Potential Pitfalls in MRI enterography - A pictorial review

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Learning objectives

MR enterography (MRE) recently has emerged, and is gaining acceptance, as a new method for evaluation of the small bowel. Knowledge of both technical limitations and imaging mimics of pathological processes are necessary to interpret studies accurately. This exhibit aims to review some of the pitfalls related to performance and interpretation of this technique.

We have categorised potential pitfalls as follows, where possible suggested corrective measures and provided pictorial examples

- MRI-specific artefacts
- Technique-related problems
- Normal variants mimicking pathology
- Extra intestinal pathologies mimicking GI pathology.
- Specific pitfalls and mimics in assessment of Crohn's Disease

Background

There are a number of inflammatory conditions of the colon and small intestine, including but not limited to Crohn's disease and ulcerative colitis. While direct visualisation of the large bowel is generally readily achievable via colonoscopy, evaluation of the small bowel has historically provided a challenge to the endoscopic and radiologist.

Traditionally small bowel follow through and small bowel enteroclysis have been the imaging studies of choice to assess the small bowel. With technological advances there has been a move towards the use of the cross sectional techniques. These newer methods confer the advantage of ability to assess for both extra-enteric complications and active inflammation.

CT and traditional enteroclysis result in high radiation doses, which is of concern in the relatively young population group that comprise the majority of patients referred for small bowel imaging. MR enterography (MRE) has become increasingly utilised in assessment of small bowel pathology, particularly Crohns disease as it eliminates radiation exposure. The technical and logistical difficulties of nasojejunal tube insertion associated traditional fluoroscopic enteroclysis or CT enteroclysis are also circumvented thus increasing patient compliance with future studies.
Caution should however be employed in interpretation of this novel technique to avoid errors in diagnosis and a knowledge of limitation of the technique, as with all imaging modalities, is essential.

All sequences described relate to, and all are images acquired on Symphony 1.5 Tesla Siemens MRI system. (TE 4.48, TE2.24, EC 0)

**Imaging findings OR Procedure details**

**MRI-specific artifacts.**

The main diagnostic T2 weighted sequences employed in MRE include;

1. True Fast imaging with steady-state free precession.
2. Balanced fast field Echo (FFE) - single shot techniques.
3. HASTE, SSFSE, Single Shot Turbo Spin ECHO.

Each have their own inherent advantages and disadvantages.

**TruFISP**

- fast technique, therefore no need to breathe hold
- highest signal noise ratio per unit time of all sequences, good soft tissue contrast
- has both T1 and T2 weighting producing strong contrast between tissues with different ratios of T1 and T2
- is insensitive to flow artefact

**Problems**

Susceptible to "black boundary" or chemical shift artifact. (Fig 1)

The black border artifact seen on trueFISP images can complicate the assessment of bowel wall thickness. Wall thickness of > 3mm is considered abnormal in well distended bowel. Black boundary artefact may lead to overestimation of bowel wall and false positive interpretation.

**Solutions**

- Bowel wall can also be differentiated from artifact by careful scrutiny as the very low signal intensity is different from normal or abnormal small bowel wall/folds which are usually moderate signal intensity.
• Fat saturation may be used. Bowel wall thickness is more accurately assessed with a HASTE sequence may be used, which is insensitive to chemical shift artifact and is hence not susceptible to black border artifact.

Bowel wall thickness is more accurately assessed with a HASTE sequence, which is insensitive to chemical shift artifact and is not susceptible to black border artifact.

**Balanced fast field echo (FFE) sequences (HASTE)**

- generated by rapid acquisition and relaxation enhancement (RARE) with ultrafast acquisition therefore time usually order of seconds
- excellent correlation between biological activity and T2 weighted wall signal
- resistant to magnetic susceptibility and chemical shift artefacts

Problems

Long TE in combination with single slice acquisition makes HASTE sequence sensitive to motion and flow artefact. (Fig 2)

Inferior soft tissue contrast and insufficient information regarding mesentry due to k space filtering effects. (Fig 3)

Fast spin-echo T2-weighted images when used in MR enterography are particularly prone to intraluminal flow artifact due to intestinal peristalsis. This may be mistaken for or mask intraluminal and mural pathology. (Fig 4)

Solutions

- Correlation with FISP images can be performed. As mentioned these sequences are relatively insensitive to flow artefact and can eliminate this problem and provide homogenous luminal opacification. (Fig 5)
- Use of antispasmodics such as hyoscine butylbromide or glucagon can reduce fluid flow in the lumen of the bowel thus reducing such artefacts

**Technique-related problems**

**Poor patient preparation**

Patient preparation varies between institutions with reference to pre-procedural fasting time. To our knowledge no rigorous studies have been performed regarding the benefits of various fasting time and successful imaging has been achieved following short fasting
time periods of as little as 4 hours Poor patient preparation can lead to suboptimal quality study as seen in figures 6 & 7.

Solution

At hour institution we ask patients to fast from midnight the preceeding evening.

Suboptimal jejunal distension

A common pitfall encountered at MR enterography is incomplete luminal distention of the small bowel, often within the jejunal loops. Collapsed bowel may both mimic and hide disease, which may reduce the overall accuracy of the study by leading to false-positive and false-negative assessments, respectively.

Solutions

This can be counteracted, where there is specific concern, by repeating the study with additional oral contrast material.

Imaging at multiple time points after ingestion may also be beneficial.

Enteroclysis may be necessary in selected cases

Normal variants mimicking pathology, extra intestinal pathology mimicking G1 pathology and pitfalls related to imaging of Crohns disease - Pictorial examples

Case 1

22 year old female with chronic diarrhoea and abdominal bloating. MRE requested to assess for features of inflammatory bowel disease disease.

See figures 9 & 10

Case 2

19 year old female with chronic right iliac fossa pain and diarrhoea. MRE requested to assess for features of Crohn's disease.

See figures 11 & 12

Case 3
75 year old male with intermittent abdominal pain and anaemia. Normal upper and lower GI endoscopy. MRE requested to assess for small bowel Crohn’s.

See figures 13 & 14

**Case 4**


See figures 15, 16 & 17.

**Case 5**


See figures 18 & 19.

**Images for this section:**
Fig. 1: Coronal TruFISP image. Note the stacked coin appearance of the jejunum in this patient with scleroderma. Dark black boundary around bowel wall represents chemical shift artifact and should not be confused with bowel wall thickening.
Fig. 2: Coronal HASTE. Poor soft tissue contrast and mesenteric detail
Fig. 3: Coronal HASTE. Motion artifact secondary to intestinal peristalsis.
Fig. 4: Intraluminal flow void secondary to flow artefact
Fig. 5: Same patient. TruFISP sequence produce homogenous luminal opacification.
Fig. 6: Figure 5 Axial TruFisp. Early images show apparent thickening of gastric wall
**Fig. 7:** Sequential coronal image in same patient demonstrates layering of extensive debris within stomach accounting for earlier appearance. Patient did not fast prior to procedure.
Fig. 8: Coronal TruFISP. Suboptimal distension precluding evaluation of small bowel

Fig. 9: Coronal TruFISP. Tubular thick wall structure in the right lower quadrant (arrowed) contiguous with the caecum suspicious for a thick walled, narrowed terminal ileum.
Fig. 10: Further images demonstrate the normal terminal ileum at the junction with caecum. The more inferior tubular structure is in fact the appendix.
Fig. 11: Coronal TruFisp. Tubular fluid filled structure adjacent to the uterus suspicious for dilated small bowel loop.
Fig. 12: Axial TruFISP of the same structure confirms this is in fact a right ovarian cyst
**Fig. 13:** Axial TruFISP. Apparent thick wall jejunal loop in left upper quadrant. (arrowed) May on initial viewing be interpreted as jejunal involvement by Crohn's disease.
**Fig. 14:** Coronal view of same abnormality reveals this is a jejunal intussusception. Dynamic fluroscopy confirmed intermittent jejunal intussusception with intervening normal appearance of bowel wall.
Fig. 15: Fig 20 Concentric wall thickening involving the distal ileum at iliocolic anastomotic site a patient with Crohn's disease and prior surgery.
**Fig. 16:** Post contrast axial ultrafast gradient echo. At the proximal end of the thickened segment post administration of contrast there is no significant wall enhancement which suggests the presence of a fibrotic stricture.

![Image of axial ultrafast gradient echo showing a fibrotic stricture](image)

**Fig. 17:** Post contrast axial ultrafast gradient echo. There is however enhancement present at the level of the anastomosis suggesting active disease which was not clear on non contrast imaging. Findings confirmed at colonoscopy and patient was managed conservatively avoiding surgery. This case highlights the role of contrast enhanced imaging which should be considered in evaluation of patients with Crohn's disease.
Fig. 18: Axial TruFISP image demonstrates ileal wall thickening with adjacent well circumscribed area of high signal, on initial review felt to represent adjacent small bowel loop.
**Fig. 19:** Axial high resolution T2 images confirm appearance actually represent localised ileal perforation (arrow) with adjacent collection. Standard SSFP sequences may not demonstrate complicated disease and use of high resolution T2 imaging may be useful in these cases to avoid misinterpretation.
Conclusion

MR enterography is a safe and effective technique for assessing small bowel pathology. With 8 years of experience, including in excess of 450 studies, the protocol we employ has been refined and optimized according to available evidence and experience. The technique has evolved into an accurate, efficient, clinically accepted method of imaging the small bowel that is well tolerated by patients. However, as with all imaging techniques, as demonstrated in this exhibit, knowledge of the limitations of the technique and familiarity with the imaging mimics of pathological processes is key to interpretation and avoidance of misdiagnosis.

Personal Information

References

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