



MR Enterography for Crohn's Disease

- CT is commonly used for the noninvasive evaluation of complications associated with Crohn's disease
- Epidemiological evidence suggests that radiation exposure as low as 50-100 mSv may be associated with risk of radiation-induced cancer
- Crohn's disease patients can require frequent CT imaging to evaluate symptomatic recurrence, resulting in exposures within this range
- MR enterography offers an alternate imaging method that provides high image resolution and excellent soft-tissue contrast without exposure to ionizing radiation
- MR enterographic assessment of bowel wall signal intensity and enhancement allows detection of small bowel disease and may help to differentiate active from inactive Crohn's disease

Crohn's disease is a chronic inflammatory bowel disease that affects approximately 600,000 people in North America. Crohn's disease frequently affects young people, with disease onset commonly occurring during adolescence or early adulthood. The disease is characterized by transmural inflammation anywhere throughout the length of the gastrointestinal tract, which can be complicated by strictures, abscess formation, and fistulae. Imaging plays an important role in the initial diagnosis of Crohn's disease as well as the evaluation of symptomatic recurrence, providing valuable information on the presence, severity, and extent of the disease. Historically, barium follow-through fluoroscopy was the method of choice, but over the past decade this has been largely replaced by CT because of its rapid scan time and its ability to evaluate extra-intestinal disease as well as the gastrointestinal tract. The current standard CT evaluation of Crohn's disease includes assessment of bowel wall thickness, perienteric and pericolic mesenteric inflammation, lymph node size and number, extraluminal collections (fistulae, abscesses, sinuses), and extra-intestinal complications. CT enterography (Figure 1A) is a specific CT technique that combines distension of bowel with high volume enteric contrast and high-resolution scanning to enhance sensitivity for detecting subtle bowel wall abnormalities in Crohn's patients.

Although CT imaging is a sensitive and specific modality for evaluating complications of Crohn's disease and for evaluating disease recurrence, there is concern about the radiation exposure associated with repeated scans over a patient's lifetime. This is of particular concern in the Crohn's disease population that undergoes frequent imaging beginning at a young age. The total number of CT scans over the course of a

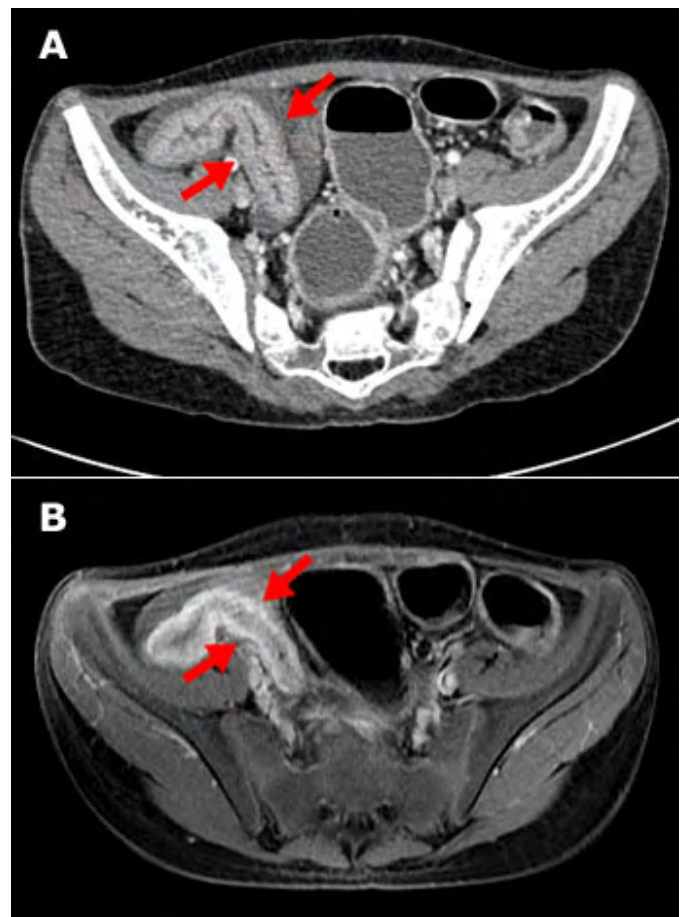


Figure 1. Representative images from CT (A) and MR enterography (B) studies performed on the same patient with Crohn's disease. Arrows indicate a thickened area of small bowel with abnormal contrast enhancement and surrounding free fluid, indicative of active inflammation.

Table 1. Accuracy of CT Enterography and MR Enterography

	CT Enterography	MR Enterography
Sensitivity	89% (95% CI 66.0, 98.1) ^a 95.2% (95% CI 76, 100) ^b	83% (95% CI 60.0, 95.0) ^a 90.5% (95% CI 70, 99) ^b
Specificity	80% (95% CI 36.0, 98.0) ^a 88.9% (95% CI 52, 100) ^b	100% (95% CI 51.1, 100) ^a 66.7% (95% CI 30, 93) ^b
Positive Predictive Value	94% (95% CI 71.1, 99.9) ^a	100% (95% CI 82.0, 100) ^a
Negative predictive value	67% (95% CI 29.6, 90.8) ^a	63% (95% CI 30.4, 86.5) ^a

^a Values for detection of active inflammation, from Lee et al., 2009

^b From Siddiki et al, 2009

lifetime will likely be greater for patients who develop Crohn's disease at an early age, and will also be associated with a longer latency period for potentially developing a radiation-induced malignancy. Recent epidemiological studies suggest that there may be a heightened risk of developing cancer from a radiation exposure of 50-100 mSv. A recent European study over a 15 year period showed that more than 15% of Crohn's patients exceeded 75 mSv in cumulative radiation exposure during the study period and, in those diagnosed when under the age of 17, the risk of high radiation exposure was more than doubled.

The potential risk from ionizing radiation exposure associated with CT has led to the development of MR techniques for the evaluation of Crohn's disease. Pelvic MR imaging is already in routine clinical practice for the evaluation of perianal fistulae and associated complications because of its high soft tissue contrast. However, up until recently, abdominal MR imaging has been limited by motion artifacts. Now, with the development of rapid pulse sequences and robust respiratory gating techniques, MR imaging can provide high-resolution motion-free images of the abdomen.

MR Enterography

MR enterography (Figure 1B) is a technique that combines the use of enteric contrast to distend the intestine and provide negative contrast to the intestinal lumen, together with intravenous gadolinium-containing contrast to detect inflammation. Signs of active Crohn's disease seen on MR enterography include wall thickening, ulcerations, increased mesenteric vascularity ("comb" sign), high signal intensity in inflamed regions of the intestinal wall, reactive adenopathy, and associated complications including penetrating disease and bowel obstruction.

Distention of the bowel with large volume enteric contrast helps identify areas of abnormal bowel wall thickening (defined as > 3mm) suggestive of Crohn's involvement. Bowel wall signal intensity on T1- and T2-weighted images may be helpful in distinguishing bowel edema associated with active inflammation from fibrosis associated with chronic scarring. MR enterography utilizes dynamic image acquisition following the administration of intravenous contrast to provide information about the time course of bowel wall enhancement. This serial imaging of bowel wall enhancement over time may help to distinguish active

from inactive disease; such dynamic imaging is not routinely performed by CT because of the radiation exposure associated with serial image acquisition. For these reasons, MR enterography is likely to be superior to CT for differentiating between acute and chronic inflammation in areas of diseased bowel, the former being more responsive to medical therapy and the latter more likely to require surgical resection. Extraintestinal manifestations of Crohn's disease depicted well by MR enterography include sinus tracts and fistulae that appear as fluid-containing tracts with associated peripheral enhancement. Abscesses are seen as extra-intestinal fluid collections with or without associated air and wall enhancement.

Two recent prospective studies comparing CT enterography and MR enterography have demonstrated that both techniques are excellent at detecting features associated with Crohn's disease; the differences in sensitivity and specificity between the two techniques were not statistically significant (Table 1). These results concur with our preliminary results of pediatric patients conducted at the Mass General, which are not yet published. However, MR enterography has not replaced CT as the standard method for evaluation. Nevertheless, it may be an appropriate imaging technique for patients, particularly pediatric patients and young adults, who require frequent follow-up for symptom exacerbation or to assess treatment response.

MR Enterography Procedure

Patients are required to drink a total volume of 1200 ml of oral contrast over the course of 60 minutes just prior to imaging. The oral contrast is a mixture of 900 ml of dilute barium and sorbitol (VoLumen) and 300 ml of a solution containing superparamagnetic iron oxide (GastroMARK). The former is given in order to distend the bowel and the latter is given to increase the contrast between the lumen and bowel wall in post-contrast and T2-weighted images. Some images are acquired during a breath-hold or multiple breath-holds. Others are acquired during free breathing with navigator triggering to acquire images during expiration. Intravenous gadolinium contrast (Magnevist) is administered and images acquired, with breath holds, at 1, 3, and 5 minutes post injection. Total scan time ranges from 45-60 minutes. For acutely ill patients, the scan time may be longer than they can tolerate and the rapid scan time of CT enterography may be preferable.

Scheduling

CT examinations can be ordered through ROE (<http://mghroe/>) or by telephone **617-724-XRAY (9729)** for all locations. MR enterography can be ordered by calling **617-724-4226**. CT and MR are performed at the main campus as well as Mass General West Imaging, Waltham, and Mass General Imaging, Chelsea. MR examinations are also performed at Mass General Imaging, Charlestown Navy Yard.

Further Information

For further information on imaging MR enterography, please contact [Michael S. Gee, MD, PhD](#), at **617-724-4207**.

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