Small bowel imaging

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Introduction
Small bowel imaging is evolving. Traditionally the realm of the ‘barium follow-through’ or ‘small bowel meal’, the small bowel is not frequently imaged with US, CT, MR, push enteroscopy and capsule endoscopy. Although a trend for increased cross-sectional imaging has been accompanied by a drop in barium studies as a whole, the numbers of barium small bowel studies remain relatively unchanged. When Medicare data in the USA was analysed for trends in GI fluoroscopic imaging between 2001 and 2006, barium enemas USA was analysed for trends in GI fluoroscopic imaging between 2001 and 2006, barium enemas and barium small bowel studies remain relatively unchanged. When Medicare data in the USA was analysed for trends in GI fluoroscopic imaging between 2001 and 2006, barium enemas were performed in 56% and UGI studies by 37% but the barium small bowel examination itself fell by only 7%. Barium swallowing studies actually rose by 8%.

Computed Tomography (CT) and Magnetic Resonance Imaging (MR) are increasingly advocated by various authors, particularly in the investigation of patients with known or suspected Crohn’s disease. However, there is a significant radiation burden imposed by CT and in the UK there may be limited access to MRI. In daily clinical practice, the barium follow-through (SBFT) still has its place in the evaluation of the small bowel and is usually a relatively quick, non-invasive and inexpensive test to perform.

In a recent study the accuracies of CT, MR and SBFT for identification of active terminal ileitis were comparable in 30 patients with Crohn’s disease, using ileocolonoscopy as the reference standard. The sensitivity for detection of extrinsic complications, however, was higher for CT and MRI than for SBFT.

Choice of most appropriate imaging examination
In patients with known or suspected inflammatory bowel disease the choice of the most appropriate investigation is very dependent on the clinical context. A distinction should be made between those patients without a diagnosis in whom Crohn’s disease is suspected – with a high or low index of suspicion – and those patients with established disease, who are presenting with possible complications.

In the first context, where symptoms are suspicious for IBD, then ileocolonoscopy with barium follow-through are usually advocated. Where this is negative but Crohn’s is still suspected, then capsule endoscopy may be useful. In early disease it is important to visualise the mucosa to detect superficial ulceration. High quality barium examination – ideally utilising compression techniques – can identify the small aphthoid ulcers which are a feature of early Crohn’s disease. In addition, barium studies can identify segments of fold thickening indicating mucosal oedema, more florid ‘cobblestone’ or linear ulceration, strictureting, asymmetric bowel wall changes and bowel loop separation.

In the context of established or complicated disease, where abscesses/mass, fistula or fibro-stenotic strictures are suspected, CT enterography is particularly useful due to the high spatial resolution and ability to reformat in various planes after acquisition. However, the impact of high radiation dose must always be considered.

In the paediatric age group and in young patients in whom multiple studies are likely, then avoidance of ionising radiation using ultrasound or MR enterography is preferred. Investigation of perianal disease for abscess and fistulas is best performed with MR due to high soft tissue contrast. CT/MR

Both CT and MR, whether enterography (oral contrast) or enteroclysis (contrast via NJ tube), require luminal distension. Numerous regimens have been proposed including water, dilute barium, polyethylene glycol solution, mannitol and Lactulose. Most MR studies utilise biphasic contrast which produces high or low signal depending on the pulse sequences used (‘black lumen’ – low on T1 and ‘white lumen’ – high on T2). The osmotic effect of Lactulose can be utilised by giving 30 to 50mls of lactulose one hour before the study and then asking the patient to drink up to one litre of water in divided doses over one hour prior to the study. Buscopan (20 mg iv) reduces motion artefact. The specific protocols used are largely equipment dependent but include T2, TrueFISP and fat suppressed T1 sequences with intravenous contrast enhancement with sequences in both axial and coronal planes.

Some studies advocate NJ intubation with formal MR enterography as opposed to enterography. Proponents of enteroclysis emphasise the increased detection of strictures with more uniform luminal distension.

Following gadolinium enhancement, the degree of enhancement of the bowel wall and of the adjacent mesenteric vasculature aid in the assessment of disease activity. The advantages of CT in Crohn’s disease include the short examination time, the high spatial resolution and the ability to choose an imaging plane after the test has been performed. The use of negative intraluminal contrast enables an appreciation of mucosal enhancement with iv contrast reflecting superficial inflammatory change. However, in some instances – particularly in the demonstration of fistulae or interloop abscesses – positive intraluminal contrast is preferred.

Capsule endoscopy
For this study, the patient swallows a small capsule measuring 2.6cm in length by 1.1cm diameter which collects intraluminal images of the mucosa at a rate of two images per second. Interpretation time depends on the experience of the gastroenterologist but varies from 40 to 60 minutes.

Capsule endoscopy is used when Crohn’s disease is suspected and ileocolonoscopy and SBFT are negative. It has also been used in chronic diarrhoea, malabsorption and polyposis surveillance. However, capsule retention and localisation may present problems and there is a significant false positive rate; approximately 14% of normal subjects will have small bowel abnormalities on capsule endoscopy.

Ultrasound in IBD
Abdominal ultrasound is extremely useful, particularly in paediatric populations with IBD. Interpretation of ultrasound findings is very operator dependent and requires experience. Grey scale sonography can measure wall thickness, extent and distribution of both small and large bowel involvement and in experienced hands has good sensitivity and specificity in the diagnosis of mesenteric abscesses and fistulae. Colour Doppler can be used to demonstrate disease activity. Objective measurements of bowel wall thickness (greater than 3mm) have proved the most useful objective indicator for diseased segments of bowel.

Analysis of patterns of disease in the small bowel
Although much of the previous discussion has centred on Crohn’s disease, the small bowel can be affected by a wide range of pathological processes including inflammation, infection, malignancy, malabsorption, ischaemia, obstruction and malrotation. Although the techniques used to investigate the small bowel are changing, the basic principles of lesion analysis within the small bowel can be applied to...
all modalities – barium, US, CT and MR. The radiologist needs to assess for changes in calibre or contour, fold pattern, thickening or nodularity and the presence of focal lesions – single or multiple.

CT/MR signs of Crohn's disease include bowel wall thickening, hypervascularity – either of the bowel wall or in the adjacent mesentery (comb sign): fatty proliferation of the mesentery, increased size and number of lymph nodes, fistulation and abscess formation.

Analysis of the spectrum of changes in the small bowel fold pattern has recently been excellently reviewed by Levine. This requires an assessment of the extent and distribution of the changes; is the abnormality widespread or segmental and are the affected folds straight or irregular. Thickened folds can be due to a number of pathological processes including cellular infiltrate, bleeding into the bowel wall or oedema.

Fold thickening that is straight and diffusely distributed is seen in hypoalbuminaemia, portal hypertension and in gastroenteritis.

Straight, segmental fold thickening has been termed ‘stack of coins’ and may be due to ischaemia, vasculitis, haemorrhage or radiation. This pattern of thickening has also been seen in graft-vs-host disease and in small bowel lymphoma.

Where the fold thickening is irregular and segmentally distributed then the most obvious cause is Crohn’s disease. However, lymphoma, TB and Yersinia of the terminal ileum can also give this picture. Other infections, such as giardia and strongyloides, have also been reported to produce this effect on small bowel folds.

When fold thickening is irregular but diffusely distributed, then intestinal lymphangectasia, eosinophilic gastroenteritis and mastocytosis and Whipples disease are indicated.

Such a pattern approach to interpretation enables a more focused characterisation of an underlying disease process.

**Summary**
Small bowel radiology is changing and expanding but the underlying pathology remains the same. It is important to understand the underlying clinical question before choosing an appropriate test.

A dedicated small bowel follow through remains a useful and inexpensive imaging test for the diagnosis of many small bowel disorders and should not abandoned in favour of CT or MR unless there are specific indications for these investigations.

**Reading list**