Dynamic MRI Enterography of the Small Bowel in Crohn's Disease

B. Statton, C. Todd, A. Boxall & D. Goswami
Charing Cross Hospital, Imperial College Healthcare NHS Trust, London, UK

Background

Magnetic Resonance Imaging (MRI) of the small bowel with oral and intravenous contrast media is a well recognised technique for the imaging of patients with Crohn's disease (1,2). MRI has the advantages of demonstrating areas of inflammation and stricture as well as the extramural components of the disease such as enlarged mesenteric vessels and lymphadenopathy.(2)

MRIs lack of ionizing radiation means it is ideal for the serial imaging of patients with relapsing remitting diseases such as Crohn's disease (3).

Oral contrast media can be given either via a naso-jejunal (NJ) tube (enteroclysis) or ingested orally (enterography). When using MR Enterography the amount of contrast and timing of examination need to be considered carefully (4). We have developed a technique of MR Enterography, which includes a dynamic sequence, to image our patients with Crohn's disease.

This poster deals with two of the challenges that are faced in imaging the small bowel with MRI: obtaining optimum distension of the bowel lumen with the minimum discomfort to the patient and differentiating true strictures from collapsed segments of normal, peristalsing small bowel.

MRI Technique

The patient is required to fast for 8 hours prior to their arrival in the MRI department.

They are instructed to arrive one hour before the beginning of their examination, during which time they drink 1.5 liters of Polyethylene glycol solution, prepared by dissolving 1.5 59g sachets of Klean-Prep® (Norgine, Middlesex, UK) in water. It is important that the patient drinks this solution gradually over the whole hour to ensure even distension of the entire small bowel. In the majority of cases the patient can manage to drink at least one liter of this solution.

The initial images are acquired one hour after the commencement of the oral contrast ingestion. All examinations are performed on an Avanto 1.5T MR system(Siemens Medical Systems, Erlangen, Germany). Two body matrix coils are placed over the abdomen and the patient is given headphones through which they receive breathing instructions.

The sequences are planned on a 3 plane free breathing localizer.

Dynamic Imaging

A coronal True Fast Imaging with Steady-state free Precession (Tru-FISP) sequence is performed first (FFE-Philips, FIESTA-GE). A set of 13 coronal images covering the entire small bowel is acquired during a single breath hold. This set is then repeated 8 more times. The images of these nine measurements are then re-ordered by their table position and provide a view where each coronal slice is viewed nine times before moving onto the next slice position. When viewed in a cine format this presents a view corresponding to the peristalsis of the small bowel.

Before the remaining sequences 20mg hyoscine-N-butylbromide (Buscopan®, Boehringer, Ingelheim, Germany) is administered I.V. to achieve bowel paralysis and avoid motion artefact on subsequent sequences.

The parameters of the subsequent sequences are summarized in Table 1.

Teaching Points

MR Enterography vs MR Enteroclysis
Although MR enteroclysis achieves better distension of the small bowel, MR enterography has been shown to be just as sensitive in showing active inflammation and strictures in patients with Crohn's disease (5).

MR enteroclysis requires the placement of an NJ tube, either fluoroscopically, exposing the patient to ionizing radiation, or endoscopically, both techniques incurring increased costs and demanding coordination with departments outside the MRI unit.

MR enterography is better tolerated and causes less discomfort to patients who will then be more willing to undergo repeat procedures as may be required by the relapsing remitting nature of Crohn's disease (1).

Dynamic MR Sequences
Dynamic MR imaging has been shown to allow monitoring and quantification of small bowel peristalsis in normal subjects(6).

During MR imaging of the small bowel a dynamic sequence can help differentiate fibrotic strictures from those segments in normal peristalsis (Image 1).

A segment of bowel that appears to be collapsed on any of the static sequences can be checked against its appearance on the dynamic Tru-Fisp images. In this sequence the segment has been imaged at nine time points and therefore if it shows normal distension at any point during the dynamic sequence this provides reassurance that it is a normal segment of bowel, imaged during contraction on the static sequence. However, a segment which is consistently undistended on the dynamic sequence is likely to represent a true stenosis.

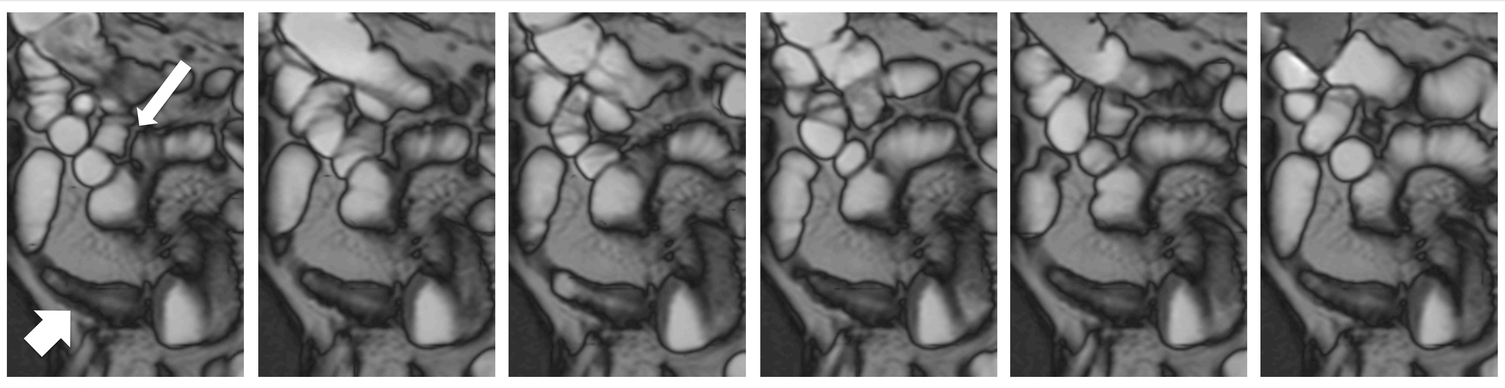

Image 1.
A series of cropped images from the dynamic Tru-Fisp sequence.
The stenosis (short arrow) remains undistended on every frame throughout the sequence whereas normal bowel (long arrow) shows the collapse and distension of normal peristalsis.

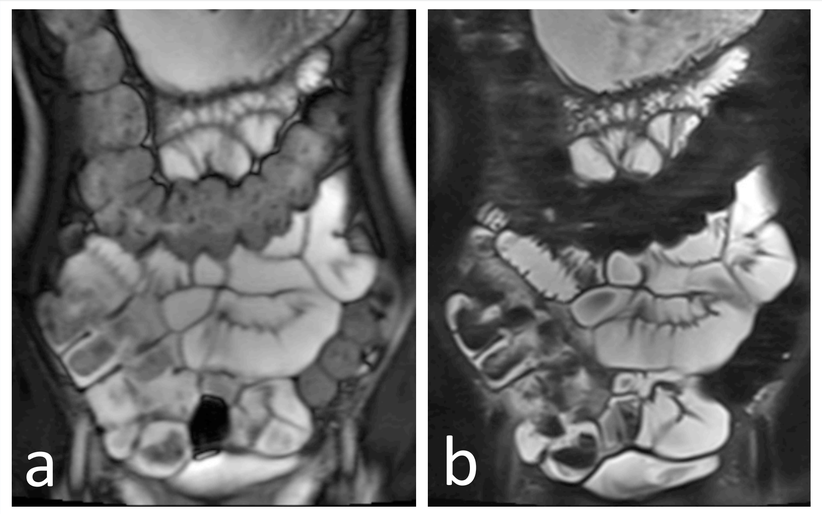

Image 2.
A coronal Tru-Fisp (a) and HASTE (b) showing even distension of the whole small bowel achieved with MR enterography.

Sequence	Dynamic T2 Tru-Fisp	T2 Tru-Fisp	T2 Tru-FISP	T2 HASTE	T1 Flash pre/ post Gd
Orientation	Coronal	Coronal	Axial	Coronal	Coronal
Scan Time	2m54sec (9x8secs)	20sec	13sec	30sec	2m07s (2x26secs with 75s break)
Slices (mm)	12	24	23	24	72
Thickness (mm)	7	5	7	5	2
Gap (mm)	5	0	7	0	.4
TR (ms)	3.79	3.34	2.83	1240	3.52
TE (ms)	1.9	1.38	1.2	93	1.16
Averages	1	1	1	1	1
Matrix	156x256	192x256	166x256	218x256	230x256
Flip Angle (°)	70	60	70	150	12
Measurements	9	1	1	1	2

Conclusion

MR enterography can provide multi-planar, high contrast resolution imaging of the small bowel without the use of ionizing radiation, an important factor for patients who require serial imaging.

Motion related artefacts due to breathing can be overcome by the use of ultra fast sequences that can be acquired in one breath hold.

Provided the patient can adhere to a strict drinking regimen we have found that MR enterography can provide good visualization of the entire small bowel lumen (Image 2).

A dynamic sequence can provide differentiation of fibrotic strictures and those segments in normal peristalsis.

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