Recent Advances in Imaging of Small and Large Bowel

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KEYWORDS

• Multidetector CT • MR imaging • PET-CT • Enterography • Colography

KEY POINTS

- With the advances in cross-sectional imaging, bowel imaging has reached a new zenith.
- Multidetector computed tomography (CT) is a frequently used modality because of its ease of performance in a few seconds as well as its easy availability these days.
- MR imaging is particularly useful in pediatric patients and in conditions like inflammatory bowel disease (IBD) whereby frequent imaging is necessary to avoid CT- or fluoroscopy-associated radiation.
- Present-generation PET-CT or PET-MR imaging hybrid scanners combine the functional information of PET with state-of-the-art CT or MR imaging to provide information about disease activity with precise anatomic localization.

INTRODUCTION

The diagnosis of bowel pathologic conditions is challenging in view of the nonspecific clinical presentation. Currently, there are various imaging modalities available to reach an accurate diagnosis. These modalities include conventional techniques (radiographs, small bowel follow-through, conventional enteroclysis), ultrasonography (US), and cross-sectional examinations (computed tomography [CT] and MR imaging) as well as functional imaging modalities, such as PET-CT or PET-MR imaging. Each modality has its own advantages and disadvantages and can be used in isolation or combination. This review discusses the role of CT, MR imaging, and PET-CT in the evaluation of small and large bowel diseases.

EVALUATION OF THE BOWEL

Conventional radiographs (erect and supine) are now mainly used for an initial diagnosis of obstruction and perforation of the bowel. In case of a suspected subacute intestinal obstruction, the radiographs need to be performed during the acute episode. Chest radiograph is an inexpensive tool to detect pneumoperitoneum as gas under the diaphragm.

Small bowel follow-through and conventional enteroclysis can well depict intraluminal pathology; however, they have radiation exposure and are unable to evaluate bowel wall and extraluminal disease.[1]

Bowel wall thickening can be well visualized with US without any risk of radiation exposure.

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However, it is difficult to evaluate all the loops or make an etiologic diagnosis. Moreover, it is operator dependent and difficult to perform in acute state as well as in obese patient.

CROSS-SECTIONAL IMAGING

Computed Tomography

CT-based methods include abdominal CT (unenhanced and enhanced), CT enteroclysis (CTEc), CT enterography (CTE), and CT colonography (CTC).

Routine Computed Tomography Abdomen

Unenhanced and contrast-enhanced CT abdomen is a routine procedure and can be performed in emergency and post-trauma settings. Images are acquired from the diaphragm to the symphysis pubis in the portal venous phase after the administration of intravenous nonionic iodinated contrast. Positive oral contrast material is given in the form of 1% to 2% barium sulfate or 2% to 3% iodine-based solution. These positive agents help in the differentiation of bowel loops and for determining pathology as intraluminal or extraluminal. However, these interfere in the evaluation of intestinal wall characteristics and angiography images.[2] Positive contrast materials should not be used in patients with suspicious vascular disease and clinical presentation of gastrointestinal (GI) bleeding.

Negative oral contrast agents like lactulose, water, oil emulsion, methylcellulose, polyethylene glycol (PEG), mannitol, and ultra–low-dose barium with sorbitol (volumen) are preferred in the assessment of intestinal wall enhancement. However, it is difficult to evaluate hypodense lesions like abscess and cyst.[3]

CTEc is performed after nasojejunal intubation under fluoroscopy. As this process is invasive for patients and requires an extra tube, CTE is the preferred technique these days. For this 300 mL 20% w/v mannitol is mixed with 1.5 L water. A total of 500 mL of mixture is given orally to patients in the first 15 minutes followed by 500 mL in the next 15 minutes, then 500 mL in the next 15 minutes. The scan is performed at 50 minutes with the remaining solution given on the table along with intravenous contrast injection to patient (**Box 1**).

Computed Tomographic Colonography

CTC is easy to perform and is less invasive than colonoscopy. The details of the technique are summarized in **Box 2**.

Box 1
CT enteroclysis

Fasting: at least 8 hours of fasting before the examination

Intestine cleansing: 1 day before all of the enteroclysis and enterographic examinations with 50 to 100 mL of laxative diet solution (polyethylene glycol)

Acquisition: from the diaphragm to the symphysis pubis

Intravenous contrast agent: 100 mL nonionic

Portal venous phase: images obtained 50 seconds after the administration of contrast material (flow rate, 4 mL/s; total 150 mL)

Oral contrast: 300 mL 20% wt/vol mannitol mixed with 1.5 L water

PET with Fludeoxyglucose F 18/Computed Tomography

PET with fludeoxyglucose F 18 (^{18}FDG-PET)/CT has rapidly obtained a foothold in the evaluation of bowel disorders, chiefly in neoplasms and inflammatory bowel diseases (IBDs). ^{18}FDG-PET imaging relies on the increased uptake and metabolism of ^{18}FDG in inflammation, infection, or neoplasm.[4,5] Combining ^{18}FDG-PET with CT, both morphologic and functional information regarding disease site and activity can be obtained. This imaging technique has been enhanced further by combining CTE/CTEc and CTC with ^{18}FDG-PET imaging for the evaluation of the small and large bowel, respectively.[6,7]

Technique of PET with Fludeoxyglucose F 18/Computed Tomography Enterography

For ^{18}FDG-PET/CTE, patients are asked to come with 6 to 8 hours of fasting and intestinal preparation similar to that for CTE. The blood glucose is checked for hyperglycemia, and ^{18}FDG is administered either at a fixed dose of 10 mCi or as a weight-based dose (0.15 mCi/kg) in the pediatric population. For PET-CTE, patients are asked to drink 1.5 L of mannitol solution over 45 minutes to 50 minutes, whereas for PET-CTEc, a nasojejunal tube is inserted up to the proximal jejunum and 1.5 L of normal saline is given through it until patients complain of abdominal distension/discomfort. The ^{18}FDG-PET/CTE scanning begins 45 minutes to 60 minutes after injection of ^{18}FDG. Initially a low-dose CT is obtained from the domes of the diaphragm to the pubic symphysis followed by ^{18}FDG-PET imaging, and the data obtained from CTE are used for attenuation correction for ^{18}FDG-PET. The authors do not administer