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Research Article

Diagnostic Utility of MR Enterography in Small Bowel Pathologies: A Prospective Observational Study

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Abstract: ***Introduction:*** **Aim:** The small bowel is difficult to evaluate because of its length, tortuosity and mobility, and conventional techniques carry limitations of radiation exposure and restricted transmural assessment. Magnetic resonance enterography (MRE) offers radiation-free, high-soft-tissue-contrast, multiplanar imaging with functional (cine) evaluation. This study was undertaken to evaluate the diagnostic utility of MRE and to characterise the spectrum of imaging findings in patients with suspected small bowel disease.**Materials & Methods:** This prospective observational study included 66 patients referred to the Department of Radiodiagnosis over 18 months with clinical suspicion of small bowel disease, unexplained abdominal pain, chronic right iliac fossa pain, malabsorption or obscure gastrointestinal bleeding. All patients underwent static and cine MRE on a 1.5-T scanner following biphasic oral contrast (polyethylene glycol) distension and intravenous antispasmodic. Bowel wall thickness, segment length of involvement, site of involvement and ancillary signs were recorded. Findings were correlated with clinical and histopathological follow-up. **Results:** The mean age was 41.1 ± 15.1 years (range <20 to >60 years) with a slight female predominance (51.5%). Diarrhoea (n = 39) and abdominal pain (n = 33) were the commonest presentations. MRE demonstrated abnormal findings in 40 patients (60.6%). The terminal ileum and ileal/proximal ileal segments were most frequently involved (each 13.6%), followed by ileocaecal involvement (6.1%) and skip lesions / comb sign (7.6%). Mean bowel wall thickness was 5.4 ± 3.0 mm, and mean length of involved segment was 11.3 ± 5.2 cm.**Conclusion:** MRE is a valuable, non-invasive, radiation-free modality that yielded abnormal findings in the majority of patients with suspected small bowel disease, most often affecting the terminal ileum. It reliably depicts mural thickening, disease extent and extramural complications, and is well suited to diagnosis and longitudinal monitoring, particularly in inflammatory bowel disease.

Keywords: MR enterography; small bowel; Crohn's disease; inflammatory bowel disease; cine MRI; terminal ileum.

INTRODUCTION

The small bowel comprises a major portion of the gastrointestinal tract and is responsible for most nutrient absorption, yet it has historically posed considerable diagnostic difficulty because of its length, convoluted anatomy, mobility and relative inaccessibility to conventional endoscopy. Small bowel follow-through, barium studies and enteroclysis have long been used to evaluate small bowel disorders, but these techniques are time-consuming, involve ionising radiation and provide limited assessment of the bowel wall and extramural disease [1,8].

Cross-sectional imaging has substantially changed this landscape. Computed tomography enterography provides excellent mural and extramural detail and rapid acquisition, but its dependence on ionising radiation limits its use in young patients and in those requiring repeated follow-up [10]. Magnetic resonance enterography (MRE) has emerged as a powerful, non-invasive alternative that combines enteric distension with cross-sectional imaging, offering superior soft-tissue contrast, multiplanar capability and functional assessment without ionising radiation [2,11]. It permits evaluation of both intraluminal and extraluminal disease and is particularly valuable in Crohn's disease, small bowel neoplasms, obscure gastrointestinal bleeding and vascular or ischaemic conditions, enabling assessment of disease activity, complications and treatment response [2,14].

A recognised strength of MRE is its ability to differentiate active inflammatory change from established fibrosis and to depict extramural complications such as fistulae, abscesses and stricturing disease that are not visible at endoscopy [3,17]. Cine (dynamic) MRE additionally allows real-time assessment of bowel motility, adding a functional dimension to morphological imaging. Against this background, the present study was undertaken to evaluate the diagnostic utility of MRE and to characterise the spectrum of imaging findings in a cohort of patients presenting with clinical suspicion of small bowel disease.

MATERIALS AND METHODS

Study design and population
This prospective observational study was conducted in the Department of Radiodiagnosis over a period of 18 months. Sixty-six consecutive patients referred for MRE and meeting the eligibility criteria were enrolled. Written informed consent was obtained from every patient prior to enrolment, and the study was conducted after institutional ethics committee approval.

Inclusion criteria
Patients of any age with a strong clinical suspicion of small bowel disease were included, comprising suspected inflammatory bowel disease, unexplained abdominal pain, chronic right iliac fossa pain, a history of malabsorption, and unexplained (obscure) gastrointestinal bleeding.

Exclusion criteria
Patients with a general contraindication to MRI, acute bowel obstruction, acute or emergent symptoms, severe vomiting, critical illness, or those who declined consent were excluded.

Bowel preparation and oral contrast protocol
Patients fasted for a minimum of 6 hours before the study; clear liquids were permitted during this period, and no laxatives or enemas were administered. On arrival, patients ingested 1200–1500 mL of polyethylene glycol (PEG) with electrolytes over approximately 50 minutes as a divided dose, each portion consumed over about 25 minutes to achieve even distension of the small bowel. Oral metoclopramide (10 mg) was given with the first portion to promote gastric emptying, and a further 200 mL of oral contrast was given immediately before imaging to opacify the stomach and duodenum.

MRI technique
Approximately one hour after commencing oral contrast, imaging was performed on a 1.5-T scanner (Magnetom Avanto, Siemens, Erlangen, Germany) using a phased-array abdominal coil. Prior to acquisition, 1 mg of intravenous hyoscine butylbromide (buscopan) was administered to minimise peristaltic motion artefact. The protocol comprised T1- and T2-weighted sequences in coronal and axial planes with fat suppression, diffusion-weighted imaging, and gadolinium-based dynamic post-contrast T1-weighted imaging. Cine (balanced steady-state free precession) sequences were acquired for functional assessment of bowel motility. Standardised breathing instructions were given throughout.

Image analysis
Images were evaluated for site of involvement, bowel wall thickness, length of involved segment, mural and stratified enhancement, restricted diffusion, the comb sign, skip lesions, strictures, lymphadenopathy and extramural complications. Wall thickness exceeding 3 mm was regarded as abnormal. Bowel motility was assessed on cine sequences as normal, hypomotile, hypermotile or absent. Imaging findings were correlated with clinical and histopathological follow-up.

Statistical analysis
Data were tabulated and analysed using descriptive statistics. Categorical variables are expressed as frequencies and percentages, and continuous variables as mean ± standard deviation (SD).

RESULTS

Age distribution
The age of the study population ranged from below 20 years to over 60 years. The largest proportion of patients was in the 50–60-year group (25.8%), followed by the 30–39-year (19.7%) and 20–29-year (18.2%) groups. The mean age was 41.1 ± 15.1 years (Table 1).

Table 1. Distribution of cases according to age

Age group (years)	No. of cases (n)	Percentage (%)
<20	**6**	**9.09**
20–29	**12**	**18.18**
30–39	**13**	**19.70**
40–49	**11**	**16.67**
50–60	**17**	**25.76**
>60	**7**	**10.61**
Total	**66**	**100.00**
Mean ± SD	**41.12 ± 15.12**	

Gender distribution

There was a slight female predominance: 34 patients (51.5%) were female and 32 (48.5%) were male (Table 2).

Table 2. Distribution of cases according to gender

Gender	No. of cases (n)	Percentage (%)
Male	**32**	**48.48**
Female	**34**	**51.52**
Total	**66**	**100.00**

Duration of symptoms

Symptom duration ranged from 2 weeks to 4 months. A 4-month duration was most frequent (30.3%), followed by 6 weeks (21.2%) and 2 weeks (19.7%) (Table 3).

Table 3. Distribution of cases according to duration of symptoms

Symptom duration	No. of cases (n)	Percentage (%)
2 weeks	**13**	**19.70**
1 month	**8**	**12.12**
6 weeks	**14**	**21.21**
3 months	**11**	**16.67**
4 months	**20**	**30.30**
Total	**66**	**100.00**

Clinical presentation

Diarrhoea was the most common presenting symptom (n = 39), followed by abdominal pain (n = 33), fever (n = 14) and gastrointestinal bleeding (n = 11). As several patients had more than one symptom, the totals exceed the number of patients (Table 4).

Table 4. Distribution of cases according to clinical presentation

Clinical presentation	No. of cases (n)
Abdominal pain	33
Diarrhoea	39
Gastrointestinal bleeding	11
Fever	14

Note: symptoms are non-exclusive; a single patient may report multiple presentations.

Prior investigations

Before MRE, ultrasonography was the most commonly performed preliminary investigation (34.9%), followed by colonoscopy (30.3%), CT abdomen (19.7%) and serological testing (15.2%) (Table 5).

Table 5. Distribution of cases according to prior investigations

Prior investigation	No. of cases (n)	Percentage (%)
Colonoscopy	20	30.30
CT abdomen	13	19.70
Serology	10	15.15
Ultrasonography (USG)	23	34.85
Total	66	100.00

MRE findings: overall yield

MRE demonstrated abnormal findings in 40 of 66 patients (60.6%), while 26 (39.4%) were reported as normal (Table 6). This high yield of abnormal findings, in a population largely investigated inconclusively by other means beforehand, underscores the value of MRE as a problem-solving modality.

Table 6. Distribution of cases according to MRE findings (overall)

MRE finding	No. of cases (n)	Percentage (%)
Normal	26	39.39
Abnormal	40	60.61
Total	66	100.00

MRE findings: site of involvement

Among the abnormal studies, the terminal ileum and ileal/proximal ileal segments were most frequently involved (each 13.6%). Skip lesions or the comb sign, indicative of active inflammation, were seen in 7.6%, ileocaecal involvement in 6.1% and rectal/colonic findings in 4.5%. Other specific pathologies (masses, strictures or lymphadenopathy) were noted in 10.6%, while isolated jejunal abnormality was rare (1.5%) (Table 7).

Table 7. Distribution of cases according to site and type of MRE finding

MRE finding	No. of cases (n)	Percentage (%)
Normal	26	39.39
Terminal ileum findings	9	13.64
Ileal / proximal ileal	9	13.64
Ileocaecal involvement	4	6.06
Rectal / colonic findings	3	4.55
Skip lesions / comb sign	5	7.58
Other specific pathologies	7	10.61
Jejunal abnormalities	1	1.52
Total	66	100.00

Bowel wall thickness

Wall thickness of ≤3 mm (within normal limits) was seen in 37.9% of patients. Mild-to-moderate thickening (4–6 mm and 7–10 mm) was seen in 28.8% each, and marked thickening (>10 mm) in 4.5%. The mean wall thickness was 5.4 ± 3.0 mm (Table 8).

Table 8. Distribution of cases according to bowel wall thickness

Wall thickness (mm)	No. of cases (n)	Percentage (%)
≤3	25	37.88
4–6	19	28.79
7–10	19	28.79
>10	3	4.55
Total	66	100.00
Mean ± SD	5.41 ± 3.04	

Length of involved bowel segment

Segment length of involvement varied widely: ≤5 cm in 16.7%, 6–10 cm in 28.8%, and 11–15 cm and >15 cm in 27.3% each, indicating relatively extensive involvement in a substantial proportion. The mean involved segment length was 11.3 ± 5.2 cm (Table 9).

Table 9. Distribution of cases according to length of involved bowel segment

Segment length (cm)	No. of cases (n)	Percentage (%)
≤5	11	16.67
6–10	19	28.79
11–15	18	27.27
>15	18	27.27
Total	66	100.00
Mean ± SD	11.27 ± 5.20	

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DISCUSSION

Evaluation of the small bowel remains challenging owing to its length, tortuosity and motility, and no single conventional technique adequately depicts both mural and extramural disease without radiation. In this prospective series of 66 patients with suspected small bowel disease, MRE demonstrated abnormal findings in 60.6% of patients, most of whom had already undergone inconclusive ultrasonography, colonoscopy, CT or serological testing. This high diagnostic yield in a pre-investigated population supports the established role of MRE as a problem-solving and disease-characterising modality in small bowel disease [2,11].

The demographic profile—a mean age of 41 years, a wide age range and a slight female predominance—is consistent with the epidemiology of inflammatory small bowel disease reported in the literature. The predominance of diarrhoea and abdominal pain as presenting complaints likewise reflects the typical clinical spectrum that prompts small bowel imaging [15]. The distribution of disease in our cohort mirrors the known predilection of Crohn's disease for the distal small bowel: the terminal ileum and ileal/proximal ileal segments were the most frequently involved sites, with only a single case of isolated jejunal disease. This pattern is in keeping with the enterographic manifestations of small bowel Crohn disease described by Tolan et al. and others [1,6]. Mural thickening was a central finding, with a mean wall thickness of 5.4 mm and thickening beyond the normal 3 mm threshold in the majority of abnormal studies; bowel wall thickness is a well-recognised and reproducible MRE marker of disease and, together with mural hyperenhancement, correlates with activity [18,20].

Ancillary signs of active inflammation, including the comb sign and skip lesions, were identified in 7.6% of patients, and extensive segmental involvement (>10 cm) was common—features that carry implications for disease severity and management. The ability of MRE to depict such transmural and extramural changes, along with strictures, lymphadenopathy and other complications, is a key advantage over endoscopic techniques, which are limited to the mucosal surface [17,19]. A particular strength of MRE, repeatedly emphasised in the literature, is its capacity to distinguish active inflammatory strictures from fibrotic ones—a distinction that directly influences the choice between medical and surgical management [3].

Compared with CT enterography, MRE offers equivalent depiction of mural and extramural disease while avoiding ionising radiation, an advantage of particular importance in young patients and in those with chronic relapsing disease who require repeated follow-up [10,17]. The addition of diffusion-weighted imaging and dynamic contrast enhancement improves sensitivity for active inflammation, while cine sequences add a functional assessment of bowel motility that is not available with other cross-sectional techniques [14]. Reported sensitivities and specificities for MRE in detecting active small bowel inflammation are of the order of 80–90% in the published literature [17,20], and our high yield of clinically relevant findings is consistent with that experience.

This study has limitations. It was a single-centre observational study with a modest sample size, and the descriptive design precludes formal calculation of diagnostic accuracy against a uniform reference standard in the present analysis. MRE also has recognised limitations—longer acquisition times with susceptibility to motion artefact, dependence on adequate bowel distension, limited depiction of superficial mucosal lesions relative to endoscopy, higher cost and limited availability—which should be considered when selecting the modality [20,23]. Larger multicentre studies with systematic histopathological correlation would further define the diagnostic performance of MRE across the range of small bowel pathologies.

CONCLUSION

MR enterography is a valuable, non-invasive and radiation-free imaging modality for the evaluation of small bowel disease. In this cohort it yielded clinically relevant abnormal findings in the majority of patients presenting with suspected small bowel pathology, most commonly involving the terminal ileum, and reliably depicted mural thickening, the extent of involvement and ancillary signs of active inflammation. With its superior soft-tissue contrast, multiplanar and functional (cine) capabilities, and freedom from ionising radiation, MRE is well suited both to initial diagnosis and to longitudinal monitoring of small bowel disease, particularly inflammatory bowel disease, and its role in gastrointestinal radiology is likely to continue to expand.

DECLARATIONS

Ethics approval and consent: The study was approved by the institutional ethics committee; written informed consent was obtained from all participants.
Conflicts of interest: The authors declare no conflicts of interest.
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