MR ENTEROGRAPHY

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The mesenteric small bowel is traditionally the most difficult portion of the gastrointestinal tract to investigate and at that level desease may present with chronic non-specific signs; for this reason the small bowel has been a challenging organ for clinical and radiologic evaluation.

Endoscopic methods for evaluating the small bowel, including ileocolonoscopy, capsule endoscopy, and double-balloon enteroscopy, offer distinct advantages for assessing superficial mucosal abnormalities and obtaining biopsies for histologic assessment. However, endoscopic evaluation is invasive and may be limited by bowel strictures

No endoscopic technique allows assessment of extraenteric abnormalities.

Imaging of the small bowel has traditionally included small-bowel follow-through examinations and enteroclysis, which can be used to accurately depict the bowel lumen and mucosal surface.

Cross-sectional imaging modalities are playing an increasing role in the evaluation of small bowel disorders; MR and CT techniques optimized for small bowel imaging become widely accepted at centers dedicated to the diagnosis, staging and follow-up of small bowel disease.

Computed tomographic (CT) enteroclysis and enterography provides detailed information on the bowel wall and extraenteric structures, although superficial lesions cannot be accurately depicted; CT should thus not be used as a first-line examination when early disease is suspected.

Moreover, the exposure of patients to ionizing radiation is an important concern, particularly in pediatric patients, in pregnant women, and in patients with inflammatory bowel disease who require frequent repeated imaging examinations.

Contrast-enhanced Magnetic resonance (MRI) with ingestion of a hyperosmotic solution to aid resolution of SB loops, either orally (MRI enterography) or via nasoenteric tube (MRI enteroclysis), is the preferred imaging technique if available.

MRI enteroclysis is known to provide better depiction of mucosal lesions in the small intestine than MRI enterography but MR enterography is preferred to the first one because enterography is easier, takes less time and is better tolerated by patients.

Magnetic resonance imaging has many properties that make it well suited to imaging of the small bowel: the lack of ionizing radiation, the improved tissue contrast that can be achieved by using a variety of pulse sequences, and the ability to perform real-time functional imaging. Moreover, MR modalities allow visualization of the entire bowel, without overlapping bowel loops, as well as the detection of both intra- and extraluminal abnormalities.

MRI TECNIQUE

Good bowel distention and fast imaging sequences are required to obtain small-bowel MR images of diagnostic quality. The bowel distention is obtained with a large volume (1–1.5 L) of an isosmotic solution of PEG that the patient will have to drink in 45 minutes before the examination.

A dose of glucagon is intravenously administered to reduce small-bowel peristalsis before the exame.

Chemical shift artifact is sometimes seen on images obtained with steady-state precession sequenze and may complicate the assessment of bowel wall thickness. Coronal and axial FISP images are obtained first to allow a rapid overview of the entire abdomen for the assessment of bowel distention. If distention is deemed adequate, T2-weighted MR images are obtained in the coronal and axial planes with a single-shot half-Fourier RARE sequence (ie, HASTE [half- Fourier acquisition single-shot turbo spin echo). Fast or turbo spin-echo sequences that are based on the half-Fourier reconstruction technique help limit or overcome artifacts related to small-bowel peristalsis. They produce high contrast between the lumen and the bowel wall, providing excellent depiction of wall thickening and changes in the fold pattern. However, single-shot half-Fourier RARE sequences are susceptible to intraluminal motion, and the resultant images may be degraded by intraluminal low-signal-intensity artifacts due to flow void. Familiarity with these artifacts, and correlation of the half-Fourier RARE images with the corresponding FISP images, are important to avoid misinterpreting findings at MR enterography.

CROHN DISEASE

Crohn disease is the primary indication for MR imaging of the small bowel.

The evaluation of chronic inflammatory bowel disease presents several problems. First, it is important to identify the presence of Crohn disease and to differentiate it from other small-bowel diseases. Second, the number, length, and locations of the segments involved in each patient need to be determined. Third, if a stenosis is present, it needs to be classified as inflammatory or fibrous so that the patient can receive appropriate medical or surgical therapy.

Furthermore, if inflammatory activity is present, it is important to distinguish between mild, moderate, and severe disease, because medical management differs depending on the disease stage. Fourth, the presence of mesenteric complications, such as abscesses and fistulas, needs to be assessed because these parameters influence the choice of therapy.

MR signs that indicate active Crohn disease include mucosal hyperenhance ment, mural stratification with a prominent vasa recta (comb sign), and mesenteric fat stranding.

In the fibrostenotic disease subtype, MR imaging demonstrates a fixed narrowing of the involved bowel with associated wall thickening (> 5mm) and marked prestenotic dilatation. In the fibrotic phase of Crohn disease, the signal intensity on T2-weighted images of the thickened wall also decreases because of the lack of mural inflammation and edema. On MR fluoroscopic and cine images, fibrotic strictures appear as aperistaltic bowel segments that often display fixed mural thickening and luminal narrowing. The fistulizing-penetrating subtype is characterized by transmural extension of the inflammatory process, with resulting fistula formation or perforation. Abscesses are seen as fluid collections either with or without associated air and wall enhancement; MR images accurately depict abscesses.

The MR subtype classification appears to correlate with the response to continuing medical therapy and surgery, thereby supporting the use of MR imaging as a diagnostic and prognostic tool in the care of patients with small-bowel Crohn disease . MR imaging helps accurately determine disease activity and detect bowel remodeling (normalization of wall thickness and enhancement) after therapy.

It has been suggested that MR imaging may evolve into the “all-in-one” examination technique that can provide an answer to all the major clinical questions that arise in patients with Crohn disease.

SMALL-BOWEL NEOPLASMS

The diagnosis of small-bowel tumors, particularly early detection and differential diagnosis, is still somewhat challenging.

MR signal appearances of the lesions, combined with the contrast enhancement behaviour and the characteristic of the stenosis, can help in differentiating from other nonneoplastic diseases of the small-bowel.

Adenomas are the most common benign tumours of the small-bowel. Grossly, adenomas present with three possible patterns: a polypoid pedunculated mass on a stalk; a sessile mass (broad-based and without a stalk); or a mural nodule within the mucosa.

MR fluoroscopy sequences show an intraluminal filling defect with mild narrowing of the lumen, which is not usually associated with proximal dilatation

Polyps appear as hypointense filling defects on FISP images and typically show marked enhancement similar to that of the bowel wall mucosa after the intravenous administration of a gadolinium chelate.

Gastrointestinal stromal tumor (GIST) is the most commonly occurring mesenchymal neoplasm of the GI tract, is relatively rare. At MRI GIST often manifests as an exoenteric, rounded mass that expands the small-bowel wall with a smooth, broadly pushing border; however, endoluminal development of the tumor is also possible. The tumor may show evidence of internal hemorrhage or necrosis, but satellite adenopathy is lacking. Small tumors usually enhance markedly. In lesions with extensive regions of hemorrhage or necrosis, cavities may form that communicate with the digestive lumen and contain air. Size is an important factor, as lesions >10 cm are generally malignant.

Carcinoids are well-differentiated endocrine tumours that arise from the enterochromografin cells at the base of the crypts of Lieberkuhn, accounting for nearly 25% of primary malignant small-bowel neoplasms. At MRI, carcinoid tumours appear as nodular mural thickening, usually associated with linear soft-tissue strands radiating towards the surrounding mesentery in a stellate appearance. On unenhanced sequences, these lesions are isointense to muscle on T1 weighted images and isointense or mildly hyperintense to muscle on T2 weighted images. The primary lesion shows hypervascular contrast enhancement. Tumours secreting serotonin usually induce a typical sclerosis and retraction of the adjacent mesenteric stroma, thus producing a sharp bend in the lumen. Secondary manifestations include liver metastases, typically hypervascularised in the arterial phase, enlarged lymph nodes and ascites due to peritoneal seeding. Calcifications are frequently present both in the primary mass and in the lymph node; they are easily detected at CT, but can also be observed at MRI as voids of signal. Sclerosing mesenteritis commonly appears as a soft-tissue mass in the small-bowel mesentery, which may envelop the mesenteric vessels, and collateral vessels may develop over time. There may be preservation of fat around the mesenteric vessels, a phenomenon that is called the ‘‘fat ring sign’’. This finding may help distinguish sclerosing mesenteritis from neoplastic mesenteric processes.

Lymphomas originate from lymphoid intestinal tissue (mucosa-associated lymphoid tissue) or may involve the bowel from widespread systemic disease. They represent about 20% of primary malignancies of the small intestine. Risk factors for small-bowel lymphoma include coeliac disease, previous extraintestinal lymphoma, chronic lymphocytic leukemia and immunoproliferative small intestinal diseas. The terminal ileum is the most frequent site, owing to the increased amount of lymphoid tissue normally present relative to the duodenum and jejunum. GI lymphomas at MRI manifest in three principal patterns: polypoid; infiltrating, which causes wall thickening, destroying parietal folds; or exophytic, which tends to ulcerate and fistulise. Characteristic feature of lymphoma is the aneurysmal dilation of the lumen, due to the loss of tone of intestinal musculature invaded and destroyed by pathological tissue. Mesenteric

involvement with enlarged lymph nodes is frequent, which may become confluent and cause progressive narrowing of the lumen of the affected loop.

CELIAC DISEASE

Although a diagnosis of celiac disease is verified with biopsy of the small intestine, imaging findings are often suggestive of the diagnosis in adult patients with nonspecific intestinal disorders and a presumably low risk for celiac disease, and they may be helpful for detecting complications such as intestinal intussusception, lymphoma, and carcinoma. Small-bowel MR findings in celiac disease reflect the underlying villous atrophy. A decrease in the number of jejunal folds and an increase in the number of ileal folds results in a jejunoileal fold pattern reversal.

MECKEL DIVERTICULUM

Meckel diverticulum is a type of congenital intestinal diverticulum that occurs around the distal ileum. It is considered the most common structural congenital anomaly of the gastrointestinal tract.

MD is typically asymptomatic but may present with malaena/haematochezia, small bowel obstruction or intussusception

Imaging these may be occasionally detected incidentally or may be identified if there is complication.

At MR enterography MD is a saccular, blind-ended structure continuous with the ileum is identified on imaging. MR functional study can be useful in evaluating the absence of peristalsis in the diverticulum, differentiating it from the bowels.

MRI technique offers a number of distinct advantages over diagnostic techniques, including the non-invasiveness, opportunity to study the extraluminal structures, absence of associated ionizing radiation exposure, multiplanar imaging capabilities, superb contrast and temporal resolution, facilitation of sequential imaging over prolonged periods of time, useful to assess small bowel peristalsis.

MR enterography should be used as a non-invasive and radiation-free procedure for the evaluation of cooperative non-acute patients with suspicion of small-bowel diseases.

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