Magnetic Resonance Enterography for Inflammatory and Noninflammatory Conditions of the Small Bowel

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KEYWORDS

• MR enterography • Crohn's disease • Small bowel

KEY POINTS

- Magnetic resonance enterography (MRE) is an effective noninvasive means to assess disease activity in Crohn disease (CD) patients on a recurrent basis without exposure to ionizing radiation.
- Elements of successful MRE technique typically include patient preparation, good bowel distention with biphasic enteric contrast, use of anti-peristaltic agents, administration of a gadolinium-based contrast agent, and acquisition of cine images.
- CD findings on MRE correlate with disease status and can be used to guide management and assess response to therapy.
- MRE can depict findings of active inflammatory CD, fibrostenotic CD, penetrating CD, quiescent or inactive CD, as well as enteric and extraenteric complications.
- Cine images acquired as part of MRE protocol assist in differentiating luminal narrowing secondary to active inflammation from luminal narrowing due to fibrostenotic disease.

INTRODUCTION

Over the last several years, cross-sectional imaging has replaced fluoroscopic techniques for the evaluation of select inflammatory and noninflammatory conditions of the small and large bowel. Computed tomography (CT) and magnetic resonance (MR) enterography are routinely performed for assessment of inflammatory bowel disease (IBD), small bowel neoplasms, bowel obstructions, infection, or for systemic conditions, such as celiac disease or systemic sclerosis. These cross-sectional techniques allow for direct visualization of the bowel wall and better detection for extraenteric complications.[1] Visualization in multiple planes allows for easier separation and tracking of bowel segments and associated abnormalities.

MR and CT enterography have similar diagnostic accuracy for detection of findings of active small bowel Crohn disease (CD)[1–3]; however, magnetic resonance enterography (MRE) may be superior in terms of stricture detection.[2] MRE costs more and takes longer to perform than computed tomography enterography (CTE). Other

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limitations of MRE include variable image quality related to patient and technical factors; however, MRE avoids exposure to ionizing radiation and iodinated contrast. The lack of exposure to ionizing radiation is particularly advantageous in young CD patients who require multiple examinations over time to evaluate disease status. Gadolinium-based contrast agents (GBCAs) used for MR imaging are not nephrotoxic at approved doses, but caution should be used when administering GBCAs to patients with renal insufficiency. MR imaging also offers superior soft tissue contrast resolution, which assists in detecting abnormal enhancement, edema, and mural fibrosis. The lack of exposure to ionizing radiation during MRE allows for multiple acquisitions at various time points and phases of contrast enhancement. Dynamic cine imaging provides functional information about motility and helps differentiate transient narrowing of bowel segments from persistent strictures. Newer MR imaging techniques also offer higher spatial resolution, allowing for subtle details such as linear ulcers to be detected. Utilization of proper, efficient technique and interpretive expertise allows one to leverage these advantages of MRE to improve diagnosis and management of small bowel disease. In this article, the authors review optimal MRE technique, demonstrate its application to various disease processes afflicting the small bowel, discuss pearls and pitfalls that may be encountered during image acquisition and interpretation, and discuss reporting strategies.

TECHNIQUE

Patient Preparation

Optimal MRE technique requires patient preparation before image acquisition. Appropriately timed administration of a sufficient volume of oral contrast material facilitates adequate distention of the bowel. Oral contrast agents used for MRE can be categorized as positive contrast agents, negative contrast agents, or biphasic agents. Positive contrast agents result in high intraluminal signal intensity (SI) on both T1-weighted (T1w) and T2-weighted (T2w) images and include paramagnetic substances, such as dilute gadolinium solutions, or manganese-containing liquids, including low concentrations of blueberry juice.[4,5] Positive enteric agents depict bowel wall thickening well; however, the high SI luminal contents obscure mucosal enhancement on postcontrast T1w images. Negative contrast agents such as superparamagnetic iron oxide solution or air induce low SI in bowel lumen on both T1w and T2w sequences[5] and allow for visualization of bowel wall edema and perienteric inflammatory changes on T2w images, and mucosal enhancement on T1w postcontrast images, although susceptibility artifact can degrade bowel wall visualization on gradient echo– and echo planar–based diffusion-weighted sequences and obscure low SI intraluminal lesions.[6] The most commonly used MRE contrast agents are biphasic, exhibiting high SI on T2w images (allowing for detection of wall thickening, endoluminal abnormalities, and transmural ulcers) and low SI on T1w images (enhancing detection of mucosal enhancement and hypervascular endoluminal masses).[6] Examples of biphasic contrast agents include water, polyethylene glycol (PEG), mannitol, and sorbitol-containing 0.1% barium sulfate (SCBS) solution. Because of their osmotic properties, PEG and SCBS solution provide better bowel distention than water. Water fails to provide adequate distal bowel distention but is better tolerated with a lower incidence of side effects and does not incur additional cost.[7] At the authors' institution, patients are asked to remain fasting before the examination and to ingest 900 mL of SCBS solution starting 45 minutes before the examination. They are instructed to ingest the oral contrast at a steady pace to obtain uniform distention throughout the small bowel. Immediately before supine positioning on the MR table, patients ingest one 16-ounce cup of water to distend the stomach and duodenum. Multichannel phased-array torso coils are used to cover the abdomen and pelvis. Images from initial sequences are assessed to ensure adequate small bowel distention before further image acquisition. The authors administer additional oral contrast or water if needed for adequate bowel distention as discussed in the pearls and pitfalls section.

Imaging Protocol

The standard MRE protocol at the authors' institution as published previously (**Table 1**)[8] includes thick-slab (40 mm) 2-dimensional (2D) heavily T2w single-shot fast spin echo (SSFSE) sequences with fat suppression (FS) and balanced fast field echo (BFFE) sequences. Each of these sequences is acquired in the coronal plane from anterior to posterior repeatedly over 2.5 minutes. The images are sorted by slice location and viewed as cine-loops, thus allowing for visualization of bowel wall and change in luminal content over time. An important technical consideration after completion of these cine-type sequences is the administration of an