Assessing the activity of Crohn's disease

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Aim

With this predominantly pictorial based overview, we aim to enlighten the reader about the different features of disease activity of Crohn's disease. The review focuses on small bowel Crohn's disease, as assessment of colonic disease is mostly endoscopic.

We will briefly discuss the importance of accurate assessment of disease activity in Crohn's disease and the increasingly important role MRI plays in this assessment. ¹,²

With this poster we aim to:

• highlight what the clinician needs and wants to know from our Crohn's disease MRI reports.

• enable the reader to perform an assessment of disease activity by using key MRI signs of active and inactive disease.
Methods and materials

• In a stepwise approach, using examples from MRI small bowel studies as well as a review of the literature, we aim to demonstrate and discuss the common and validated key signs seen in the different stages of disease activity.
• These signs include layered/stratified enhancement, the comb sign, bowel wall oedema, restricted diffusion within the bowel wall and fibrotic strictures.  
3,4
• By using these key signs we have subdivided MRI-based disease activity into two groups, active and inactive disease. We also outline a simplified and structured approach to the complex task of assessing disease activity in small bowel MRI studies in patients with Crohn's disease.
Results

- The assessment of disease activity is complex, but vital for treatment planning and to guide the clinician in the use of immune-modulating, biologic and surgical therapies.\(^4,5\)

- Assessing disease activity and severity remains difficult as there is a lot of overlap between stages of disease activity. Within individual patients, and even within lesions, active and inactive disease may co-exist. Accurate assessment requires a combination of clinical, biochemical, endoscopic, histological and radiological measures.\(^5\)

- There are numerous tools to assess the disease activity, including: Crohn's disease activity index, faecal calprotectin, ileocolonoscopy, imaging, surgery and histopathology.

- The role of imaging is ever increasing in the assessment of disease activity in Crohn's disease in which CT enterography/enteroclysis (CTE) and MR enterography/enteroclysis (MRE) play dominant roles. The signs in the MR enterography and MR enteroclysis studies are the same. CTE and MRE have similar diagnostic accuracies and imaging findings and can image areas of the small bowel that are difficult to reach with ileocolonoscopy.\(^2,6\)

- MRI has become the preferred imaging modality as there is no ionising radiation involved. It also allows multiplanar and dynamic interrogation, has a high soft tissue contrast and has a high sensitivity of 88-89\% and specificity of 78-100\% for assessing disease activity.\(^1,2,7\)

The clinician wants to know:

1. if there is **active disease**
2. the **location** of disease, and how much normal small bowel is present proximal to the diseased segment.
3. the **extent** of the disease
4. if there are **strictures/stenoses**
5. presence of **fistulas** to adjacent organs
6. if there are **obstructions/adhesions**
7. about other **complications** e.g. abscess formation

All these questions can be answered with an adequate MRI small bowel study.

We will now mainly focus on how to assess the disease activity (active versus inactive disease) through the assessment of common MRI signs seen in the different stages of
disease activity in Crohn's disease, illustrating the key findings with the use of numerous imaging examples from MRI small bowel studies.

**Active versus inactive disease**

There are many signs to look for on MRI when assessing disease activity, but try and keep it simple and subdivide the disease into active (acute active or chronic active disease) versus inactive disease (fibrostenosing disease).\(^1,2,4,5,8,9\)

1. **Active disease signs (acute/chronic):**

   **Acute**
   
   - Bowel wall thickening and edema in active inflammatory lesions (fig.1-3)
   - Layered/stratified enhancement of the bowel wall (fig.4-7)
   - Comb sign indicating mesenteric engorgement/hyperemia (fig.8 and 9)
   - Mesenteric edema and enhancement (fig.10)
   - Restricted diffusion (fig.11) \(^3,6,10\)
   - (abscess/phlegmon) (fig.12)

   **Chronic (perforating)**
   
   - Deep ulcerations/sinuses/fistulas (fig.13,14,21-23)
   - Fat halo sign (fig.15-17)
   - Cobblestoning (fig.18)
   - Fatty proliferation (fig.19 and 20)

2. **Inactive disease (signs):**

   - Fibrostenotic stricture (fig.24 and 25)
   - Pseudosacculations (fig.26)
   - Adhesions/obstructions (fig.27)
   - Reparative stage *(pseudopolyps and filliform polyposis)* (fig 28)

As mentioned before, there is a lot of overlap between the different stages of disease activity (fig 29). We ideally look for multiple MRI signs that can be seen in the different stages of disease activity to help us decide if active disease is present. The above described signs should merely be used as a guide to establish the activity, knowing and remembering that there is a lot of overlap and that lesions may show features of both active and inactive disease."
Fig. 1: A T1 post contrast image demonstrating bowel wall thickening (yellow arrow).

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Fig. 2: A T2 weighted image with fat saturation demonstrating mural edema of the thickened bowel wall.

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Fig. 3: Bowel wall thickening and a long segment of narrowing in keeping with an active inflammatory stricture (yellow arrow).

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**Fig. 4:** A T1 post contrast image demonstrating layered or stratified wall enhancement, with vivid mucosal and serosal enhancement and less vivid submucosal enhancement.

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**Fig. 5:** A schematic diagram further illustrating the concept of layered enhancement, with the white lines representing the mucosal and serosal enhancement.

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Fig. 6: A T1 post contrast image demonstrating an image of layered enhancement transverse to the actively inflamed bowel, the so called "Target-sign".

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Fig. 7: A schematic diagram of the "Target-sign" with the white lines demonstrating vivid enhancement of the mucosa and serosa, separated by the less vividly enhancing (grey zone) submucosa.

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Fig. 8: "Comb sign" of the engorged vasa recta supplying the actively inflamed loop of bowel.

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Fig. 9: Another example of a "comb sign", with enlarged and enhancing lymph nodes draining the inflamed segment of bowel (yellow arrow).

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**Fig. 10:** A T2 fat sat image demonstrating mesenteric edema (yellow arrow) adjacent to actively inflamed bowel.

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**Fig. 11:** Diffusion weighted imaging is a relatively new technique and merging as an important tool in the assessment of actively inflamed bowel. This image demonstrates quite striking restricted diffusion in a segment of actively inflamed bowel, demonstrated by bright signal on the DWI images and corresponding low signal on the ADC map (yellow arrows).

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Fig. 12: A T1 post contrast image of an abscess adjacent to a loop of actively inflamed bowel (yellow arrow), an important complication for the clinician to be made aware of.

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**Fig. 13:** Extensive deep transmural ulcers in chronic active (perforating disease) as demonstrated by T2 bright lines extending through the full thickness of the bowel wall (yellow arrow). This could go on to form sinuses and fistulas.

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Fig. 14: The same deep transmural ulcers as in fig.13, but now demonstrated by enhancing transmural ulcers on this T1 post contrast image.

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**Fig. 15**: Thickened terminal ileum (yellow arrow), difficult to assess the exact stage of activity on this single sequence, now move onto fig.16.

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**Fig. 16:** This fat saturated T1 weighted image of the same segment of bowel in fig.15, demonstrates a similar layered pattern of enhancement as seen with the "Target sign", however there is fatty infiltration of the bowel wall with no submucosal enhancement seen at all. This is the "Halo-sign", with the fatty infiltration indicating a more chronic state of disease activity.

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Fig. 17: A schematic diagram illustrating the difference between the "Target-sign" (seen in acute active disease) and the "Halo-sign" type of enhancement (seen in chronic active disease). The black zone in the "Halo sign" representing fat infiltration of the bowel wall.

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**Fig. 18:** This image demonstrates the appearance of "cobblestoning" on MRI in Crohn's disease, which is caused by transverse and longitudinal fissuring interspersed by islands of mucosa.

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**Fig. 19:** This image (yellow arrow) demonstrates proliferation of fat adjacent to a more chronic actively inflamed loop of bowel, otherwise referred to as "creeping fat".

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**Fig. 20:** This is the transverse image of the "creeping fat" seen in fig.19

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Fig. 21: This image demonstrates an active enhancing fistula (yellow arrow) between ileum and the right iliacus muscle. Chronic (inactive) fistulas are generally of low signal and do not demonstrate this type of vivid enhancement.

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Fig. 22: An active, enhancing, enterocolic fistula is evident on this image (yellow arrow).

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**Fig. 23:** A True Fisp image demonstrating a low signal chronic fistula (yellow arrow) between distal small bowel and the skin surface.

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**Fig. 24:** This T1 post contrast image demonstrates a fibrotic stricture with mild transmural enhancement, rather than a layered type of enhancement. There is no significant bowel wall thickening, nor are there any other signs of active inflammation.

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**Fig. 25:** This still image of a dynamic True Fisp cine study demonstrates a fibrostenotic stricture (yellow arrow), with dilatation of the bowel proximal to the stricture (red arrow). These types of strictures are not amenable to medical therapy and if severe may need to be resected.

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Fig. 26: Pseudo-sacculations can be seen on the anti-mesenteric side of inactive diseased bowel.

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Fig. 27: T2 weighted image demonstrating areas of kinked small bowel (yellow arrows) adherent to/inseparable from other loops of small bowel in keeping with adhesions.

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**Fig. 28:** On rare occasions we can identify a reparative stage of disease, which in this patient is demonstrated by the relatively uncommon finding of filiform polyposis (yellow arrow).

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**Fig. 29:** This is an example of overlap of findings that can been seen in active and inactive (fibrostenosing) disease. There is a fibrostenosing stricture with dilation of the bowel proximal to the stricture (red arrow), superimposed on this there is active inflammation as demonstrated by the "comb sign" and layered enhancement (yellow arrow). There is also some fatty infiltration of the bowel wall.

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Conclusion

Small bowel MRI is an important and useful tool in assessing disease activity in patients with Crohn's disease.

Assessing disease activity can be complex and there is a lot of overlap between active and inactive disease, but when a simplified and structured approach is applied, using the key MRI findings we have illustrated, achieving an accurate assessment of Crohn's activity is significantly easier.
References