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Magnetic Resonance Enterography in Crohn's Disease

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Over the past decade, magnetic resonance (MR) enterography has become established as the first-line imaging test for patients with Crohn's disease. This article reviews the role of MR enterography in assessing the extent and activity of Crohn's disease at baseline and on treatment follow-up. It discusses the role of diffusion-weighted imaging, and the recent introduction of MR scoring systems to facilitate noninvasive objective assessment of disease activity and cumulative bowel damage.
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Introduction

Crohn's disease (CD) is a chronic inflammatory bowel disease of multifactorial etiology that may affect any part of the gastrointestinal tract from mouth to anus. CD is more common in Europe and North America and has a U.K. incidence of 83 per million people.[1] Patients typically present with this disease in adolescence and young adulthood, thus the effect of this chronic and often disabling condition on both the health service and economy is significant. The histologic hallmark of CD is cryptitis and granuloma formation. Transmural ulceration may result in penetrating complications such as abscess and fistula formation.

In the past decade, magnetic resonance enterography (MRE) has become established as the preferred first-line imaging technique for the evaluation of small bowel involvement in CD. Although the gold standard diagnostic test for CD remains ileocolonoscopy and terminal ileal biopsy, the small bowel remains relatively inaccessible to endoscopic assessment. MRE now has a well-established role in supporting the diagnosis of CD, grading of disease severity, and assessment of extraenteric and penetrating disease. It is also becoming increasingly used in the subjective and objective assessment of treatment response.[2]

This article outlines the advantages of MRE over other cross-sectional imaging techniques, briefly describes the technique and sequences used, outlines the imaging characteristics of active, penetrating, and fibrotic disease, and provides an update on the more recent research in this area, in particular the use of diffusion-weighted imaging (DWI), assessment of fibrosis, and the development of MRE scoring systems.

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Comparison of MRE to Other Imaging Modalities

MRE has several advantages over other imaging modalities. It does not involve the use of ionizing radiation that is of particular importance, given that the patients to be imaged are often young and may require multiple studies during the course of their disease. MRE is noninvasive and often better tolerated than enteroclysis that requires nasojejunal intubation and has the additional disadvantages of being both time consuming and involving the use of ionizing radiation. Although MR enteroclysis does result in improved small bowel distension and is thus better able to detect proximal disease, several studies have demonstrated that this does not significantly affect clinical outcomes when compared with MRE.[3,4] Additionally, recent technological advances have resulted in improved diagnostic quality of MRE sequences, for example, improved tissue contrast and edge sharpness with updated 3D gradient-echo sequences.[5]

MRE provides high tissue contrast images of the entire bowel wall and can provide detailed information regarding bowel wall enhancement patterns. This facilitates distinction between predominantly inflammatory vs fibrotic disease and can aid decision-making regarding medical vs surgical treatment. MRE has both multiplanar and multiphasic capability, facilitating the assessment of bowel motility; thus, one can

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differentiate between transiently collapsed bowel segments and true strictures. The multiphasic capability of MRE also allows bowel wall enhancement to be assessed at multiple time points. MRE is also able to assess for the presence of penetrating disease, a distinct advantage of MRE over non–cross-sectional diagnostic modalities.

Table 1 provides a detailed comparison of MRE with other imaging techniques, namely ileocolonoscopy, capsule endoscopy, MR enteroclysis, CT, and barium follow-through. It should be noted that CT continues to play an important role in the emergency setting, for example, patients presenting with acute small bowel obstruction or bowel perforation.

Table 1 Comparison Between Commonly Available Diagnostic Techniques for Assessment of Crohn's Disease

	Ileocolonoscopy	Wireless Capsule Endoscopy	MRE	MR Enteroclysis	CT	Barium Follow-Through
Radiation	No ionizing radiation	No ionizing radiation	No ionizing radiation	Yes (for purposes of nasojejunal tube insertion)	Ionizing radiation	Ionizing radiation
Invasive	Yes	No	No	Yes, as involves nasojejunal tube insertion	No	No
Detect early disease	Yes, can detect superficial aphthous ulceration	Yes, can detect superficial aphthous ulceration	Limited ability to detect early disease	Better than MRE at detecting early disease	No	Yes, can detect superficial aphthous ulceration
Assess entire bowel wall	Assess mucosa only	Assess mucosa only	Can clearly depict mucosa, submucosa, and serosa	Can clearly depict mucosa, submucosa, and serosa	Depicts entire bowel wall but tissue contrast is inferior to MRE	Assess mucosa only
Assess extraluminal complications	Cannot assess for extraluminal complications	Cannot assess for extraluminal complications	Can depict extraluminal complications, eg, fistulae and abscesses	Can depict extraluminal complications, eg, fistulae and abscesses	Can depict extraluminal complications, eg, fistulae and abscesses	May detect fistulae, however, cross-sectional techniques are superior

Technique

MRE technique differs slightly between institutions; however, there are several universally recognized principles as follows.

Good luminal distension of the small bowel is essential, and most institutions advocate ingestion of 1000-1500 mLs of oral contrast approximately 40 minutes before imaging. Several types of oral contrast agent are available; however, most institutions prefer a biphasic agent, for example, mannitol or polyethylene glycol. Biphasic agents are hyperintense on T2-weighted sequences, thus enabling assessment of bowel wall thickness, and hypointense on T1-weighted sequences, allowing optimal depiction of bowel wall enhancement on T1-weighted fat-saturated sequences. Negative-contrast agents (low T1 and low T2), comprising superparamagnetic iron oxide agents, result in improved visualization of bowel wall edema but are poorly tolerated, whereas positive contrast agents, for example, dilute gadolinium and manganese-containing fruit juices (high T1 and high T2), give information on bowel transit but result in poorer depiction of bowel wall enhancement.[6]

Bowel peristalsis should be minimized with the use of an antiperistaltic agent unless contraindicated, for example, 20 mg of buscopan or 1 mg of glucagon (intravenous or intramuscular route). T1-weighted breath-hold 3D gradient-echo postcontrast sequences are susceptible to motion artifact, and therefore most institutions administer an antiperistaltic agent directly before this sequence or as a split dose (initial bolus before examination itself and second bolus before gradient-echo sequence).[7]

Optimal patient positioning is also important. Patients are ideally imaged prone, as this compresses the abdomen and reduces the number of coronal sections, distends the bowel, and limits peristalsis. Caveats to this include pregnancy, presence of a stoma, or abdominal wall fistulae. The MRE protocol used at our institution is as shown in Table 2.

Rationale for Sequences

T2-Half-Fourier Acquired Single-Shot Turbo Spin-Echo

T2-half-fourier acquired single-shot turbo spin-echo (HASTE) sequences are used to assess mural thickness and edema and