

Radiology in Intestinal Failure

Arun Gupta and the BIFA Committee

Radiology is important at all stages of the management of intestinal failure (IF), starting from the initial diagnosis (e.g. ischaemia, perforation, obstruction and sepsis), to detecting and treating complications (e.g. sepsis and its drainage), inserting parenteral or enteral feeding tubes, and the planning of reconstructive surgery (mapping the in and out of circuit bowel, fistula tracts and the abdominal wall). These tips highlight what radiology can offer with regards to diagnosis and therapeutic options (excluding access for nutritional support and radio-isotopic tests).

Key points

1. The radiologist is a key member of the IF multidisciplinary team (MDT) and helps with both diagnostic and therapeutic procedures. Radiological tests should be discussed with the radiologist before they are requested.
2. The choice of radiological technique depends upon the availability of equipment, the expertise of the local radiology department, and whether the patient is acutely unwell or stable with chronic problems.
3. A plain abdominal radiograph (AXR) may be appropriate in the acute setting to diagnose obstruction, ileus, perforation and the extent/severity of inflammatory bowel disease (IBD), and can be helpful in monitoring the progress of acute colitis.
4. Computerised tomography (CT) (with intravenous and oral contrast when possible) is usually the best test in an acute setting, as it is readily accessible in most acute hospitals and is quick to perform. In both acute and elective settings, CT can provide an accurate diagnosis and allows an extra-intestinal assessment including the state of the abdominal wall.
5. Magnetic resonance enterography (MRE) can produce high quality images of the small bowel (SB), but it can be challenging to consistently obtain optimal quality images in all patients. Patient movement, bowel peristalsis or inability to maintain a breath hold can result in sub-optimal non-diagnostic images, so careful patient selection is needed.
6. Ultrasound (US) is user dependent, but with appropriate expertise, US scans can provide greater resolution and information than is possible with other imaging modalities, particularly in thin patients or when the probe can be placed close to the structure being evaluated.
7. A barium follow through (BFT) alone, or in combination with a CT scan, will usually give the information required (length and quality of bowel) for mapping bowel before reconstructive surgery.
8. Contrast fluoroscopy (with bowel distension) is useful for the determination of patency, length and quality of out of circuit bowel prior to distal feeding or reconstructive surgery.
9. Intra-abdominal sepsis is usually detectable by CT, but a multi-modality approach may be needed. Drainage can be achieved by CT or US guidance, depending upon which provides the best accessibility or visibility of the collection.
10. Diagnosis of small bowel obstruction (SBO) or ischaemia can be challenging. If there is a strong clinical suspicion of either condition and the initial radiology report doesn't match the clinical concern, urgent review by a specialist gastro-intestinal (GI) radiologist maximises the chance of making a correct diagnosis.
11. The best technique for mapping a fistula tract is dependent on its location, accessibility and complexity, and upon the general state of the patient. A CT and/or BFT can provide an accurate overview for SB mapping, with fluoroscopy (fistulogram) adding more detail.
12. Review by a GI radiologist of all current and previous imaging, including those obtained in other institutions, may provide the required understanding of complex bowel anatomy not discernible on a single examination or modality, and can guide further imaging.

Explanations

- The radiologists are key members of the MDT caring for patients with IF. They are critical to defining the initial diagnosis (e.g. of perforations, sepsis, ischaemia and obstruction/ileus) and reducing the risk of misdiagnosis. SBO, for instance, can easily be mistaken for ileus and, similarly, reversible bowel ischaemia can be missed as signs can be non-specific. Radiologists perform key therapeutic procedures, including draining sepsis, inserting stents to relieve bowel obstruction as an alternative to surgery or for vascular strictures to enhance blood supply.
- Choosing the best radiological modality is a highly individualised decision dependant on the patient and clinical context. In complex cases, it is preferable to seek the advice of the radiologist as soon as possible, to help determine the best test to utilise in each situation. They can best make that decision when provided with all relevant clinical and surgical history, allowing them to consider the patient's clinical state, local radiological expertise and availability of each modality in the time frame required. The importance of providing a comprehensive and accurate clinical history to allow the correct choice of radiology techniques, cannot be overstated.
- An AXR is one of the oldest imaging tests, and its persistence, despite the many advances in medical imaging, is testament to its extensive utility. Globally, it's most common role lies in the assessment of the acutely unwell patient, particularly if CT scanning is not readily available. Advantages include ease of access (such as the potential for portable films for the unstable patient) and a relatively low radiation dose (usually <0.5 mSV). Plain films can often be more readily interpreted by non-radiologists than other modalities, allowing rapid identification or exclusion of major pathology. AXR following water-soluble contrast (e.g. oral Gastrografin®) can be used in prognostication of acute SBO, helping to predict which patients can be managed conservatively. Often 100 ml of contrast is diluted with an equal volume of water with films taken at 4 and if necessary 24 hours post-ingestion. An AXR may also demonstrate other bowel pathologies, such as colitis (for which it remains a time and cost-efficient test) and perforation and can be used in the diagnosis of SB ileus (either post-operative or related to other systemic processes).
- Most types of CT scans are quick to acquire and readily available in acute hospitals, but as CT enterography (CTE) requires the patient to drink up to 1 litre of oral contrast, it may not be appropriate in the acute presentation. In most non-urgent settings CTE should be considered in patients who may not be able to hold their breath as required for MRE, as CT is less susceptible to breathing/motion artefact. In addition, CTs can be easier to interpret when compared to US or MRE. A CT scan also allows a thorough extra-intestinal assessment and is sensitive for detecting deep seated collections. CT is often preferable in larger patients, whereas US may be more appropriate in thin patients. However, CT has a significant radiation dose (typically between 10-20 mSV), so it is essential to discuss cases with the radiologist to ensure the most appropriate protocol is utilised, that will maximise the information obtained from a single scan.
- MRE scanning can potentially provide much of the required information when electively evaluating the SB, but careful patient selection is crucial as any problems (e.g. claustrophobia, difficulty breath-holding or lying still for the time required) can result in sub-optimal or even non-diagnostic images. Unfortunately, much of the literature fails to highlight these practical challenges, sometimes leading clinicians and patients to inappropriately choose MR scanning when other techniques may be preferable.
- Ultrasound is very user dependent, but with appropriate expertise and patient selection, can provide a more detailed assessment of the bowel than CTE or MRE. US can be challenging in patients with stoma bags or other abdominal wall coverings, which may limit the access for an US probe to allow an adequate assessment. Considering these factors, early discussion with radiologists can highlight patients in whom US is the best test.
- Although BFT is less frequently utilised than CTE or MRE in many UK centres, it still has a significant role in SB assessment, particularly in SB mapping. It is best performed after a period of fasting (between 4-12 hours), to ensure the small intestine is empty. BFT involves oral ingestion of barium suspension (typically 300-600 ml of 50% w/v BaSO₄). Ideally the barium is followed from DJ flexure to the terminal ileum, using intermittent fluoroscopic imaging, initially every 15 minutes, whilst the barium is progressing. Some centres limit fluoroscopic assessment to the terminal ileum for simple cases. Insertion of a trans-nasal catheter into the SB, to perform a SB enema/enteroclysis is now only used in a few centres or selected patients, as this test can be unpleasant for the patient. Barium is not used if there is a risk of it leaking into the peritoneal cavity as it can precipitate peritonitis. Nonetheless, the examination still has significant utility and can provide a greater assessment of mucosa, fold pattern and motility, that is not easily appreciable with other tests.
- Fluoroscopy (contrast studies including BFT) have the distinct advantage of allowing the operator to provide functional assessment by acquiring dynamic ('cine') images. Amongst other information, it provides the opportunity to assess SB motility. Fluoroscopy studies utilise either barium based or iodinated (water-soluble) contrast. Barium is generally preferred when opacifying the GI tract, as it provides more detail and does not become so diluted in the distal bowel, which can minimise the interpretation difficulties due to overlapping bowel segments.

In addition, the greater density and other properties of barium may increase the sensitivity in identifying a fistula. Barium should be avoided where acute, non-mature enteric fistulae are suspected, and should not be given within 3 months of acute fistulation. Water soluble contrast may be useful in these circumstances and when there is a risk of acute perforation or if surgery may be performed soon after the study. Water soluble contrast can safely be administered via any route, including vascular or where there is risk of entering the peritoneal cavity, whereas barium is only safe to administer into the lumen of the GI tract. Fluoroscopy is used to assess in and out of circuit bowel in addition to fistulas. In thin patients, defunctioned bowel is often hard to assess on CT or MRI, so fluoroscopy combined with contrast distension and a dynamic assessment, can improve detection of strictures or adhesions.
- Internal fistulae in the lower abdomen or pelvis can often be accurately delineated with a tailored MRI or CT scan, but for those with a skin opening large enough to cannulate, a contrast fistulogram may be useful in cases where diagnostic uncertainty remains.
- CT is the best test in the diagnosis of acute obstruction, using a standard CT rather than a CTE protocol (in an acute setting oral contrast isn't usually appropriate). BFT can be useful in non-acute presentations or where uncertainty remains.

Fluoroscopic cine images can provide a focused dynamic assessment by allowing serial evaluation over the course of several (usually 2-4) hours. In difficult cases when obstruction is clinically suspected, real time fluoroscopy videos may demonstrate low grade, intermittent obstruction (most commonly due to adhesions),

or dysmotility which can be difficult to differentiate on static modalities such as CT and MRI (although newer emerging MRI techniques described later may allow similar but less tailored dynamic evaluation).

For bowel ischaemia, most centres opt for a dual phase approach CT, with an arterial phase to assess the arterial vasculature and portal venous phases to assess bowel wall enhancement and mesenteric/portal venous system. The appearances of bowel ischaemia on CT include: bowel wall thickening (>3 mm); mesenteric oedema and/ascites; decreased bowel wall enhancement; pneumatosis (intramural gas) with or without associated gas in the mesenteric/portal veins. Pneumatosis is a late sign and is suggestive of infarction. The vasculature should be carefully scrutinised, with accompanying knowledge of the arterial supply and venous drainage of the bowel.

11. Mapping means determining the length, type and quality of bowel remaining in and out of circuit and an assessment of any fistula and the abdominal wall. It is done before any planned procedure, often to restore bowel continuity. Bowel length can be determined by one or more of a CT, MR enterography or BFT, and providing the remaining SB length is less than 2 m, the result correlates well with a surgical measurement.

12. Review of all available imaging studies at an MDT, ensuring both recent and past scans from all hospitals are available, can be critical to finding answers not available from a single exam, particularly for all complex patients or where uncertainty remains regarding critical questions. This is especially important prior to reconstructive surgery as delineating bowel length quality and surrounding anatomy, is critical so the surgeon can be advised about the best surgical site to gain safe access to the abdominal cavity.

Suggested reading

- Gupta A, et al. (2023). Radiology in intestinal failure. In *Intestinal Failure Second Edition*. Ed: Nightingale JMD, Springer Nature Switzerland AG. P469-488
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- de Jonge CS, et al. (2018). Evaluation of gastrointestinal motility with MRI: Advances, challenges and opportunities. *Neurogastroenterol Motil.*; doi: 10.1111/nmo.13257.
- Garzelli L, et al. (2023). Insights into acute mesenteric ischaemia: an up-to-date, evidence-based review from a mesenteric stroke centre unit. *Br J Radiol.*; 96(1151): 20230232.

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