Comprehensive Magnetic Resonance Enterography of Crohn's Disease in the Pediatric Population: Technique, Interpretation, and Management

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Magnetic resonance enterography (MRE) plays a critical role in the management of Crohn's disease in the pediatric population. The ability to provide dynamic assessment of disease burden, complications, and therapeutic response without ionizing radiation makes it an ideal tool for younger patients requiring frequent follow-up. With a growing array of available treatment options, a sound understanding of MRE is critical in directing management aimed at curbing the physical and emotional morbidity associated with the lifelong condition. The goal of this article is to provide a practical overview of MRE in the pediatric population. This includes a review of our technique, approach to interpretation, pictorial collection of findings, and discussion of the role MRE plays in management.

Introduction

Crohn's disease is a chronic inflammatory bowel disease with a rising incidence in the pediatric population.[1,2] Prompt diagnosis and appropriate surveillance is critical in directing therapy to curb the physical and psychological morbidity associated with the lifelong condition.[3] Because of its systemic nature, disease monitoring requires a multifaceted approach. Cross-sectional imaging plays a vital role in disease characterization by visualizing bowel loops that are inaccessible to endoscopy, allowing disease assessment beyond the mucosal surface, and detecting extraintestinal manifestations. Both computed tomography (CT) and magnetic resonance imaging (MRI) have established excellent accuracy profiles in characterizing disease activity and complications, especially when performed in bowel-specific (ie, enterography) protocol.[4-6] MR enterography (MRE) offers the ability to visualize the entire abdomen and pelvis in multiple sequences and postcontrast phases while avoiding exposure to ionizing radiation. Attention to the cumulative radiation dose is particularly important in patients diagnosed at a younger age who will require frequent surveillance.[7] A sound understanding of the application and interpretation of MRE can help clinicians to control the disease earlier in its course. The goal of this article is to provide a practical understanding of MRE in the pediatric population. This includes a review of our technique, approach to interpretation, pictorial collection of findings, and discussion of the role MRE plays in management.

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Technique

Although MRE protocols vary between institutions, some general principles are universally necessary for adequate image acquisition[8-10]: inclusion of a wide field of view (above the diaphragm to below the anus), appropriate small bowel distention, slowing of bowel peristalsis, intravenous contrast enhancement, and T1- and T2-weighted sequences that can be obtained in a single breathhold.

At our institution, patients are asked to fast for 4 hours before the study. They are then made to drink

TABLE 1. Routine MRE protocol in our institution

Precontrast sequence	TR/TE/flip angle	TI/ETL	Slice thickness (mm)	Matrix	FOV	NEX
Localizer	7.8/3.69/20	–/1	6	320 × 240	400*400	1
Coronal T2 HASTE	1500/209/150	–/256	5	240 × 320	399*470	1
Coronal T2 fat saturation	2620/205/140	–/28	5	180 × 256	470*470	1
Axial T2 HASTE	1500/183/150	–/256	5	320 × 240	285*400	1
Axial T2 fat saturation	3750/105/120	–/29	5	384 × 384	295*440	1
Diffusion-weighted fat saturation EPI	2500/81/90	–/1	7	192 × 192	308*379	1
Coronal VIBE precontrast	3.55/1.2/13	–/1	3	256 × 320	373*460	1
Coronal VIBE (20, 40, and 60 seconds postcontrast administration)	3.55/1.15/12.38	–/1	3	256 × 320	373*460	1
Axial VIBE 180 seconds postcontrast	3.55/1.24/12.14	–/1	3	320 × 256	284*305	1

EPI, echo planar imaging.

1 L of biphasic contrast (VoLumen; Bracco, Milan, Italy) gradually over an hour before scanning. This aims to obtain uniform distention along the length of the bowel via its osmotic effect.[11] We find that this agent is relatively pleasant in taste or can be easily flavored using hot cocoa powder (Nestlé, Rich Chocolate). Its biphasic nature (dark on T1-weighted images [T1WI] and bright on T2WI) allows better differentiation between the bowel wall and intraluminal contents[11] whereas routine positive oral contrast may obscure the bowel wall.[12,13] Scanning is performed on a 3-T magnet (MAGNETOM; Siemens, Erlangen, Germany) in the supine position. The higher magnetic strength offers lower scan times, higher signal-to-noise ratio and better depiction of mucosal ulcers without sacrificing sensitivity.[14] Although prone positioning may serve to "spot compress" bowel loops, no significant difference in lesion detection was found when compared with supine positioning, which is generally better tolerated.[15] When the patient is first placed on the scanner 1 mg of glucagon (Xeris Pharmaceuticals, Austin, Texas) is injected intramuscularly. This improves bowel visualization by reducing bowel peristalsis and reduces blurring and artifacts due to bowel motility.[15] When injected slowly, nausea is minimized and emesis is rarely experienced. For postcontrast images, 0.075 mmol/kg of gadolinium-based contrast (gadobenate dimeglumine, MultiHance; Bracco, Milan, Italy) is injected intravenously at 2 mL per second.

All sequences are obtained with breathholding to help limit artifact due to diaphragmatic excursion. The use of saturation bands is typically not needed, as phase encoding is right to left, allowing reduction in TR. We used 2 phased-array body coils capable of parallel imaging to cover from the top of the abdomen to the pubic symphysis in a single field of view. We employ an iPAT factor of 2, which helps reduce ghosting, motion artifacts, and acquisition times with only mild tradeoff for signal loss.

The following sequences are routinely obtained:

- Axial and coronal half-fourier acquisition single-shot fast spin echo (HASTE) without fat saturation. With strong T2 weighting, this provides good anatomical detail and can be used to

TABLE 2. High-resolution scanning protocol for perianal disease. This is typically reserved for patients with known or suspected perianal disease

Perianal disease	TR/TE/flip angle	TI/ETL	Slice thickness (mm)	Matrix	FOV	NEX
Axial STIR	8590/33/131	210/9	4	256 × 204	200*200	1
Coronal T2 STIR	7960/32/139	210/9	4	204 × 256	200*200	1
Axial T2 high-resolution non–fat saturation	4050/100/130	–/25	4	320 × 288	200*200	3
Axial T2 with fat saturation	4050/100/130	–/25	4	320 × 288	200*200	3
Sagittal STIR	7380/88/140	210/9	4	256 × 204	200*200	1
Axial T1 TSE precontrast	700/11/130	–/3	4	320 × 288	200*200	1
Coronal T1 TSE	700/11/130	–/3	4	256 × 320	200*200	1
Sagittal T1 postcontrast with fat saturation	670/10/130	–/3	4	256 × 166	220*220	2

STIR, short tau inversion recovery; TSE = turbo spin echo.