New Magnetic Resonance Imaging Modalities for Crohn Disease

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KEYWORDS

• MR enterography • Crohn disease • DWI • DCE-MR imaging • Small bowel

KEY POINTS

- Three types of sequences constitute a basic magnetic resonance (MR) enterography protocol: single-shot fast spin echo, balanced refocused gradient echo, and fat-suppressed three-dimensional T1 gradient echo.
- High-resolution MR enterography, diffusion-weighted imaging, dynamic contrast-enhanced MR imaging, magnetization transfer, and MR motility imaging are newer techniques that may further enhance the accuracy of MR enterography.
- The goals of imaging in Crohn disease are accurate diagnosis and localization and assessing disease severity, activity, and extent. Assessing disease activity and the presence of penetrating disease have significant implications for the choice of therapy.

INTRODUCTION

Magnetic resonance (MR) enterography is playing an increasing role in the evaluation of the small bowel in patients with Crohn disease (CD). Conventional enteroclysis or small bowel follow-through have been used to evaluate the small bowel; however, with advances in technology, several cross-sectional imaging modalities including computed tomography (CT), MR imaging, positron emission tomography CT, and ultrasound are now available for small bowel imaging. The aim of imaging is to aid in the accurate assessment of the extent, severity, activity, and complications of CD. This role remains the subject of active research with numerous studies and publications in the past decade.[1]

This review article discusses the conventional and emerging MR enterography sequences, and reviews the small bowel imaging findings of CD on MR imaging and the clinical role of MR imaging in the diagnosis of CD and monitoring therapy.

Pathology

CD is an idiopathic, chronic, transmural inflammatory disease that can affect any part of the gastrointestinal tract. It has a tendency toward segmental multifocal distribution. The causes and pathogenesis are not completely understood but are thought to be multifactorial. It is commonly complicated by fistulas, abscesses, bowel obstruction, and neoplasms. CD most commonly affects the small bowel, particularly the terminal ileum. About 70% of patients have small bowel involvement and about 30% have disease limited to the small bowel.[2]

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Clinical Presentation, Evaluation, and Management

The classic presentation of CD is abdominal pain, weight loss, and diarrhea; however, it can have various presentations and tends to have an unpredictable course marked by flares, remissions, and relapses. CD most commonly occurs in early adulthood with a second peak in the elderly. Its diagnosis is based on a combination of clinical findings, endoscopic appearance, biopsy, radiological studies, and/or biochemical markers.[3] Most commonly, ileocolonoscopy and biopsies from the terminal ileum and colon are used to establish the diagnosis. In clinical practice, CD is stratified by disease severity (mild, moderate, or severe), disease location (upper gastrointestinal, ileal, ileocolonic, colonic, or perianal), extent of disease, and disease phenotype (penetrating, stricturing, or inflammatory).[4] Clinical scoring systems have been developed to assess disease severity and activity, the most common of which is the Crohn Disease Activity Index (CDAI), which has been used in many clinical trials; however, it is inconclusive on the severity of the disease.[5,6]

The management of CD is divided into medical therapies and surgical therapies. Therapeutic options are determined by an assessment of the disease location, severity, and extraintestinal complications.[7] Surgery is typically used to treat the penetrating and stricturing complications of CD as well as neoplastic/preneoplastic lesions, suppurative complications, or medically intractable disease.[4,7] Many patients require surgery during the course of the disease; however, surgery is not curative and the disease recurs in most patients within 5 years. Several medical therapies are used in treatment of CD, including corticosteroids, immunomodulators (such as azathioprine, mercaptopurine, and methotrexate), and biologic agents (such as tumor necrosis factor [TNF] alpha inhibitor). The goal of therapy is to induce and maintain symptomatic control, improve quality of life, and minimize short-term and long-term toxicity and complications. A newer goal of therapy is the induction and maintenance of mucosal healing.[7]

MR Enterography Technique

The small bowel is first distended by oral contrast agents. In MR enterography, a large volume of enteric contrast is ingested by the patient over a period of 1 to 2 hours before the onset of the scan. MR enterography is generally preferred to MR enteroclysis because of its comparable performance[8,9] and patient acceptance.[10,11] The most commonly used type of oral contrast agents are biphasic agents that have low T1-weighted signal, which provides good visualization of wall enhancement, and have high T2-weighted signal, which allows assessment of the wall and fold thickness. A spasmolytic agent, such as glucagon, is usually administered before the scan to reduce bowel peristalsis.

Three types of sequences constitute a basic MR enterography protocol: half-Fourier acquisition single-shot turbo spin echo (HASTE), also known as single-shot fast spin echo (SSFSE); balanced refocused gradient echo, also known as balanced steady-state free precession (SSFP), fast imaging using steady-state acquisition (FIESTA), balanced fast field echo (FFE), fast imaging with steady-state precession (true FISP); and postcontrast fat-saturated three-dimensional (3D) T1-weighted ultrafast GRE. In the literature, SSFSE and true FISP sequences are considered complimentary and they are both commonly included in MR enterography protocols. We mostly rely on T2-weighted SSFSE images and, in most cases, have not found true FISP sequences as helpful. In addition to these standard sequences, T2-weighted turbo spin echo (TSE) sequence with fat suppression could be useful to improve the conspicuity of bowel wall edema, but their use is not standard.

Contrast-enhanced images are obtained using T1-weighted ultrafast GRE sequences with fat suppression, which are acquired in 2 or 3 dimensions. The postcontrast images are helpful in evaluating the extent and severity of the disease[12] and are better at visualizing mural stenosis.[13,14] There is no agreement on the optimal scan delay. Inflamed bowel segments enhance early compared with the normal small bowel segments, and enhancement keeps increasing into the delayed phases of 5 to 6 minutes after contrast enhancement. Normal jejunal segments enhance early and more intensely compared with ileal segments. In addition, nondistended small bowel segments may also mimic increased enhancement due to inflammation. One main advantage of MR enterography is that multiple phases of contrasts could be obtained and dynamic contrast enhancement techniques have the potential to provide quantitative parameters to assess wall enhancement and, therefore, disease activity.[15]

ADVANCES IN MR ENTEROGRAPHY TECHNIQUE

High-resolution Images

High-resolution sequences provide the potential for focused evaluation of a small segment of small bowel that is suspected of having disease. In an article by Sinha and colleagues,[16] high-resolution