significant capsule retention (need for surgical/endoscopic intervention) occurred. In one patient where capsule progress was halted at an inflammatory stricture (not included in the analysis), corticosteroid treatment resulted in spontaneous capsule passage.

WCE, MRE and Ileo-colonoscopy Findings in the TI

Mucosal inflammation in the TI was visualized at ileocolonoscopy in 12 (60%) patients, in contrast to 16 (80%) by WCE (including two cases where TI not intubated and no TI biopsies obtained), and 12 (60%) by MRE (including one case where TI not intubated) (Table 2). Ileo-colonoscopy and WCE were in agreement regarding mucosal findings in 16 patients (89%, $\kappa = 0.73$, $P = 0.01$); 12 with inflammation and 4 without. WCE identified an additional four cases of active mucosal TI inflammation not seen at ileo-colonoscopy, likely at a site proximal to the area examined by ileo-colonoscopy. Ileo-colonoscopy and MRE were in a agreement regarding mucosal findings in 13 patients (72%, $\kappa = 0.40$, $P = 0.08$); 9 with inflammation and 4 without. However, MRE identified inflammation in 2 patients where ileo-colonoscopy was normal (and 1 patient where TI not intubated), and ileo-colonoscopy identified inflammation in 3 patients where MRE was normal. Agreement

Table 2. Diagnostic yield of IC, MRE and WCE in SB segments

SB Lesions	IC	MRE	WCE	*P*
Terminal Ileum, *n* (%)	12 (60)	12 (60)	16 (80)	0.133
Ileum, *n* (%)		7 (35)	16 (80)	0.007
Jejunum, *n* (%)		4 (20)	16 (80)	0.003
Panenteric, *n* (%)		1 (5)	15 (75)	<0.001

IC, ileocolonoscopy; MRE, Magnetic resonance enterography; SB, Small bowel; WCE, Wireless capsule endoscopy.

between WCE and MRE was reported in 16 patients (80%, $\kappa = 0.55$, $P < 0.01$); 12 with inflammation and 4 without. Notably, WCE identified inflammation in four patients where MRE was normal. Agreement among all three modalities was reported in 13 of 18 (72%) patients; nine with active inflammation and four without (Figures 1 and 2).

When endoscopy and histology agreed regarding presence or absence of TI inflammation, activity agreed with WCE in 10 of 12 cases ($\kappa = 0.57$, $P = 0.03$) and with MRE in 8 of 12 ($\kappa = 0.47$, $P = 0.39$). Categorical Lewis score in the TI was significantly related to bowel wall thickening ($X^2(2, N = 20) = 14.05$, $P < .001$), and bowel wall enhancement ($X^2(2, N = 20) = 14.05$, $P < 0.001$), but not fibro-fatty proliferation ($X^2(2, N = 20) = 0.73$, $P = 0.69$), or hyperemia/vascular engorgement ($X^2(2, N = 20) = 2.63$, $P = 0.27$).

WCE and MRE Findings in the Small Bowel

Active SB inflammation was identified in 17 of 20 (85%) patients by WCE and in 16 of 20 (80%) by MRE (Figure 3, Table 2). Pan-enteritis (inflammation throughout SB) was identified in 15 (75%) patients by WCE, in contrast to 1 (5%) by MRE ($P < 0.001$). In the cases with nonpan-enteric SB inflammation detected on WCE, inflammation was identified in the jejunum (1), and ileum (1), and on MRE inflammation was identified in the TI only (6), ileum only (2), jejunum only (2), TI and ileum (4) and TI and jejunum (1).

Agreement between modalities regarding presence or absence of any SB inflammation occurred in 17 (85%) patients (85%, $\kappa = 0.48$, $P = 0.02$); 15 with inflammation and 2 without. WCE identified 2 (10%) patients with active inflammation (1 pan-enteritis, 1 jejunum only) where MRE was normal, and MRE identified 1 (5%) patient with active SB CD (jejunum only) where WCE was normal. In three cases where TI inflammation was not identified by MRE (two ileal only, one jejunal only), WCE detected pan-enteric inflammation. McNemar's exact test showed that WCE was superior to MRE in detecting disease in the ileum, other than TI (Difference 45%, $P < 0.01$) and jejunum (Difference 60%, $P < 0.01$). WCE identified stenoses in six (30%) patients, whereas MRE identified two (10%) patients with dilated SB segments suggestive of distal obstruction. Per-patient, no agreement regarding presence of a SB stricture was identified ($\kappa = -0.18$, $P = 0.33$).

Paris Classification

MRE led to nine patients (45%) being further classified with SB disease proximal to the TI (L4b disease) (24), with six initially categorized with L4a disease by endoscopy. Conversely, WCE resulted in 17 patients (85%) being categorized with L4b SB disease with 9 (26%) initially categorized with L4a disease by endoscopy. An additional patient was categorized with L4a disease by WCE alone. All patients except one categorized with L4b by MRE were categorized with L4b disease by WCE (Figure 3, Table 2).

Treatment Optimization

Due to REB restrictions recruited patients had mild endoscopic and MRE evidence of disease. Four patients were initiated on exclusive enteral nutrition (EEN), and eight on a 5-ASA compound prior to WCE study. The remaining patients did not commence therapy until after WCE. Following WCE, 13 patients commenced an immune modulator (IM), 6 in combination with prednisone, and 2 following EEN. Nine patients began an anti-TNF agent (five in combination with IM and four on anti-TNF monotherapy). Of the remaining three patients, two were treated with a 5-ASA, and one was continued on intermittent courses of antibiotics. At 1-year postdiagnosis, 73.7%

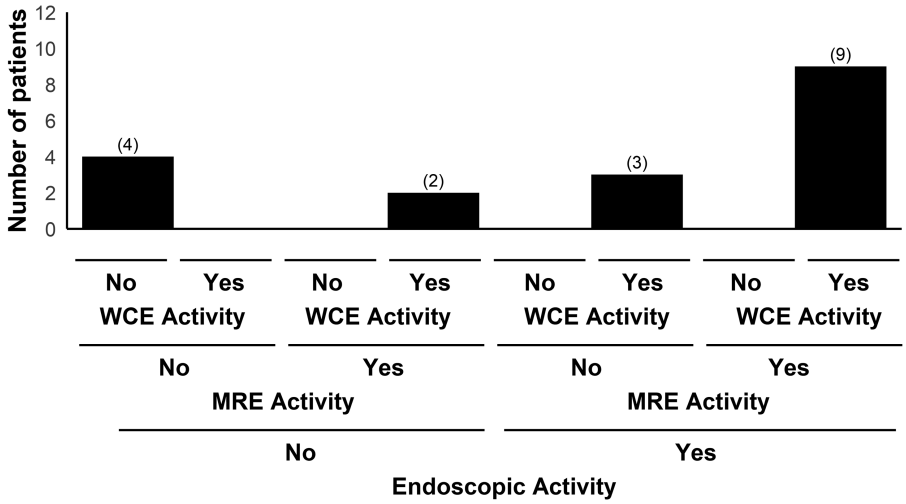

Figure 1. Active terminal ileal inflammation as determined by ileo-colonoscopy, magnetic resonance enterography (MRE) and wireless capsule endoscopy (WCE) in 20 paediatric patients with newly diagnosed Crohn's disease.

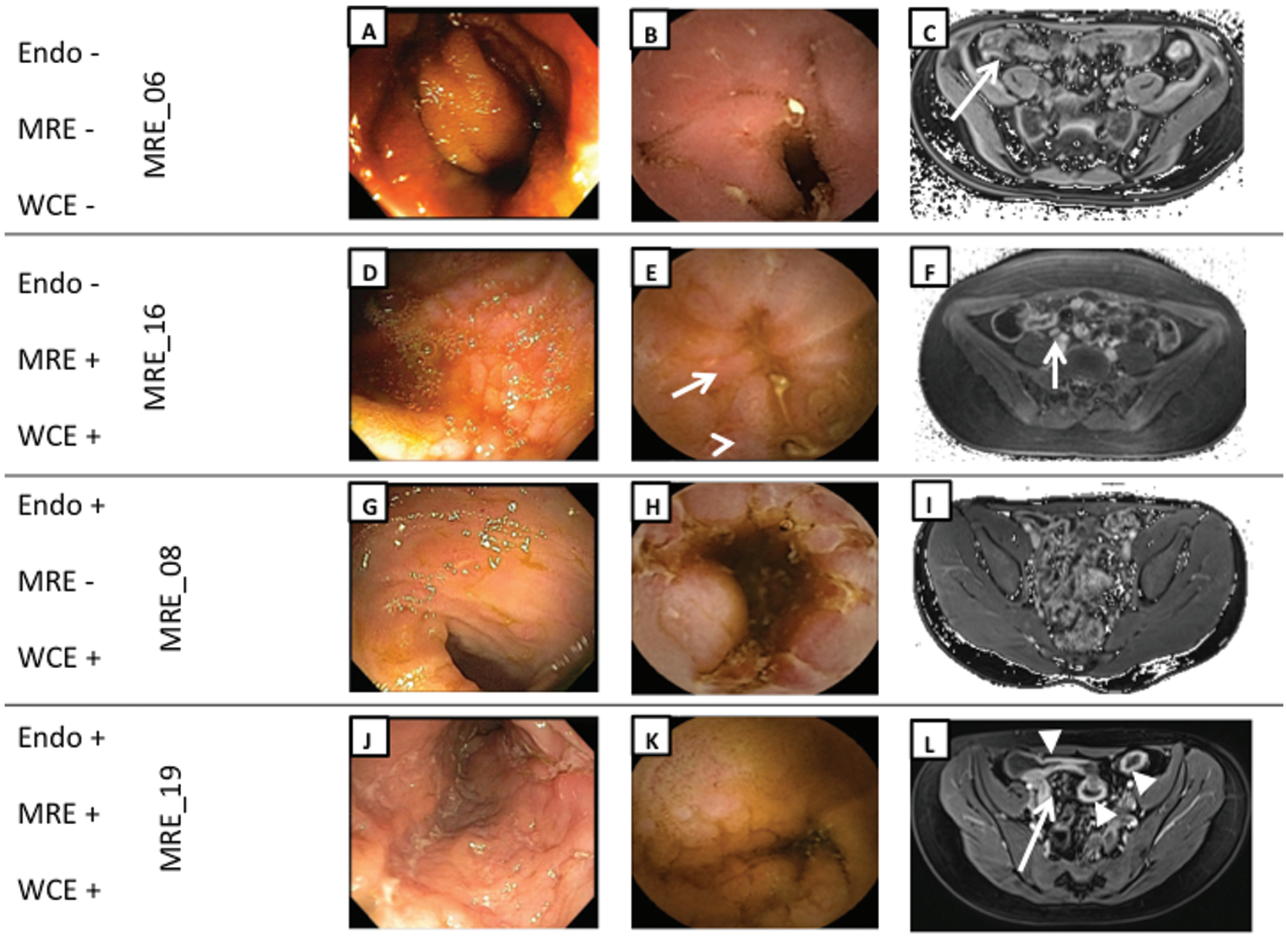

Figure 2. Representative images of terminal ileum identified by ileo-colonoscopy, wireless capsule endoscopy and magnetic resonance enterography. (A–C) Normal terminal ileum by endoscopy, wireless capsule endoscopy (WCE) and magnetic resonance enterography (MRE): A) Endoscopy, B) WCE image demonstrating normal villi and no ulcerations, C) Axial T1 VIBE Sequences post-Gadolinium demonstrating normal terminal ileum (arrow) which enhances to the same extent as other bowel. (D–F) Normal terminal ileum by endoscopy, but active disease by WCE and MRE: D) Endoscopy, E) WCE demonstrating an aphthous ulcer (arrow), a deeper ulceration (arrowhead) and intervening villous edema, F) Axial T1 VIBE Sequence post-Gadolinium demonstrating a narrowed thickened short segment of terminal ileum (arrow) with bowel wall enhancement possibly reflecting an inflammatory stricture. (G–I) Active disease terminal ileum by endoscopy and WCE, but negative MRE: G) Endoscopy, with scattered aphthous ulcers H) WCE demonstrates circumferential ulceration with narrowing of the lumen, I) Axial T1 VIBE Sequences post-Gadolinium demonstrating a nonthickened terminal which enhances (arrow heads) only mildly with no other findings. This represents MR-negative disease. (J–L) Active disease documented on all three examinations. J) Endoscopy demonstrates linear ulcerations, mucosal thickening (edema) and loss of vascular pattern K) WCE demonstrates Villous edema is seen in the lower left hand corner of the image, L) Axial T1 VIBE Sequences post-Gadolinium demonstrates bowel wall thickening and enhancement postcontrast (arrow heads) with hyperemia in the engorged vasa recta (arrow).

of patients were in clinical response and 68.4% in clinical remission, and at 2 years 75% were in clinical response and 68.8% in clinical remission. With further subdivision of patients based on MRE and WCE findings, in the eight patients with active SB disease identified on WCE but not MRE, four (20%) were initiated on an anti-TNF agent (alone three, or in combination with IM one), and four on an immune modulator (two initially in combination with prednisone). Six patients (75%) were in clinical/biochemical remission at 2 years follow-up. Of the nine patients with SB disease identified by both MRE and WCE, four commenced an anti-TNF agent and were in clinical/biochemical remission at 2 years follow-up.

Discussion

The findings of this study suggest that in children with newly diagnosed CD WCE complements MRE and ileo-colonoscopy in detecting macroscopically active inflammation in the TI, is superior to MRE in identifying SB inflammation other than TI inflammation, and the distribution of SB inflammation is more extensive when characterized by WCE.

Using the 12 of 18 patients with active endoscopic disease as the reference standard, our data demonstrate a positive predictive value of 82% for MRE and 86% for WCE in the detection of TI inflammation. The high level of agreement between readers of MRE and WCE studies (equivalent or better than that

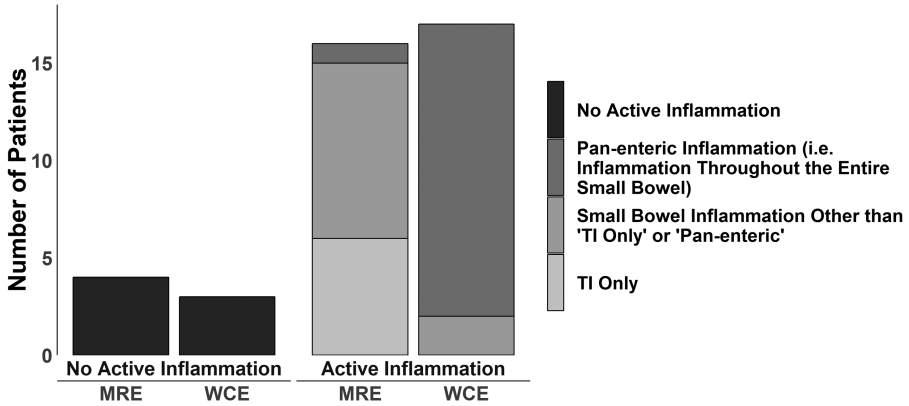

Figure 3. Distribution of active small bowel inflammation as determined by magnetic resonance enterography or wireless capsule endoscopy. MRE, Magnetic resonance enterography; TI, Terminal ileum; WCE, Wireless capsule endoscopy.

reported in the literature (22,25–28)) suggests the findings are robust. Moreover, endoscopic evaluation independent of, but including, the performing endoscopist's impression likely reduced bias associated with individual endoscopy reporting. Although studies comparing CT and endoscopy have demonstrated a phenomenon called 'endoscopic skipping of the TI' (especially with short disease duration) (29), evaluation of WCE and MRE data confirmed that active inflammation was at, or near, the ileocecal valve. Taken together these factors in association with the high level of agreement between MRE and WCE regarding TI CD activity (80%, $\kappa = 0.55$, $P < 0.01$), especially among those where endoscopy demonstrated no TI activity, argue that the MRE and WCE data represent true findings, and suggest that these investigations are sensitive for evaluating TI CD. Further research is required to validate these findings.

In contrast to the TI, the jejunum and ileum have less frequently been used for comparative evaluation of diagnostic modalities. Where consensus opinion has been used by investigators as the reference standard, where findings cannot be validated by ileocolonoscopy, the sensitivity of WCE in detecting paediatric SB CD appears similar, and the sensitivity of MRE lower, to that seen in the TI (30,31). Similar findings regarding MRE are reported in the adult literature where surgical evaluation was used as the reference standard (32). When WCE and MRE have been directly compared, WCE demonstrates superiority in detecting SB mucosal lesions (12,14,15,33), although a recent paediatric study using MEGS for quantitative evaluation, reported similar detection rates with both modalities (16). Consistent with the literature, agreement between WCE and MRE in this study was less compelling for the SB than for the TI. Indeed, this study showed a significantly higher sensitivity of WCE for detecting jejunum and ileum disease compared to MRE (85% versus 50%, $P = 0.04$), and identified inflammation throughout the SB in a significantly greater number of patients than MRE (15 versus 1, $P < 0.001$, Figure 3). Although WCE is known to be poor at localizing findings (25,34), because both the duodenum and TI act as localizing points, documentation of inflammation overall throughout the SB is a more robust finding than specific site of demarcation. Notably, MRE missed patients with mild inflammation ($n = 3$), but detected all patients with deep ulcers ($n = 14$).

Sorrentino and Nguyen recently reported that WCE findings changed management in 12 of 23 (52%) cases with 83% showing clinical/biochemical improvement at up to 18 months follow-up (35). In our study, WCE led to early initiation of anti-TNF therapy in 4 of 20 (20%) patients, while WCE and MRE resulted in an additional 4 patients commencing early anti-TNF therapy with 7 (88%) achieving and maintaining clinical/biochemical remission at 2 years follow-up.

Among CD patients, incomplete WCE studies are reported in up to 29% of studies (36). Even with a negative imaging study, 5% of capsule examinations may not be completed (37,38). Conversely, the use of a patency capsule prior to WCE in all CD patients appears to offer little benefit in reducing the risk of clinically significant capsule retention; while the risk of retention is fivefold higher in those with a positive patency study, 90% of capsules will pass spontaneously (39). In our series, no significant retention episodes occurred, although in one individual where capsule progress was halted at an inflammatory stricture (not included in the analysis), corticosteroid treatment resulted in spontaneous capsule passage. The presence of dilated SB on MRE, suggestive of a potential SB stricture, did not correlate with either stenosis on WCE or with capsule retention. However, in patients with symptoms suggestive of obstruction, or evidence of SB dilation on MRE, a patency capsule should be considered. Moreover, in patients with evidence of severe diffuse SB inflammation on MRE, WCE is unlikely to alter management and should be avoided.

The strengths of this study include a newly diagnosed cohort of CD patients and the robust objective data analysis utilizing independent readers. However, we acknowledge the study limitations, particularly of applying adult scoring systems. The SES-CD has not been validated in paediatrics, nor is the

reporting of endoscopic findings universally consistent. The MRI scoring system utilized is similar to other scoring systems based on bowel wall thickness, bowel wall enhancement and extramural findings (20,40) and reflects our imaging clinical practice (41,42). The MaRIA score, may be more accurate in adults, but is complicated to use and remains predominantly a research tool (43) and in paediatrics no single MRE scoring system is universally used. The time interval between investigations could potentially have led to changes in disease activity, although treatment was not initiated until investigations had been completed. Finally, we acknowledge the limited power; a problem frequently encountered in paediatric clinical research (44). Despite the limited sample size, our findings suggest that WCE is at least equivalent to MRE and ileo-colonoscopy in its ability to identify active TI inflammation and appears superior to MRE in the detection of SB disease proximal to the TI. This is particularly relevant in instances where children may not be able to have an MRE due to the need for sedation or where there are issues relating to use of oral or intravenous contrast; WCE (albeit potentially endoscopically placed) provides an additional way of investigating SB involvement. It is also important to note that the study only assessed patients with no/mild findings on MRE and consequently may not be generalizable to patients with more significant disease in the small bowel.

Early in the course of paediatric CD when clinically significant stricturing disease is rare, WCE can be included as a complementary study to MRE for full evaluation of the small bowel particularly at centers where WCE is routinely used in clinical practice. WCE should not be utilized in the presence of suspected high-grade SB stricture and for evaluation of extraluminal complications.

SUPPLEMENTARY DATA

Supplementary data are available at *Journal of the Canadian Association of Gastroenterology* online.

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