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Seminars in ULTRASOUND CT and MRI

Pearls and Pitfalls in MR Enterography Interpretation for Pediatric Patients

SG Harrington, MD, MSc,* MK Johnson, MD, MPH,* MLC Greer, MBBS,† and Michael S. Gee, MD, PhD*

Magnetic resonance (MR) enterography is now the preferred modality for evaluation of acute and chronic presentations of Crohn disease in pediatric patients. There has been increasing standardization in the performance and interpretation of these studies, given the growth in volume and impact on clinical management. This article will focus on technical considerations in the performance of MR enterography in children and adolescents, as well as "do not miss" findings on MR enterography that will impact clinical management and potential problems encountered with MR enterography that may limit its diagnostic utility in some patients.

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Introduction

Inflammatory bowel disease (IBD), including Crohn disease and ulcerative colitis, is a significant cause of morbidity in children. Fifteen to twenty percent of patients with IBD present during childhood or adolescence.[1] Historically, inflammatory bowel disease was primarily evaluated with barium fluoroscopy and endoscopy/colonoscopy. Imaging plays a more important role in the management of Crohn disease compared with ulcerative colitis because Crohn disease can involve any portion of the GI tract, including the entire small bowel that is not easily visualized by optical endoscopy. In recent years, MR enterography has emerged as the imaging gold standard for evaluation of both new and established pediatric patients with Crohn disease.[2] MR enterography offers a variety of advantages over CT and fluoroscopy, including lack of ionizing radiation exposure as well as superior soft tissue evaluation for assessment of disease activity and penetrating complications.[3,4] While MR enterography is primarily used in the evaluation of Crohn disease,[5] it is also useful for a variety of other pediatric conditions, including polyposis syndromes, suspected bowel masses, unexplained gastrointestinal bleeding, and nonspecific abdominal complaints.[6] This article will focus on MR enterography of Crohn disease, including protocols (Table 1) and the pearls and pitfalls the radiologist needs to be aware of (Tables 2 and 3).

Although MR enterography protocols may vary by indication, they generally include both large volume oral contrast and intravenous contrast administration.[7] Oral contrast is preferably nonabsorbable, biphasic (T1-weighted hypointense, T2-weighted hyperintense) and is administered over a 45–60-minute period to allow for optimal small bowel distention. Intravenous contrast is particularly useful for the evaluation of penetrating disease including perianal fistulas and abscesses.[6] Sequences are optimized for evaluation of bowel wall and bowel peristalsis, the mesentery, fluid collections, and penetrating disease. MR enterography protocols typically include single shot T2-weighted (ssT2W), balanced steady-state free precession (bSSFP), single-shot or fast spin-echo T2-weighted fat-saturated (ss/FSE T2W FS), thick slab cinematic bSSFP, diffusion-weighted imaging (DWI), and multiphase T1-weighted fat-saturated gradient recalled echo (GRE) pre- and postcontrast images[6-9] (Table 2). The field of view should extend from the top of the colon to the bottom of the anal sphincter complex.

A systematic approach to the interpretation of MR enterography is essential. Consensus recommendations from the Society of Abdominal Radiology, the Society of Pediatric Radiology, the American Gastroenterological Association and other expert organizations delineate specific imaging findings associated with mural inflammation, penetrating disease and mesenteric

*Department of Radiology, Massachusetts General Hospital, Harvard Medical School, Boston, MA.

†Department of Diagnostic Imaging, The Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada.

Address reprint requests to Michael S. Gee, MD, PhD, Division of Pediatric Radiology, Massachusetts General Hospital, 55 Fruit St, Ellison 237, Boston, MA 02114. E-mail:

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Table 1 Typical MR Enterography Protocol for Pediatric Patients

Sequence	Imaging Plane	Time Per Sequence
Single shot T2-weighted (ssT2W)	Axial, Coronal	1-2 minutes
Balanced steady-state free precession (bSSFP)	Coronal	0.5-1 minute
Option 1: Single shot T2 fat-saturated	Axial	Option 1: 1-2 minutes
Option 2: Fast spin-echo T2 fat-saturated (FSE T2W FS)		Option 2: 3-5 minutes
Thick slab cinematic bSSFP	Coronal	1-3 minutes
Diffusion-weighted imaging (DWI) with typical b-values of 50, 400, and 800	Axial	4-8 minutes
Multiphase T1-weighted fat-saturated gradient recalled echo (GRE) pre- and postcontrast images	Coronal	4-5 minutes
T1-weighted fat-saturated gradient recalled echo (GRE) postcontrast, delayed	Axial	2-4 minutes

Table 2 Pearls Associated With MR Enterography

Pearls
Wall thickness ≥3 mm in distended bowel is abnormal
Imaging features of penetrating disease are often indications for biologic therapy
Penetrating disease typically occurs at sites of luminal narrowing
Penetrating disease associated with an abscess is a contraindication to most immunomodulatory therapies
Extraintestinal Crohn disease manifestations can be evaluated on MR enterography

inflammation.[10] Key findings relating to mural inflammation include: (1) segmental mural hyperenhancement—especially if it is asymmetric; (2) bowel wall thickening; 3) intramural edema; (4) stricture, with or without upstream dilatation; (5) ulcerations; (6) sacculations; (7) and diminished motility.[10] Additionally, interpretations should focus on detection of perienteric disease manifestations including fistulas (simple or complex), sinus tracts, perianal fistulas, inflammatory masses, abscesses, perienteric edema/inflammation and engorged vasa recta.[10] Identifying penetrating disease and abscesses is particularly important as they can have implications for patient management.

Reporting should be structured, addressing disease activity and extent, strictures and penetrating complications. For example, the findings should provide a detailed assessment of disease location, number and length of diseased segments, inflammation characteristics, strictures, penetrating complications, perianal disease and response to therapy. Extra-intestinal complications and unrelated findings should also be included. The impression of the report should describe the presence and degree of inflammation, presence of strictures and any associated active inflammation, penetrating disease type and location, with particular note of perianal disease, and any other complications.[10]

Pearls

Below are listed some important principles to keep in mind when interpreting MR enterography studies in pediatric patients.

Wall Thickness ≥3 mm in Distended Bowel Is Abnormal

It is well established that small bowel thickness ≥3 mm on imaging with adequate enteric contrast distention is usually abnormal[11-13] (Fig. 1A). The measurement of the bowel wall should be obtained at the site of the most severe inflammation.[10] The severity of the disease can be graded by wall thickness, with mild measuring 3-5 mm, moderate measuring >5-9 mm, and severe measuring ≥10 mm.[10] Of note, the bowel must be properly distended in order to accurately

Table 3 Pitfalls Associated With MR Enterography

Pitfalls	Solutions
Suboptimal distention of bowel loops can lead to apparent wall thickening	Administer large volume oral contrast Wait 20-30 after ingestion of contrast Place in prone position Void immediately prior to scan
The perianal region may be incompletely imaged or evaluated	Add small field of view fluid sensitive sequence
Artifacts can degrade MR enterography image quality	Optimize oral contrast ingestion Obtain digital subtraction images Administer antispasmodic agent
Patient compliance with MR enterography can be challenging for the pediatric population	Coordinate care with child life specialist Consider sedation Optimize MR sequence to minimize time
Access to MR enterography may be limited off-hours and/or in patients with acute presentation	Consider low-dose CT

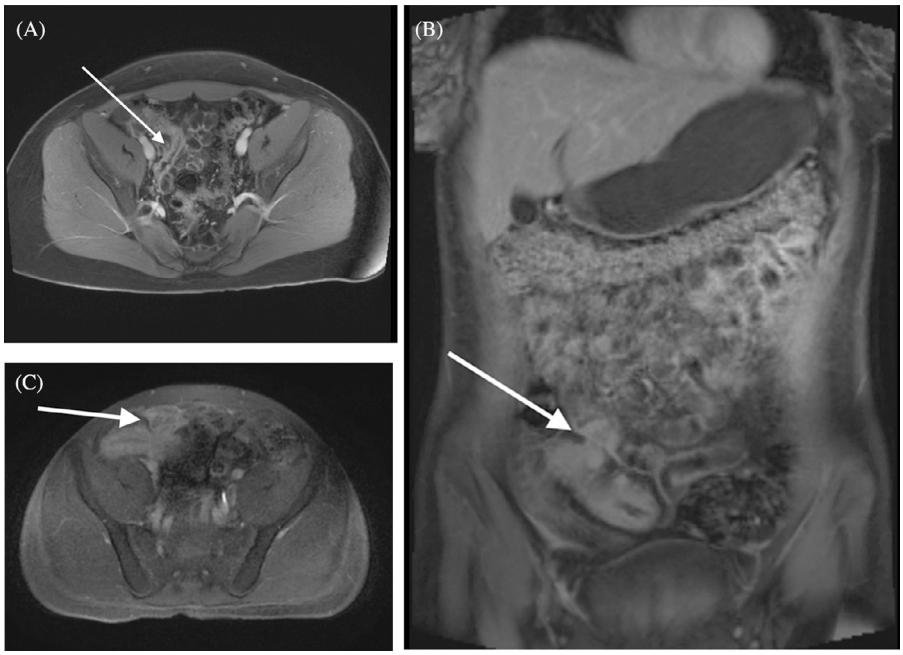

Figure 1 MR enterography features of active disease. (A) 17-year-old boy with history of Crohn disease presented with abdominal pain. Postcontrast axial T1-weighted VIBE fat-saturated image demonstrates wall thickening of the terminal ileum and hyperenhancement consistent with active inflammation. (B) 17-year-old girl with Crohn disease presenting with abdominal pain. A postcontrast coronal T1-weighted VIBE fat-saturated image demonstrates loss of fat plane between the terminal ileum and a loop of adjacent small bowel, consistent with an entero-enteric fistula (arrow). (C) 16-year-old boy with Crohn disease presenting with daily abdominal pain. A postcontrast axial T1-weighted VIBE fat-saturated image demonstrates an enhancing inflammatory mass (arrow) adjacent to the inflamed ileum, deep to the anterior abdominal wall.

measure thickness. Bowel wall thickening may be present in active or inactive (chronic) disease. The coexistence of mural T2-weighted hyperintensity (compared with muscle reference) with wall thickening is more specific for active disease.[14] It is important to note that although small bowel wall thickness of 3 mm or more is abnormal, it is not specific for Crohn disease. The differential diagnosis for small bowel thickening is broad, including but not limited to infectious, ischemic, and malignant etiologies.

Penetrating Disease Imaging Features Are Often an Indication for Biologic Therapy

Medical management of Crohn disease is multifactorial based on a patient's symptoms, lab values (eg, CRP, ESR, CBC etc.), endoscopy results, and radiologic findings. Specifically, confirmation of ileocolonic disease often guides treatment.[15] The presence of penetrating disease reflects transmural inflammation that transgresses the bowel wall and elevates a patient's disease severity. Penetrating disease includes fistulas, sinus tracts, inflammatory masses, and abscesses. Penetrating disease is associated with worse outcomes, including the need for surgical intervention and re-intervention.[16-19] Biologic therapy is often indicated if penetrating disease is present and the patient is a candidate for biologic treatment.[20,21] There is accumulating clinical evidence showing the efficacy of TNFα inhibitor therapy in treating penetrating symptoms of Crohn disease.[22]

Fistulas are abnormal connections between epithelialized structures (Fig. 1B) and can be simple or complex. Sinus tracts are blind-ending outpourings from bowel, and can be intramural or extramural, extend into adjacent mesentery, with or without tethering or angulation of the related bowel loop. Description of fistulas and sinus tracts should include their location, complexity and relationship to strictures or nearby inflammatory changes.[10] Inflammatory masses, a term replacing "phlegmon," is a focal area of ill-defined soft tissue inflammation lacking fluid content, which may either progress to become an abscess later or be the sequela of a previously treated abscess (Fig. 1C).

Penetrating Disease Typically Occurs at Sites of Luminal Narrowing

Sites of luminal narrowing and active inflammation are associated with penetrating disease. In a retrospective study, Orscheln et al found that penetrating disease was found at sites of luminal narrowing 98% of the time in a cohort of 52 pediatric patients.[23] The exact pathophysiology is unclear, but the association likely related to increased bowel intraluminal pressure in combination with transmural inflammation.[24,25] Nonetheless, recognizing persistent luminal narrowing can help identify sites of penetrating disease.

Prestenotic bowel dilation in combination with luminal narrowing defines a bowel stricture—considered mild if the luminal diameter is 3-4 cm and moderate to severe if >4 cm.[10] If a stricture is suspected but there is not

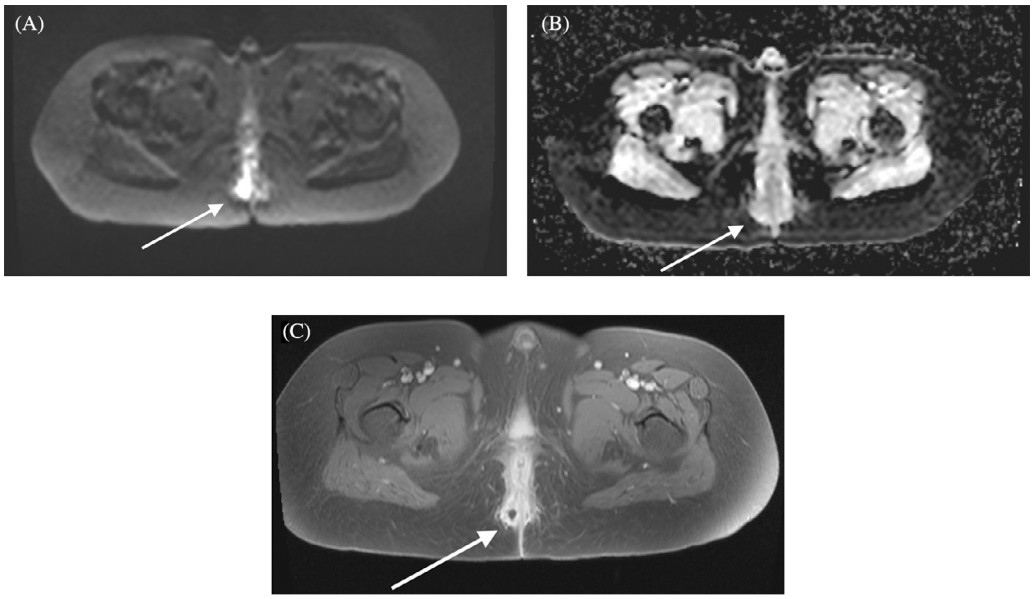

Figure 2 Crohn disease associated abscess depicted on MR enterography. A 12-year-old boy with Crohn disease status posthemicolectomy and perianal disease presenting with fever. Axial diffusion-weighted (B = 800) (A), apparent diffusion coefficient (B), and postcontrast axial T1-weighted VIBE fat-saturated (C) images show restricted diffusion and rim enhancement, in the area of a known perianal fistula, consistent with an abscess (arrows).

prestenotic dilatation, this may be an artifact related to poor patient oral contrast intake and the site can be assessed on follow-up exams or by cinematic SSFP to evaluate for poor peristalsis.[10] Fecalization (small gas bubbles and mixed density/intensity material) of distal small bowel contents may reflect chronic bacterial overgrowth and stasis related to a stricture, and is best demonstrated on unenhanced T1-weighted fat-saturated gradient recalled echo (GRE) imaging as high signal bowel contents with susceptibility voids from gas. Description of the stricture should include location, length, presence, and maximum diameter of upstream dilation, and presence/absence of active inflammation.

Penetrating Disease Associated With an Abscess Is a Contraindication to Most Immunomodulatory Therapies

Although penetrating disease is often an indication for biologic therapy, the presence of an abscess is typically a contraindication to biologic and other immunomodulatory therapies, due to the risk of overwhelming infection. The presence of an intra-abdominal or perianal abscess typically necessitates discontinuation of any immunomodulatory medications and initiation of antibiotics with possible drainage of large or antibiotic-refractory abscesses.[26] Abscesses should be treated before initiation or re-initiation of immunomodulatory therapy,[27] with one advantage of abscess drainage being prompt initiation of immunodulatory therapy and lower rates of bowel resection later.[28] On MR enterography, abscesses appear as T2-weighted hyperintense fluid collections with peripheral enhancement on postcontrast imaging. DWI is particularly useful in identifying abscesses,[29,30] which appears as bright on DWI and dark on ADC (Fig. 2).

Extraintestinal manifestations can be identified on MR enterography

Although the focus of MR enterography is often on bowel wall abnormalities, careful attention should also be paid to the extraintestinal manifestations of Crohn disease, which can affect a wide variety of organ systems. The most important manifestations to document include sacroiliitis, primary sclerosing cholangitis (PSC) and avascular necrosis (AVN), due to their clinical implications.[10] Nephrolithiasis and cholelithiasis can be seen as well. Sacroiliitis has been identified in up to 27% of Crohn disease patients,[31] although it is less common in children than adults with Crohn disease. On MRI, sacroiliitis appears as increased T2 signal or enhancement of the sacroiliac joint[32] (Fig. 3A). Although PSC is more closely associated with ulcerative colitis, Crohn patients (particularly those with colonic involvement of disease) can present with PSC (Fig. 3B). The incidence of PSC is lower in children with Crohn disease than in adults with the disease,[33] with one study showing that while 3.4% of adult Crohn patients had PSC on biopsy, while a separate study has demonstrated that only 0.3% of pediatric Crohn patients had PSC.[34,35] Since PSC can progress to liver failure and increases the risk of malignancy, it is very important to identify on imaging. PSC presents with strictures and saccular dilations of the biliary tree, creating a classic "beaded" appearance. Intra and/or extrahepatic biliary ducts also demonstrate wall thickening and enhancement.[36] If PSC is suspected on MR enterography, Magnetic Resonance Cholangio-Pancreatography (MRCP) may be warranted for as it provides better evaluation of the biliary tree.

AVN can be seen in up to 2.1% of patients with IBD[37] and presents most commonly in the femoral head. On MRI, a

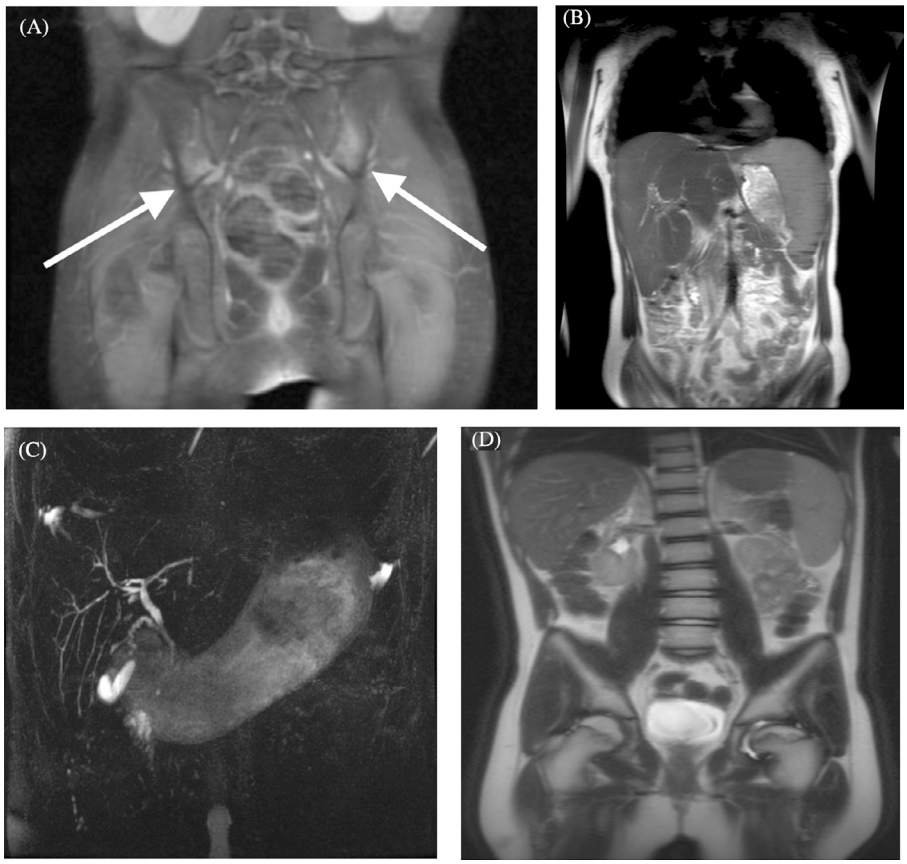

Figure 3 Extraintestinal manifestations of Crohn disease depicted on MR enterography. (A) 9-year-old boy with Crohn disease presenting with bilateral hip pain, right greater than left. Coronal postcontrast 3D T1-weighted fat-saturated images demonstrate enhancement of the sacroiliac joints, respectively, consistent with sacroiliitis (arrows). (B and C) 18-year-old female with known IBD presenting with abdominal pain. A coronal ssT2W image (B) demonstrates subtle biliary dilatation. An MRCP (C) demonstrates more obvious beading of the bile ducts consistent with primary sclerosing cholangitis. (D) 13-year-old boy with Crohn disease on immunomodulatory therapy presenting with intermittent abdominal pain. A coronal ssT2W image demonstrates flattening and widening of the left femoral head with a small joint effusion, likely sequela of remote avascular necrosis (arrow).

double-line sign is often seen, which describes an inner T2-weighted hyperintense signal representing granulation tissue, with an outer rim of T2 dark signal representing a sclerotic band of tissue. More advanced disease will present as collapse of the femoral head (Fig. 3C).

Certain extraintestinal manifestations correlate with severity of gastrointestinal inflammation, such as disorders of the skin, eyes and joints.[38] Other extraintestinal manifestations, such as hepatobiliary or cardiothoracic involvement, do not correspond to the severity of gastrointestinal inflammation. Cardiothoracic manifestations are highly variable, but include congestive heart failure and bronchiectasis.[38]

Pitfalls

Below are listed some issues to keep in mind when interpreting MR enterography studies, including factors that can lead to compromised image quality.

Suboptimal Distention of Bowel Loops Can Lead to Misdiagnosis

As previously discussed, obtaining accurate measurement of the bowel wall is crucial to the diagnosis of Crohn disease and assessment disease activity. A lack of proper bowel wall distention can lead to overdiagnosis of bowel thickening[11] (Fig. 4). Underdistention is typically related to low volume of oral contrast ingested by the patient. Reducing the likelihood of under-distention can be achieved by attention to the choice of oral contrast agent (nonabsorbable, hyperosmolar), volume and rate of administration. In patients who drink contrast slowly, waiting 20-30 minutes after the last cup of oral contrast is ingested can help ensure that contrast passed into the small bowel and is not retained in the stomach.[39] Prone positioning helps to decrease abdominal distention and scan times in adults, but supine positioning if often better tolerated by children.[40] In pediatric patients, the total volume of oral contrast consumed is often based on patient weight (eg, 20 mL/kg).[6] Ingestion of a large volume

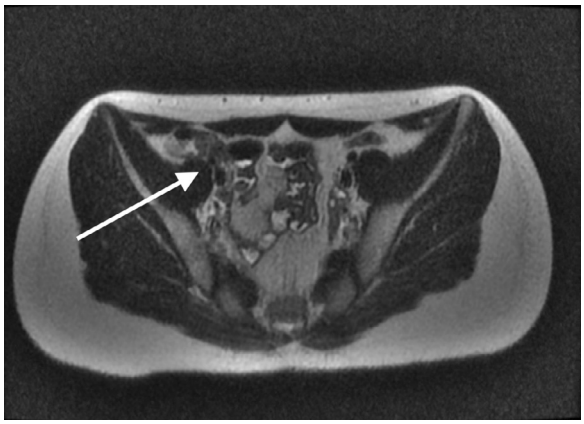

Figure 4 Suboptimal MR enterography bowel distention limits small bowel evaluation. 15-year-old girl presenting with 6 months of abdominal pain, weight loss, nausea/ vomiting, and fatigue. An axial ssT2W image demonstrates under-distention of the terminal ileum (arrow), limiting evaluation for underlying pathology.

of oral contrast can be challenging in children, particularly when patients are symptomatic. Oral contrast agents that either are less viscous or are powdered and can be dissolved in the patient's beverage of choice have been shown to improve tolerability and patient compliance with pediatric MR enterography.[6,41-44] Voiding immediately prior to the MRI scan also reduces mass effect on bowel adjacent to a distended urinary bladder and improves patient comfort during the scan.[8]

The Perianal Region May Be Incompletely Imaged or Evaluated on MR Enterography

Standard MR enterography has been shown to have good performance for detection of perianal Crohn disease in the pediatric population[45] (Fig. 5). However, occasionally the perianal region is incompletely imaged due to the large anatomic coverage required, particularly in the axial plane. Technologists and radiologists who are performing and monitoring these exams should be aware that the anal sphincter complex is an important part of MR enterography anatomic coverage.

One potential disadvantage of MR enterography for perianal disease evaluation is the large field of view that may reduce sensitivity for detecting subtle fistulae and sinuses.[45]

If there is high suspicion for perianal disease, then additional small field of view fluid sensitive sequences can be added to the standard MR enterography protocol.[46,47] These sequences are tailored to capture the complex anatomy of the anal canal, which is crucial for surgical planning.[46,48] Sequences should be obliquely oriented to be orthogonal or parallel to the anal canal.[49] Example sequences include FSE T2-weighted fat-saturated or STIR images.[50] The challenge with adding dedicated perianal sequences is to keep the overall scan times as short as possible in these patients who are full of enteric contrast. In general, total scan time should be 45 minutes or less if possible. Regardless of clinical suspicion, the perianal region should be inspected carefully on all MR enterography studies because imaging features of perianal disease may precede clinical symptoms.

Artifacts Can Degrade MR Enterography Image Quality

The radiologist should be aware of a variety of artifacts that can lead to reduced MR enterography image quality. Some artifacts are related to poor oral contrast ingestion. For example, when there is air within the bowel lumen that is not displaced by oral contrast, GRE postcontrast sequences are prone to susceptibility artifact from air, especially at 3T (Fig. 6). Also, enteric succus that is not displaced by oral contrast often demonstrates high T1-weighted signal intensity can that can obscure enhancement on T1-weighted fat-suppressed postcontrast images (Fig. 7). In this case, digital subtraction images can be obtained that can eliminate the intrinsic T1-weighted signal of small bowel contents. A third

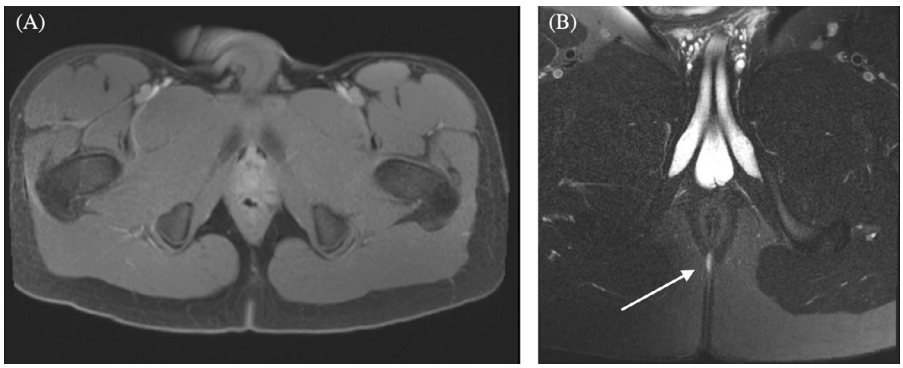

Figure 5 The perianal region should be completely imaged on MR enterography. 16-year-old boy with history of Crohn disease presented with abdominal pain and fever. An axial-enhanced 3D T1W fat-suppressed image (A) performed as part of an initial MR enterography did not include the full field of view of the perianal region. A follow-up MR perianal fistula protocol 6 weeks later was performed. Axial T2-weighted fat-saturated image (B) demonstrates a small transsphinteric fistula at the 6:00 position (arrow), which is now included on the dedicated field of view in the perianal fistula protocol and likely was present on the prior study.

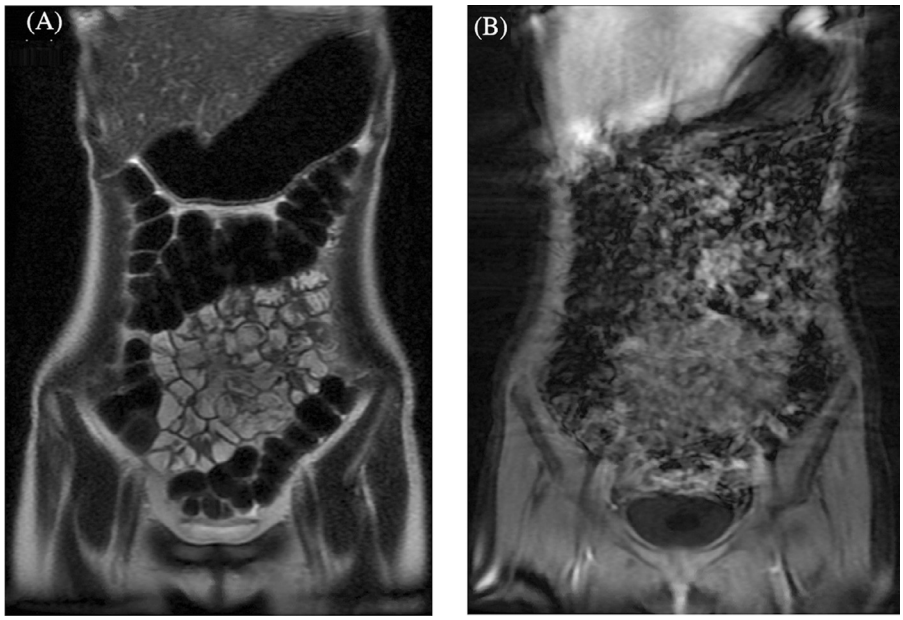

Figure 6 Susceptibility artifact from air within bowel degrades image quality of GRE postcontrast imaging. A 12-year-old girl with a history of Crohn disease presented with worsening diarrhea. A coronal ssT2W image (A) demonstrates an air-filled distended transverse colon. A coronal enteric phase-enhanced 3D GRE T1W fat-suppressed image demonstrates significant susceptibility artifact from the air (B) obscuring the bowel wall enhancement pattern.

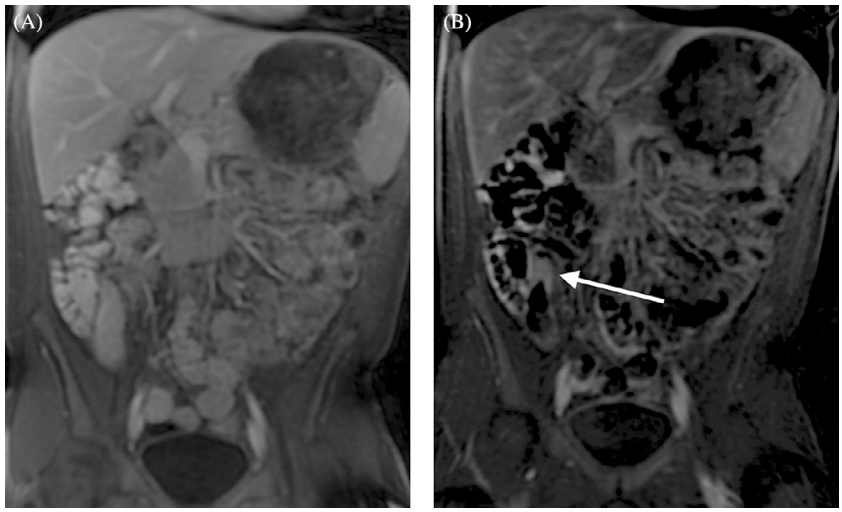

Figure 7 Intrinsic T1W signal intensity from enteric contents masks bowel enhancement, necessitating digital subtraction imaging. A 15-year-old boy with history of Crohn disease presenting with abdominal pain. A coronal-enhanced T1W fat-suppressed image (A) demonstrates high T1W signal throughout the terminal ileum due to intrinsic signal of enteric contents. However, digital subtraction imaging (B) that removes the precontrast T1W fat-suppressed mask image more clearly demonstrates abnormal enhancement of the terminal ileum (arrow).

artifact is bowel peristalsis that can result in phase encoding ghost artifacts and decreased image quality (Fig. 8). Glucagon can be used as an antispasmodic agent to reduce peristalsis artifact and improve visualization of the bowel. However, glucagon can cause nausea and vomiting, as well as increasing MR examination length by an average of 13 minutes.[51] Of note, Dillman et al showed that less than 10% of pediatric patients who received IV glucagon in conjunction with their MR enterography experienced emesis, with hyoscine butylbromide—an alternate antiperistaltic agents commonly used for MR enterography outside the United States—also well tolerated.[8,51] Newer MRI acceleration techniques can reduce image time associated with MR enterography pulse sequences and help mitigate peristaltic and other patient motion artifacts.[52]

Patient Compliance With MR Enterography Examinations Can Be Challenging for the Pediatric Population

MR examinations can be particularly challenging in the pediatric population, given patients' claustrophobia, limited ability to hold still, and anxiety in an unfamiliar setting. Occasionally, deep sedation is required for MR enterography

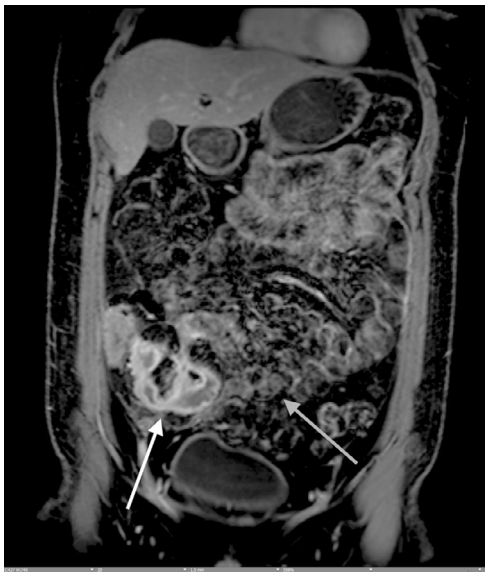

Figure 8 Bowel peristalsis causing motion artifact. A 16-year-old female with a history of Crohn disease presenting with abdominal pain. Coronal-enhanced T1W fat-suppressed image obtained without bowel antiperistaltic agent administration demonstrates active inflammation in the terminal ileum (white arrow), that is well visualized due to relative aperistalsis. The remaining small bowel is obscured by bowel peristalsis (gray arrow).

examinations, with one institution reporting up to 20% of all pediatric MR enterography studies requiring general anesthesia.[53] Deep sedation is generally considered for patients under the age of 9 or 10.[54] For patients who are unable to tolerate MR exams and are not candidates for sedation, CT enterography can be used for initial diagnosis.[55] CT enterography can be performed in <5 seconds and is less likely to provoke claustrophobia. However, CT enterography results in exposure to ionizing radiation, which is a concern for the pediatric Crohn disease population that is likely to undergo multiple image studies over the course of their lifetime.[4] One way to improve the MRI experience or children is to involve child life specialists, who help to prepare children for MRI and help them cope with the experience. Child life specialist involvement has been shown to reduce the sedation requirement for pediatric MRI.[56,57] Additionally, optimizing MR enterography protocols to utilize new acceleration techniques (such as compressed sensing reconstruction and multiband excitation) and reduce redundant sequences can substantially decrease imaging time and allow more children to under MR enterography awake.[56]

Access to MR Enterography May Be Limited; Consider Low-Dose CT in These Cases

Availability of MR enterography may be limited in certain situations. For example, although the United States has the second highest number of MRI units per population (38 per 1 million), the distribution of units is not uniform[58,59] and scanners may not available in rural communities. Similarly, the technologist and radiologist expertise to perform and interpret MR enterography exams in children may be limited, particularly off-hours and on weekends. CT enterography can be considered as an alternate imaging modality in these situations since CT scanners are generally more readily available in emergency room settings compared with MRI, and CT exams can be performed easily 24/7.[58]

Another consideration for the role of CT as an alternate imaging modality is in children presenting with urgent symptoms who are unable to tolerate the oral contrast preparation for MR enterography.[60,61] In this situation, CT with intravenous contrast only (no oral contrast) is likely to be more helpful in the evaluation for bowel disease as well as urgent complications (free intraperitoneal air from perforation, abscess) compared with MRI without oral contrast.

Other Challenges in MR Enterography Interpretation

While the imaging features of active Crohn disease on MR enterography are well established,[10] there are other challenges related to image interpretation, including how to deal with cases in which some imaging features of active disease but not others are present. One study of pediatric MR

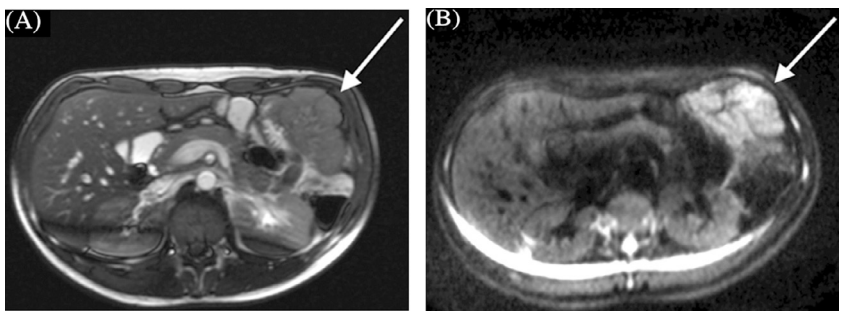

Figure 9 Normal jejunum can exhibit restricted diffusion on DWI that can be mistaken for active Crohn disease. In this 17-year-old female undergoing MR enterography who did not have Crohn disease, an axial bSSFP image (A) shows normal nodularity of the jejunum and mild apparent wall thickening from under-distention (arrow), while an axial DWI (B = 800) image (B) shows restricted diffusion (arrow).

enterography patients found that mural MRI features (bowel wall thickening and hyperenhancement) were more reliable than mesenteric features compared with histologic reference.[14] Also, while DWI is generally helpful for detecting active bowel inflammation, the jejunum can demonstrate low ADC values and wall thickening at baseline that should not be confused with active disease (Fig. 9).[62] Finally, the characterization of strictures as inflammatory or fibrotic can be challenging by MR enterography, even with the use of advanced analysis techniques such as texture analysis.[63] In pediatric Crohn patients, stricture characterization may be less important than in adults, as pediatric patients with short segment strictures of any type may still require mechanical treatment if persistent.

Finally, while MRE is most often indicated for the evaluation of Crohn disease, it is important to realize that many of the same imaging findings can be seen in variety of other pathologic entities which involve the terminal ileum, including lymphoid hyperplasia, ulcerative colitis, infection, and NSAID use, all of which can mimic Crohn disease radiographically and endoscopically.[64] As such, it is important to consider of other entities in a child presenting with presumed Crohn disease, and realize that biopsy remains the gold standard for diagnosis.

Conclusion

Overall, MR enterography offers substantial benefits to patients and clinicians by directly impacting their clinical management. Careful assessment for abnormal bowel wall thickness, penetrating disease including abscesses and extraintestinal manifestations is crucial to the treatment of Crohn disease. The radiologist needs to also be aware of potential pitfalls, including suboptimal bowel distention, intraluminal food debris and MR artifacts. Furthermore, if there is clinical suspicion for penetrating anal disease, dedicated sequences are required. Lastly, patients' tolerance for MR exams, as well as access to MR units and appropriateness in the acute setting, may limit feasibility of MR enterography.

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