

Advances In Imaging In Crohn's Disease

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Radiologic evaluation plays a critical role in the assessment of patients with inflammatory bowel disease, particularly **Crohn's disease (CD)**. In UC, colonic mucosa is readily accessible for endoscopic evaluation; thus radiologic techniques are less useful. Traditionally, fluoroscopic studies including the small bowel series and barium enema, along with CT, were the mainstays of imaging. These modalities were used to diagnose disease, document its extent, identify complications including fistula, stricture, abscess and obstruction.

CT enterography (CTe) and, more recently, MR enterography (MRe), which provide a comprehensive assessment of both luminal and extraluminal disease, have supplanted fluoroscopic studies. MRe is particularly exciting because it provides all of the information of CTe as well as additional information regarding disease activity without exposing patients to ionizing radiation.

The small bowel series and barium enema are essentially historic examinations for the detection and evaluation of inflammatory bowel disease. These studies, while effective at detecting mucosal abnormalities, are poorly tolerated by sick patients, provide assessment only of the bowel lumen (particularly the mucosa) and are physician dependent, limiting their reproducibility. A properly performed and interpreted SBFT or BE is unfortunately a lost art and available only in select centers. Additionally, of course, these studies may involve significant doses of radiation. Colonoscopy remains an essential diagnostic tool to visualize and biopsy the mucosa of the large bowel and distal ileum in **inflammatory bowel disease (IBD)**.

CTe is currently the gold-standard imaging study for the evaluation of Crohn's disease, especially non-mucosal. The fundamental difference between a traditional CT and a CTe examination is the use of "negative" or low-attenuation oral contrast (which is dark on CT) as opposed to the more commonly used "positive" or high-attenuation contrast such as barium (white on CT). Negative oral contrast yields distension of the small

bowel with low-attenuation, dark, fluid. After administering IV contrast, the mucosa enhances, which is striking against the dark bowel lumen. The degree of mucosal enhancement has been correlated with disease activity in patients with Crohn's disease.

CTe also provides fast, well-tolerated and comprehensive evaluation of all bowel segments as well as evidence of extraluminal complications such as abscess formation. However, there are drawbacks and limitations inherent to this technique.

MRe is superior to other imaging modality in its ability to distinguish active from chronic fibrotic disease.

The potential dangers of ionizing radiation exposure have been increasingly recognized in recent years as more people undergo CT examinations, but also as more people undergo multiple CT examinations. This reality is of particular concern in Crohn's disease as patients are often diagnosed when young and will often require multiple imaging evaluations during their lives. This repeated radiation exposure may lead to an increased lifetime risk of developing cancer, particularly lymphoma. Because negative contrast is used for CTe, small abscesses may be difficult to distinguish from loops of bowel and regular CT or MRe should be employed if abscess is suspected or in the immediate post operative state.

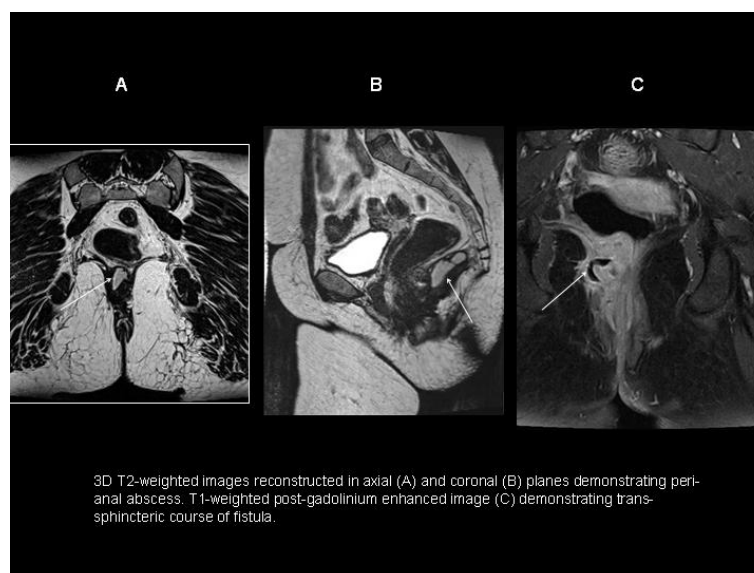
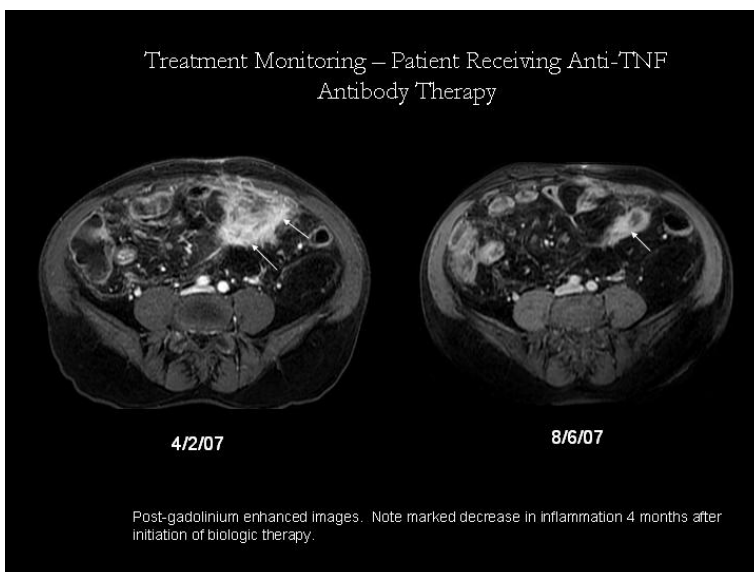
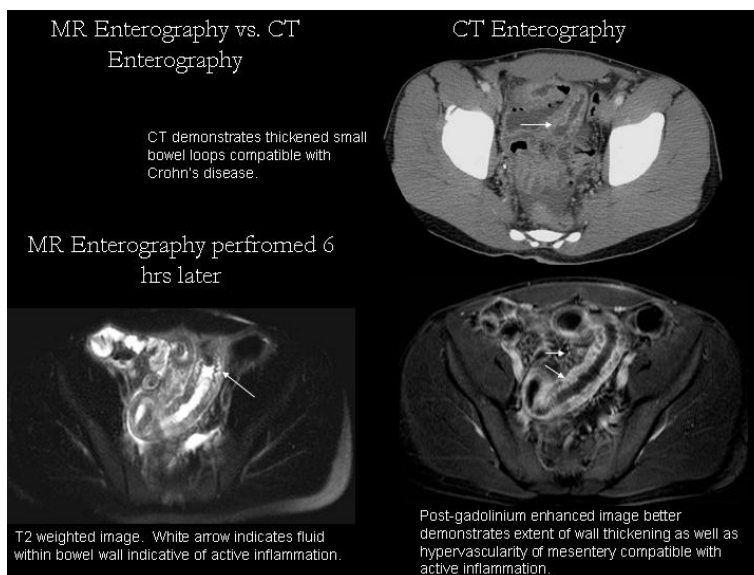
MRI evaluation of the small bowel is a fairly new application. MRe refers to comprehensive examination of the small bowel using the same oral contrast material as used in CTe. Previously, MRe could not adequately assess the small bowel because of small bowel motion as well as the presence of air within bowel loops, which created extensive imaging artifacts. Additionally, traditional MR

coils were designed to cover the abdomen or pelvis, but did not provide a large enough field of view to cover both the abdomen and pelvis simultaneously. These problems have recently been overcome with faster sequences, including the adaptation of sequences originally intended for cardiac imaging, oral contrast regimens which minimize small bowel air, and new coils which enable much larger fields of view.

MRe, however, has many potential advantages over CTe. The ability to assess disease activity is probably the most important advantage of MRe over CTe. Clinically, it is often difficult to distinguish between active and chronic changes of inflammatory bowel disease in symptomatic patients. This distinction has become increasingly important with the advent of new, biologic therapies for active inflammatory disease which, while extremely effective, are expensive and may also be potentially toxic. Although beneficial for patients with active inflammatory disease, these agents do not benefit patients whose symptoms are secondary to a fibrotic stricture. Rather, these latter patients will require surgery for symptomatic relief.

MRe is superior to other imaging modality in its ability to distinguish active from chronic fibrotic disease. This unique ability is multifactorial. First, MRI, particularly, T2-weighted images, is exquisitely sensitive to the presence of fluid which has been shown to indicate the presence of active inflammation rather than chronic disease. Fluid is detected easily as it is very bright on MRI images against the black background of fat. These fluid-sensitive and fat-suppressed images are a critical portion of MRe examinations.

Second, the contrast resolution of MRI is far superior to that of CT (see Images of the month). Contrast resolution refers to the ability to detect subtle differences in signal or attenuation of normal versus abnormal tissues. Thus, the abnormal enhancement of the small bowel mucosa on MR imaging is significantly more dramatic than the same



change demonstrated on CT, allowing both for more accurate diagnosis and grading of disease activity.

Third, MRe provides assessment of each bowel segment at multiple time points and allows for real-time cine bowel imaging. This is of critical importance. Because CTe provides only a single snapshot of the bowel, it may not be possible to distinguish a collapsed loop, which may simply be the result of normal peristalsis, from a strictured bowel loop. During a small bowel series, the radiologist would further evaluate such loops with real-time fluoroscopic imaging. This is simply not possible with CT imaging due to what would be a prohibitive radiation dose.

Because MRe does not involve exposure to ionizing radiation, imaging of each bowel segment is performed at multiple time points to allow collapsed bowel segments to reopen with normal peristalsis. Additionally, cardiac real-time cine imaging sequences have been adapted to allow imaging of concerning segments as a “movie” loop in real time.

Finally, MRe is also more accurate than CT to image some extraluminal complications of Crohn's disease, specifically fistulae. Fistulae, particularly peri-anal, can be difficult if not impossible to detect on CT examinations. Because of the exquisite sensitivity of MRI to detect fluid as well as its superior soft tissue contrast, MRe easily depicts entero-entero, enterovesicular, enterocutaneous, peri-anal fistulae and perianal abscesses. Not only is sensitivity improved with excellent depiction of the anatomic relationship of fistulae to sphincter musculature. This anatomic “road-map” is critical for accurate surgical planning. Another advantage of MRe is that it can detect Primary Sclerosing Cholangitis, an extraintestinal complication seen in some patients with IBD.

Of course, MRe has drawbacks compared to CT. It is more time-consuming, requiring 20-25 minutes and multiple episodes of breath holding. According to the 2009 Medicare reimbursement schedule, it is 1.5 X more expensive. Nephrogenic sclerosis rarely complicates gadolinium administration in patients with significant renal dysfunction. Therefore, this agent should be avoided in patients with known renal failure/insufficiency.

These factors must be considered

when choosing an examination for each individual patient. As a general rule, patients who cannot hold their breath for 15 seconds should not undergo MRe as the examination will likely be limited by respiratory motion. Additionally, in this era of rising health-care costs it is critical to utilize limited resources appropriately. The added value of MRe is particularly significant in young patients, female patients, and patients with chronic disease who will likely require multiple imaging examinations throughout their lives. MRe is worthwhile and appropriate in this population to minimize lifetime radiation dose and its consequences. Finally, MRe may be cost-effective in patients considering biologic therapies, which are very promising for active inflammatory disease but ineffective for symptoms related to fibrotic strictures.

Research on the efficacy of MRe and its role in imaging patients with CD is ongoing at Rhode Island Hospital and its affiliates. Data from our ongoing trials highlighting the spectrum of CD as demonstrated by our first 100 exams with MRe have been presented at the 2008 Annual Meeting of the American College of Gastroenterology and will be pre-

sented at the Annual Roentgen Ray Society Meeting. This study has shown that MRe nicely demonstrates the entire spectrum of CD including active and chronic disease, skip lesions, colonic lesions, abscesses and fistulae. Additionally, our data have shown that MRe is well tolerated by patients and significantly impacts patient management as evaluated by a survey of the ordering clinicians who unanimously responded that MRe positively impacted patient management and that they will use it to benefit future patients. Therefore, we speculate that MRe will be the preferred method of imaging for CD in the near future.

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