CT Enterography: Concept, Technique, and Interpretation

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KEYWORDS

- CT enterography • Crohn disease
- Gastrointestinal bleeding • Neoplasm
- Small bowel • Computed tomography

The assessment of small bowel abnormalities has traditionally been a challenging task for radiologists and gastroenterologists. Conventional radiologic and endoscopic evaluations are frequently hindered by the length and caliber of small bowel loops.[1] Although, CT in its conventional form has played a significant role in the evaluation of extraenteric manifestations of small bowel disease, it has a limited role for depicting bowel wall and luminal abnormalities.[2] CT enterography, a robust new method for evaluating the small bowel, is a byproduct of the recent advances in multidetector-row CT (MDCT) technology.[3,4] New MDCT scanners, with isotropic image acquisition in a single breath-hold, allow high-resolution multiphasic assessment of the bowel in multiple planes.[4] CT enterography uses this technology to provide a detailed evaluation of the mural features of the gut and its lumen. Additionally, it permits an accurate depiction of the perienteric tissues, thus improving assessment of the disease extension and complications.[5] Multiplanar reformations, obtained from isotropic data sets, allow radiologists to evaluate the entire abdomen in planes that facilitate visualization of the pathology.[6]

In this article, we discuss the advantages of CT enterography over conventional and newer small bowel imaging modalities. Image acquisition and interpretation for the most common indications are also discussed.

CONCEPT

A wide variety of methods are available for the assessment of the small bowel, attesting to the difficulty of evaluating this organ. The current methods of small bowel evaluation include radiologic as well as endoscopic techniques.[7] The radiologic armamentarium includes barium studies (small bowel follow-through [SBFT] and enteroclysis), CT techniques ("routine" CT, CT enterography, and CT enteroclysis), ultrasound, nuclear medicine, and MR (MR enterography and MR enteroclysis). Endoscopic methods include ileoscopy, push enteroscopy, double-balloon endoscopy, and wireless capsule endoscopy.[7] CT enterography and wireless capsule endoscopy are two of the most robust imaging techniques with proven efficacy.[8]

CT enterography combines isotropic-voxel acquisition with the oral intake of large volumes of neutral contrast agents and rapid intravenous administration of iodinated contrast to improve visualization of the small bowel wall and its mural features.[9] Misregistration artifacts due to respiratory motion and small bowel peristalsis are effectively eliminated because data is acquired in a single breath-hold.[6] The acquired data can then be used to perform excellent two- and three-dimensional reformations, producing high-resolution images of the bowel and mesenteric vessels.[10,11] Moreover, the combined use of intravenous and neutral enteric contrast agents optimizes luminal

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distension and depicts attenuation differences among the bowel wall layers, the fluid filled lumen, and the adjacent mesenteric fat.[4,5]

The advantages of CT enterography are its noninvasiveness, its ready availability, and its operator independence. The American College of Radiology Appropriateness Criteria (2005) rates CT enterography as the most appropriate radiologic method in the evaluation of initial presentation or known Crohn disease with acute exacerbation or suspect complications.[12] CT enterography can also play an important role in evaluating obscure gastrointestinal bleeding and in detecting small bowel tumors.[5,13]

CT enterography has several advantages over SBFT study. While SBFT is both operator dependent and limited by deep pelvic and overlapping small bowel loops, CT enterography is not affected by these limitations (**Fig. 1**). The most distal portion of the terminal ileum is difficult to assess with SBFT but readily evaluated by CT enterography. However, a potential drawback of CT enterography is its higher effective radiation dose when compared with SBFT study.[14]

CT enterography should be distinguished from CT enteroclysis. In CT enterography, the patient drinks a large volume of oral contrast in a short period of time. CT enteroclysis, on the other hand, requires intubation of the descending duodenum or jejunum and administration of enteric contrast material, preferably by a pump, to obtain optimal distension of the small bowel.[15] More reliable distension of the small bowel can be achieved with CT enteroclysis because oral contrast agent is administered by the radiologist.[15] The patient is usually sedated for enteroclysis, leading to increased cost and acquisition time as well as reduced availability.[4,15] A feasibility study by Wold and colleagues[1] comparing CT enterography to CT enteroclysis did not find significant differences in bowel distension and demonstrated similar accuracy in indentifying active Crohn disease for both methods. However, there are no large studies comparing CT enterography to CT enteroclysis.

Although wireless capsule endoscopy is the most sensitive technique for small bowel mucosal evaluation, it has several limitations.[7,8] Its higher sensitivity compared with CT enterography is accompanied by its lower specificity.[7,16] Solem and colleagues,[16] comparing different imaging modalities to detect active Crohn disease, did not demonstrate significant difference in sensitivity and accuracy in disease diagnosis among CT enterography, wireless capsule endoscopy, ileocolonoscopy, and SBFT. The sensitivity for identification of active disease was 83% for CT enterography, 83% for wireless capsule endoscopy, 74% for ileocolonoscopy, and 65% for SBFT. However wireless capsule endoscopy had lower specificity (53%) and could not be performed in 17% of patients because of an asymptomatic stricture diagnosed by CT enterography.

Wireless capsule endoscopy also has several technical limitations. Retention of the capsule is a serious risk that requires surgical treatment. Cheifetz and colleagues[17] reported a 13% risk for capsule retention in patients with known Crohn disease and 1.6% in those with suspected Crohn disease. The retention rate is 0.7% to 2% in patients with obscure gastrointestinal bleeding.[8,18] Additionally, wireless capsule endoscopy generates several thousand images, requiring long interpretation times. Accurate localization of disease

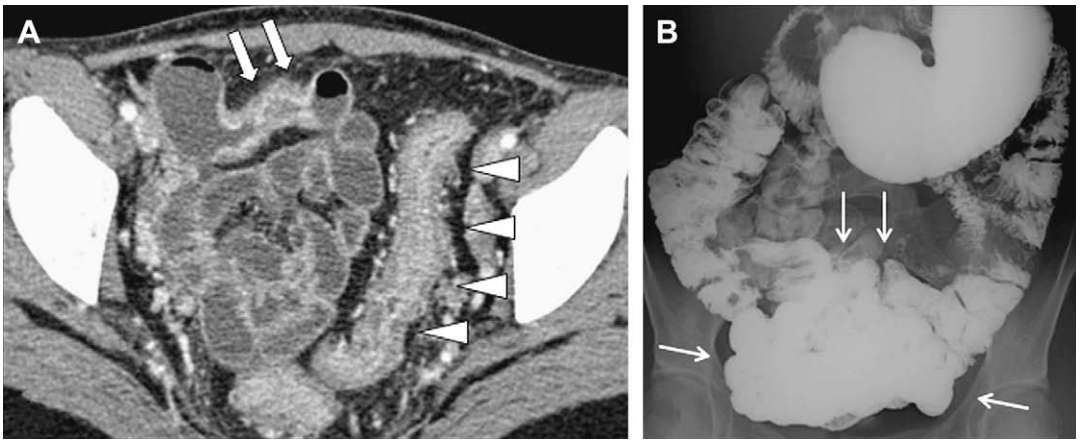

Fig. 1. CT enterography (*A*) shows segmental mural thickening and hyperenhancement of an ileal loop (*arrows*) and acute colonic inflammation (*arrowheads*). SBFT (*B*) performed in the same patient cannot evaluate the overlapping small bowel loops (*small arrows*) in the pelvis or the colon.