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ORIGINAL ARTICLE

Comparison of CT enterography and MR enterography imaging features of active Crohn disease in children and adolescents

Heather I. Gale[1] · Steven M. Sharatz[2] · Mayureewan Taphey[3] · William F. Bradley[4] · Katherine Nimkin[2] · Michael S. Gee[2]

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Abstract
Background Assessment for active Crohn disease by CT enterography and MR enterography relies on identifying mural and perienteric imaging features.
Objective To evaluate the performance of established imaging features of active Crohn disease in children and adolescents on CT and MR enterography compared with histological reference.
Materials and methods We included patients ages 18 years and younger who underwent either CT or MR enterography from 2007 to 2014 and had endoscopic biopsy within 28 days of imaging. Two pediatric radiologists blinded to the histological results reviewed imaging studies and scored the bowel for the presence or absence of mural features (wall thickening >3 mm, mural hyperenhancement) and perienteric features (mesenteric hypervascularity, edema, fibrofatty proliferation and lymphadenopathy) of active disease. We performed univariate analysis and multivariate logistic regression to compare imaging features with histological reference.
Results We evaluated 452 bowel segments (135 from CT enterography, 317 from MR enterography) from 84 patients. Mural imaging features had the highest association with active inflammation both for MR enterography (wall thickening had 80% accuracy, 69% sensitivity and 91% specificity; mural hyperenhancement had 78%, 53% and 96%, respectively) and CT enterography (wall thickening had 84% accuracy, 72% sensitivity and 91% specificity; mural hyperenhancement had 76%, 51% and 91%, respectively), with perienteric imaging features performing significantly worse on MR enterography relative to CT enterography ($P < 0.001$).
Conclusion Mural features are predictors of active inflammation for both CT and MR enterography, while perienteric features can be distinguished better on CT enterography compared with MR enterography. This likely reflects the increased conspicuity of the mesentery on CT enterography and suggests that mural features are the most reliable imaging features of active Crohn disease in children and adolescents.

Keywords Children · Computed tomography enterography · Crohn disease · Inflammatory bowel disease · Magnetic resonance enterography

✉ Heather I. Gale
heather.i.gale@gmail.com

[1] Department of Diagnostic Imaging, Rhode Island Hospital/Hasbro Children's Children's Hospital/ Women and Infants Hospital, The Warren Alpert Medical School of Brown University, 593 Eddy St., Providence, RI 02903, USA

[2] Division of Pediatric Imaging, Department of Radiology, Harvard Medical School, MassGeneral Hospital for Children, Boston, MA, USA

[3] Bumrungrad International Hospital, Wattana, Bangkok, Thailand

[4] Cambridge Mobile Telematics, Cambridge, MA, USA

Introduction

Crohn disease is an idiopathic inflammatory bowel disorder characterized by chronic relapsing transmural inflammation that can involve any part of the gastrointestinal tract [1]. Crohn disease affects more than 600,000 people in North America, with an increasing incidence (currently 25–30%) in children [2–5]. Crohn disease can have an insidious onset in young patients, with symptoms at presentation including intermittent abdominal pain, weight loss and poor growth, with or without diarrhea [5]. Because of its relapsing nature and frequent development of strictures and penetrating complications, Crohn disease is associated with significant patient lifetime

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morbidity and decreased health-related quality of life [1, 6]. The recent clinical development of molecule-targeted biological inhibitors of inflammatory cytokines has revolutionized the treatment of Crohn disease by maximizing anti-inflammatory activity while minimizing systemic toxicity [5, 7, 8].

Imaging plays an important role in assessing Crohn disease activity, especially for pediatric patients in whom general anesthesia is typically required for endoscopic evaluation [9]. CT enterography and MR enterography have emerged as the preferred imaging modalities for evaluating Crohn disease because of their utility in not only depicting bowel wall inflammatory changes but also imaging extraluminal and extraintestinal disease manifestations [9–15]. MR enterography has become the favored imaging modality for Crohn disease evaluation in pediatric patients, primarily because of its lack of ionizing radiation exposure, with other advantages including excellent soft-tissue contrast, multiphase post-contrast evaluation of the bowel, and real-time cinematic imaging of bowel peristalsis [16–19]. The main disadvantage of MR enterography is long image acquisition time in an enclosed scanner that might necessitate the use of sedation or anesthesia for the evaluation of pediatric patients [20]. Although CT uses ionizing radiation, its widespread availability and rapid scan time are advantageous for imaging young children with acute presentations without sedation or anesthesia [9, 21].

Recent studies prospectively comparing CT enterography and MR enterography have demonstrated similar performance of the two modalities for detecting active disease in both adult and pediatric populations [11, 13, 22]. Assessment for active inflammation by CT enterography and MR enterography relies on the identification of multiple well-defined imaging features that might be present alone or in combination, including mural and perienteric inflammatory features. The purpose of this study is to compare individual CT enterography and MR enterography imaging features in pediatric patients with Crohn disease compared with histological reference in order to define what individual or collection of imaging features best predicts active inflammation.

Materials and methods

Study design and inclusion criteria

We performed this single-institution retrospective study at Massachusetts General Hospital with institutional review board approval and in accordance with the Health Insurance Portability and Accountability Act. An institutional imaging report database query identified all patients 18 years or younger who underwent CT enterography or MR enterography between the years 2007 and 2014. We reviewed the electronic record to identify patients who also carried a known diagnosis of Crohn disease and underwent endoscopic evaluation with biopsy within 28 days before or following the imaging examination. The decision to order CT enterography versus MR enterography was at the discretion of the ordering physician. In general, patients in whom imaging was requested for new Crohn disease diagnosis were more likely to undergo CT enterography, while patients with concern for penetrating complications or who had undergone prior CT enterography examinations were more likely to undergo MR enterography.

Image acquisition

Computed tomography enterography

All CT enterography studies were performed on a 16-row or 64-row multidetector scanner (LightSpeed; GE Healthcare, Waukesha, WI). Oral contrast preparation consisted of dilute barium plus sorbitol (VoLumen; Bracco Diagnostics, Monroe, NJ) or polyethylene glycol 3350 suspension administered over 60 min prior to scan, with total volume ranging from 450 mL to 1,350 mL based on patient weight. Most patients drank the total volume, but some did not and were scanned after they consumed as much as they tolerated. An antiperistaltic agent was not administered. Scans were acquired in the enteric phase (55–60 s) post intravenous contrast injection. Images were acquired using a prospective slice thickness of 5 mm for collimation purposes, with 5-mm thick images reconstructed for primary review and 1.25-mm thick images generated for coronal and sagittal plane reformations. Standard departmental pediatric low-dose CT protocol was used, including tube current modulation and weight-based settings for current and noise [23]. The intravenous contrast agent iopamidol (Isovue 370; Bracco Diagnostics) was administered using a weight-based algorithm (1.6 mL/kg).

Magnetic resonance enterography

All MR enterography studies were performed on a 1.5-T scanner (Signa High-Definition; GE Healthcare) or 3.0-T scanner (Magnetom Trio; Siemens Healthcare, Malvern, PA). Oral contrast agent consisted of the same formulation, volume and timing of administration as for CT enterography. An antiperistaltic agent was not administered, and is not routinely used at our institution for CT or MR enterography. Standard MR enterography sequences (Table 1) were obtained, including coronal and axial single-shot T2-weighted fast spin echo (HASTE [half-Fourier acquired single-shot turbo spin echo]/SSFSE [single-shot fast spin echo]), coronal balanced steady-state free precession (TrueFISP [true fast imaging with steady-state precession]/FIESTA [fast imaging employing steady-state acquisition]) axial T2-weighted fast recovery fast spin echo (RESTORE [not an acronym]/FRFSE [fast recovery fast spin echo]) with fat suppression, and coronal 3-D T1-weighted gradient echo (VIBE [volume interpolated breathhold