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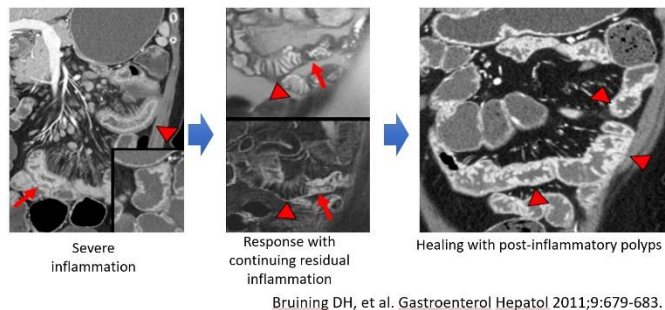
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Imaging of crohn's inflammation and strictures: our role in guiding gastroenterologists and surgeons now and in the future

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Fig. 1. The ability of CT and MR enterography to show progression, response, and remission was shown early in their implementation in clinical practice.

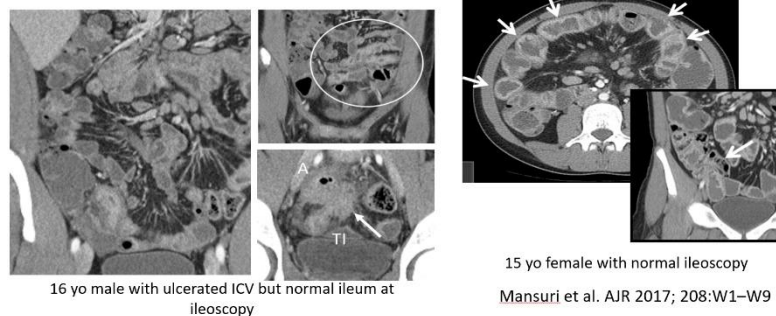


MR and CT enterography (MRE/CTE) are performed and ingestion of oral contrast agents and provide high resolution, multiplanar images of the small bowel and perienteric mesentery. The primary purpose of MR and CT enterography in Crohn's disease patients is to (1) detect small bowel inflammation, (2) penetrating and stricturing complications of Crohn's

disease, and to understand and monitor the location, severity and length of Crohn's disease inflammation and strictures.

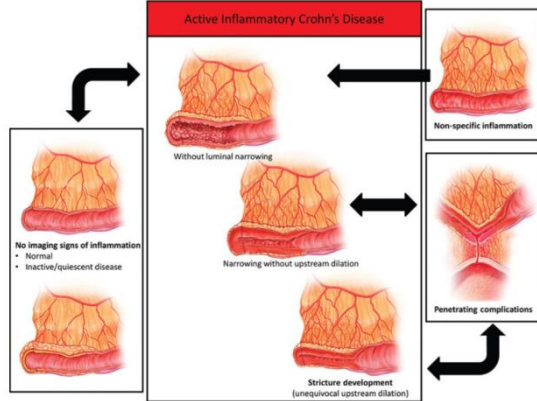
Early in the clinical development it was recognized that MR and CT enterography were able to display active inflammatory Crohn's disease and its progression or remission (Fig. 1). Moreover, up to 50% of Crohn's patients with a normal ileoscopy will have active small bowel inflammation at CTE/MRE at diagnosis, termed "endoscopic skipping of the terminal ileum" (Fig. 2). Unequivocal small bowel inflammation at CTE/MRE may be present in some patients despite normal ileoscopy and biopsy.

Fig. 2. "Endoscopic skipping" of the terminal ileum refers to proven small bowel inflammation on imaging or pathology in the presence of normal endoscopic appearance, and can occur with proximal small bowel disease, intramural inflammation, suboptimal endoscopic assessment (failed ileal intubation).



Consequently, CTE/MRE have become recognized by numerous medical societies and needed images tests to diagnose and monitor small bowel Crohn's disease. Their use is predicated on a common understanding of the progressive and remitting nature of Crohn's disease (Fig. 3).

Fig. 3. Morphologic construct depicting radiologically observed progression and remission of small bowel Crohn's disease.

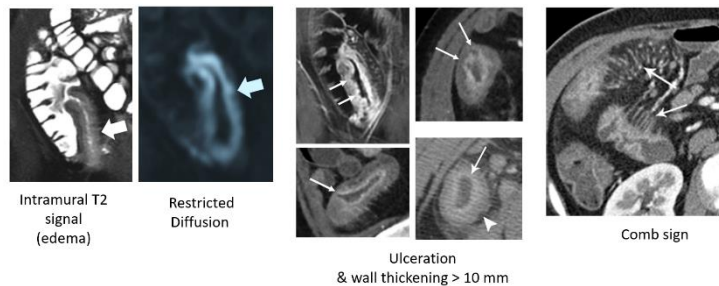


According to the SAR/AGA/SPR consensus recommendations, small bowel Crohn's disease is present when small bowel wall thickening and hyperenhancement are present in known Crohn's patients, or when enteric inflammation is asymmetric or co-exists with the typical penetrating complications of Crohn's disease. Because a variety of biologic agents are now available to treat moderate to severe Crohn's disease, radiologists should be able to identify moderate and severe inflammation when it is present.

Several MR indices of Crohn's disease inflammation severity have been developed, and they highlight reproducible imaging findings that change rapidly with treatment. Imaging findings of moderate to severe small bowel inflammation include intramural T2 signal, restricted diffusion, ulceration, marked small bowel wall thickening, and the comb sign (Fig. 4).

CTE/MRE have weaknesses in identifying mild disease activity, as well as inflammation in the proximal gut. radiologists should look diligently for gastroduodenal Crohn's (principally duodenal inflammation and strictures), jejunal Crohn's disease (as it is associated with worse outcomes). Jejunal

Fig. 4. Imaging findings indicating moderate to severe small bowel inflammation at CT and MR enterography.



Rimola J, et al. Gut 2009;58:1113-20; Zappa M et al. IBD 2011;17:984-93.; Steward MJ et al; Eur J Radiol 2012;81:2080-8; Kim KJ, et al. IBD 2015;21:101-9.

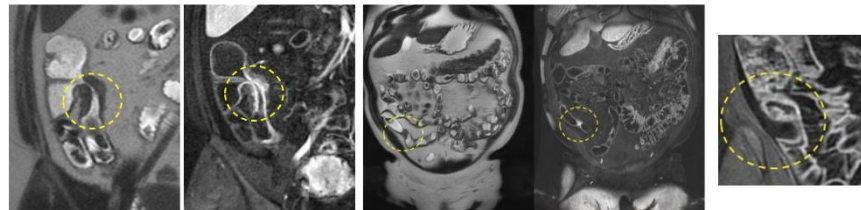
Fig. 5. Crohn's small bowel strictures are defined by the presence of luminal narrowing, bowel wall thickening, and unequivocal small bowel dilation. CONSTRUCT criteria also take into account inability of an adult or pediatric endoscope to traverse a stricture.

<p>Luminal narrowing</p> <p>(≥ 50% compared to non-obstructed distal small bowel)</p>	<p>Bowel wall thickening</p> <p>(≥ 25% compared with normal bowel or ≥ 4 mm)</p>	<p>Unequivocal proximal small bowel dilation</p> <p>(≥ 3 cm)</p>

disease disrupts the normal fold pattern and is often asymmetric. Inflammation at enteric anastomoses is generally non-specific (as can occur in non-Crohn's patients), with recurrence reserved for inflammation > 1 cm in length or asymmetric.

Small bowel strictures are defined by luminal narrowing, bowel wall thickening, and associated small bowel dilation (generally proximal and 3 cm or greater) (**Fig. 4**). It should be recognized that not all endoscopic and surgical strictures will meet CTE/MRE criteria, as associated small bowel dilation may not reach the 3 cm threshold. In particular, short anastomotic strictures often do not have threshold small bowel dilation. Short segment stricture often enhance early (**Fig. 5**). When strictures are present, radiologists should describe their location, length, association with any enteric anastomosis, degree of associated dilation, concomitant penetrating complications, and if chronic mesenteric venous occlusion is present. Small bowel strictures possess multiple regions of luminal narrowing with intervening inflammation, or may be defined surgically as two nearby regions of narrowing. Maximal associated small bowel inflammation generally occurs proximal to a stricture but may occur within a stricture with multiple regions of narrowing.

Fig. 6. Short strictures are often missed by radiologists but are generally highlighted by intense enhancement in the enteric phase (below). Additionally, short anastomotic strictures may not demonstrate threshold proximal dilation to be diagnosed as a stricture at CTE/MRE (right).



Penetrating complications of Crohn's disease include simple sinus tracts (which can be stable over long

periods of time), simple fistulas, complex fistulas (i.e., with branching, often in a "star" or "asterisk" configuration), inflammatory masses, abscess, and perforation.

Fig. 7. Transmural healing implies remission of all imaging findings of inflammation and is associated with improved long-term outcomes and prolonged remission.

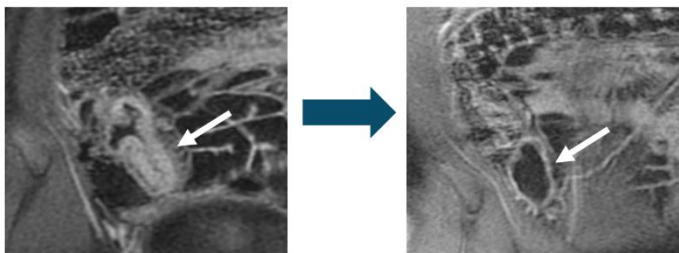


Fig. 8. While imaging response is associated with improved long-term outcomes, standardized imaging assessment of Crohn’s inflammation response is lacking. A practical proposal that can be used in clinical practice is shown.

Kwapisz L, Bruining DH, Fletcher JG. *Korean J Radiol.* 2022;23(1):1-5.

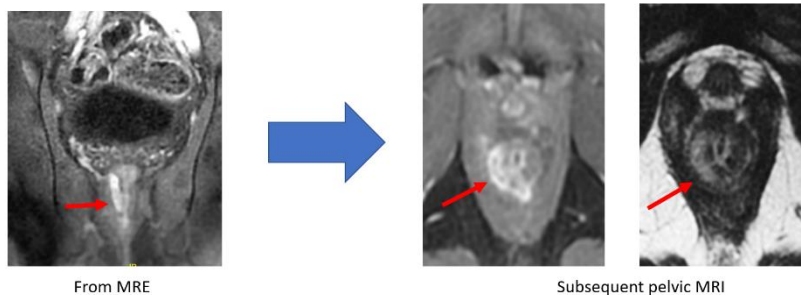
Response Assessment Category	Proposed Criteria	Rationale
Transmural Healing	Resolution of inflammation by imaging	Ass’d with mucosal healing and outcomes
Response	All sites ↓ inflammation WITHOUT new sites, strictures or penetrating complications	Ass’d with long term outcomes
Partial response	Some sites get better, none get worse	Ass’d with long term outcomes
Stable Disease	No change	Importance depends on severity and burden
Progression	↑ inflammation WITH new sites, strictures, or penetrating complications	Irreversible bowel damage and likelihood of surgery

The goal of Crohn’s disease medical therapy is the healing of all Crohn’s disease enteric inflammation. At endoscopy, the term used is “mucosal healing”,

which is associated with improved long-term outcomes. “Transmural healing” can be observed on MRE/CTE and indicates remission of all imaging findings of inflammation. Ordas et al. found that

there is about 90% agreement between mucosal healing at endoscopy and transmural healing at MRE. “Response” is another term that is associated with improved long-term outcomes (i.e., less risk of hospitalization or surgery) and indicates a decrease in the length and

Fig. 9. All CTE/MRE exams should image the anus and state presence/absence of perianal disease. Asymptomatic fistulas can occur in up to 12% (generally simple unbranched, intersphincteric fistulas), with about 20% progressing in 18 months.



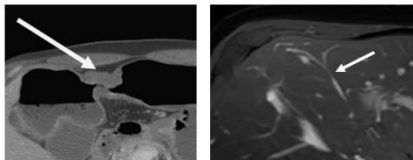
Kim et al. *Clin Gastro & Hepatol* 2020; 18:415 - 423

severity of small bowel inflammation. These terms are becoming more important in modern gastroenterologic practice, as it is realized that tight control of inflammation (i.e., escalation of therapy with progression; maintenance with response but not healing) results in improved outcomes. Progression of Crohn’s inflammation is recognized when the length and severity of small bowel inflammation increases, or when penetrating or stricturing complications develop. A practical approach to response assessment is summarized in **Fig. 8.**

Fig. 10. Extra-enteric complications detected at CTE/MRE can be related to Crohn's disease or related to Crohn's disease therapies.

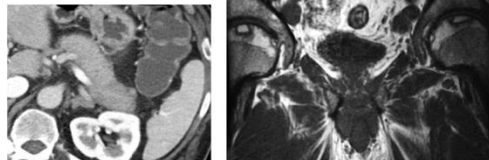
Related to Crohn's disease

- Heavy hitters – PSC, sacroiliitis, renal and GB stones, growth retardation, osteoporosis, CD of the pouch
- Occasional – Pancreatitis (Autoimmune – IDCP; AZA)
- Rare – Small bowel cancers, anal cancers



Related to therapies

- Heavy hitters – AVN, osteoporosis, infections
- Occasional – Pancreatitis (AZA-induced), skin cancers, lymphoma
- Rare – hepatotoxicity (MTX)



CTE and MRE are designed to image the large and small bowel, including the anorectum and appendix. Appendiceal

and perianal involvement occurs in about 25% of patients, and can be critical in making the diagnosis of Crohn's disease (rather than indeterminate colitis). All CTE/MRE exams should include images of the anus, with radiologists always commenting on the presence or absence of perianal fistulas. Asymptomatic perianal fistulas are often detected on routine CTE/MRE, with about 20% progressing to become symptomatic over the next 18 months (Fig. 9). Extra-enteric complications in Crohn's disease include complications that are related to Crohn's disease itself (e.g., such as PSC or osteoporosis), or related to Crohn's disease therapies (e.g., such as AVM or infection), and occur along a well-defined spectrum (Fig. 10).

Helpful References

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