
PICTORIAL ESSAY

Assessment of Crohn's Disease by Modified Computed Tomographic Enterography

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ABSTRACT

Crohn's disease is a chronic inflammatory bowel disease that can affect any part of the gastrointestinal tract and may result in both intra- and extra-enteric complications. Evaluation of Crohn's disease and its complications has always be a challenge due to the length and convoluted course of the bowel. Through this pictorial essay, we share our initial experiences in the assessment of Crohn's disease, using a modified form of computed tomographic enterography, in a regional hospital.

Key Words: Crohn disease; Intestine, small; Radiographic image interpretation, computed-assisted; Tomography, X-ray computed

中文摘要

改良版CT腸道造影用作評估克隆氏症

賈亦尊、黃文鳳、周偉強、岑承輝、鄭志成

克隆氏症是一種慢性炎症性腸病，在整個胃腸道的任何部位均可發生，有機會誘發腸道內外的併發症。由於腸道既長且迂迴曲折，要評估克隆氏症及其併發相當困難。藉著本圖片文獻，我們與讀者分享在一所分區醫院內，使用改良CT腸道造影對克隆氏症的評估。

INTRODUCTION

Crohn's disease was previously considered a disease of the western countries. However a rising incidence and prevalence has recently been observed in Asia, including Hong Kong.¹⁻³ Hence, radiologists should become familiar with radiological assessment of this disease.

Crohn's disease is a chronic inflammatory bowel disease that causes mucosal as well as transmural inflammation. Although the small bowel is most commonly affected, any part of the gastrointestinal tract can be involved and both intra- and extra-enteric complications may ensue.

Evaluation of Crohn's disease and its complications has always be a challenge due to the length and convoluted course of the small bowel. Moreover, many patients with Crohn's disease tend to be young¹⁻³ and often require repeated radiological examinations during the course of their illness. The extent of radiation they receive therefore becomes a significant concern.

Fluoroscopic barium examinations and computed tomography (CT) enteroclysis were once the mainstay in assessing Crohn's disease, but still have many limitations. With the emergence and increasing availability of multidetector computed tomography

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(MDCT), CT enterography has gained wide popularity as a novel means for evaluating the small bowel.

PREPARATION AND TECHNIQUE

Patients are asked to abstain from any food or drinks for at least six hours prior to the examination. They arrive at the department one hour before the scanning. In the intervening period, the patient drinks about 1200 ml of water, and is then positioned on the CT scanning table. While on table but before scanning commences, the patient drinks another 600 ml of water. At the same time about 600 ml of water is administered per-rectum via a rectal tube.

Scanning is performed on a MDCT (Aquilion 16; Toshiba, Otawara, Japan). The table speed is adjusted to complete image acquisition within one breath-hold. Images are acquired from the diaphragm to pubic symphysis with a section thickness of 1 mm. We perform single-phase scanning during the porto-venous phase. Intravenous contrast (Iopamiro 370) is administered at about 60 seconds after peak enhancement of the aorta (using the Sure-Start technique), and at a rate of at least 2.5 to 3.0 ml/sec. Coronal and sagittal reformations are obtained from the image processing workstation.

DISCUSSION

In the past, fluoroscopic barium examinations including small bowel follow throughs and small bowel enemas were the mainstay for evaluating Crohn's disease and the small bowel. These procedures, however, have many disadvantages. They include: operator dependence, limited indirect depiction of bowel wall, small bowel loops becoming obscured due to superimposition of abdominal contents and inability to assess extraenteric disease.⁴ Since the introduction of conventional single-slice CT, another technique — CT enteroclysis — became accepted as a useful modality for assessing Crohn's disease. CT enteroclysis managed to provide a solution to many of the problems described above.⁵ However, high radiation dose, long procedure time, patient discomfort and hence low acceptance rate were limitations, as were logistic drawbacks (requirement of two radiological examination rooms or even two radiologists). With the emergence and increasing availability of MDCT, CT enterography quickly became widely popular.

MDCT can achieve isotropic image acquisition in a single breath-hold, and allow high-resolution

multiphasic assessment of the bowel in multiple planes. CT enterography is a technique that combines these advantages with the oral intake of a large volume of contrast agent and intravenous administration of iodinated contrast. As a result, it is able to provide a detailed and accurate portrait of the mucosal, mural, and extraenteric features of the entire gastrointestinal tract (Figures 1-5). Misregistration artefacts due to respiration and bowel peristalsis are minimal, as the data are acquired in a single breath-hold.⁶ Radiologists can also produce multiplanar reformations, which not only facilitate visualisation of bowel and mesenteric pathology, but also aid communication with clinicians. Moreover, the combined use of oral and intravenous contrast enhances attenuation differences between the fluid-filled lumen, bowel mucosal, bowel wall and adjacent mesenteric fat. From the patient's perspective, the examination is much less invasive



Figure 1. Crohn's disease 'target sign' (arrow) showing bowel wall thickening with mural stratification caused by mucosal hyperenhancement and a relatively low-attenuating edematous submucosa.



Figure 2. Pericolic inflammatory stranding (arrows) suggestive of transmurial inflammation.



Figure 3. Bowel wall thickening with perienteric strands and reversible strictures. Note the presence of phlegmon (arrow) adjacent to the terminal ileum.

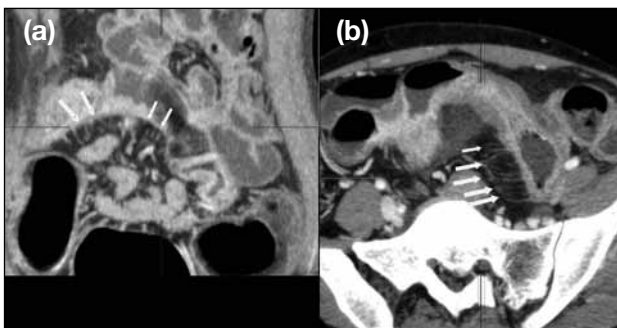


Figure 4. Comb sign and creeping fat: (a) coronal reformat and (b) axial images showing increased attenuation of the mesentery and engorged vasa recta that penetrate the bowel wall perpendicular to the bowel lumen (arrows), which are specific findings in active Crohn's disease.^{11,12} The segment of small bowel in the axial image also demonstrates mural stratification and luminal narrowing.

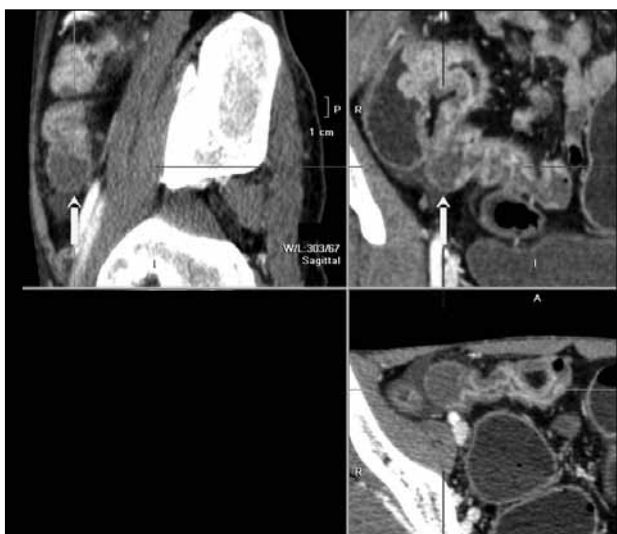


Figure 5. Ulcer and pseudodiverticulum: multiplanar reformat images showing a deep ulcer (arrows) arising from the inferior wall of the distal ileum leading to a pseudodiverticulum.

and uncomfortable, it requires getting on-and-off the table just once, and can be completed in a few minutes. Studies comparing CT enterography to CT enteroclysis did not find significant differences in bowel distension and demonstrated similar accuracy in identifying active Crohn's disease.⁷ Finally, CT enterography is much more reproducible, and therefore enables more reliable comparison of repeated examination findings, monitoring of disease progress, and assessment of treatment responses.

For several reasons we adopted a modified protocol, in that we used water instead of other oral contrast agents. Firstly, many of the commonly used commercially prepared oral contrast agents^{8,9} are not available in regional hospitals such as ours because of costs concern. Secondly, using compounds such as methylcellulose result in significant patient discomfort due to their laxative effect and low critical solution temperature. Finally, in our initial experiences using water orally as a neutral contrast was able to achieve satisfactory results and patient satisfaction. As described above, in our protocol the simultaneous administration of rectal water also enables us to assess disease involvement of the large bowel (Figures 6, 7).

In our protocol, another modification was that we only used a single-phase imaging technique at 60 seconds after peak aortic enhancement. This was because studies have shown no significant clinical difference in favour of using dual (i.e. arterial and venous) phase imaging.^{7,10}



Figure 6. Pseudopolyps: (a) coronal and (b) sagittal reformat images demonstrating presence of inflammatory pseudopolyps, consisting of areas of hyperplastic growth surrounded by inflamed mucosa with shallow ulcers in the transverse and ascending colon (arrows). Inflammatory pseudopolyps are usually seen in severe cases of Crohn's disease.



Figure 7. Thumbprinting and Cobblestone appearances: a coronal maximum intensity projection image showing thumbprinting and cobblestone appearance (arrows) as deep ulcers with interposed thickened oedematous mucosa.

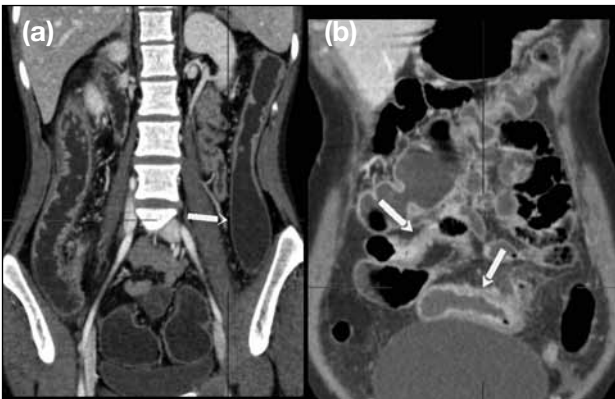


Figure 8. Skip lesions: coronal reformat images showing non-continuous inflammatory involvement (arrows) sparing (a) the lower descending colon and (b) different segments of small bowel (right).

More importantly, many of our patients with Crohn's disease are relatively young, and therefore liable to undergo repeated imaging to assess disease progression and treatment response. Using single-phase instead of dual-phase imaging significantly reduces cumulative radiation exposure.

In our experiences, routine use of multiplanar reformations is essential for the interpretation of a CT enterography study. This is one of the reasons why we acquire thin (1 mm) slices, from which we obtain our reformations. Multiplanar images provide

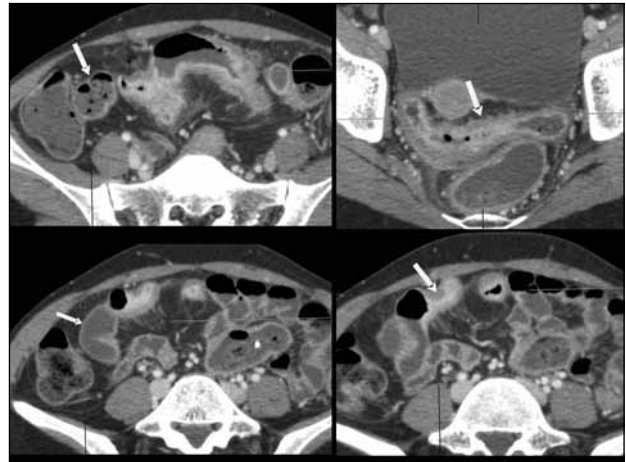


Figure 9. Skip lesions: axial images showing skip lesions with patchy non-continuous involvement of different segment of small bowel (arrows). The involved segments show wall thickening associated with comb sign and reversible strictures.



Figure 10. Crohn's disease abscess: (a) axial and (b) coronal reformat images showing an abscess cavity (arrows) adjacent to a segment of diseased small bowel.



Figure 11. Fistula: a coronal image showing the presence of an enterenteral fistula (arrows).

an excellent depiction of both enteric and extraenteric abnormalities. Coronal images allow a more global view of the small bowel. They facilitate quantification of diseased segments, identification of skip lesions and assessment of mesenteric vascularity (Figures 8, 9). Sagittal images are particularly helpful in assessing the duodenum, rectum, and presacral region. Detection of fistulae and abscesses becomes substantially improved in both coronal and sagittal reformations (Figures 10, 11). In addition, coronal maximum intensity projections are useful in the detection of mesenteric vascular abnormalities, perienteric strandings, and bowel mucosal changes.

CONCLUSION

Limitations of CT enterography are mainly related to underdistention of the bowel. This can be due to various factors ranging from patient's non-compliance to small bowel obstruction. Over time, we anticipate there will be further optimisation of these imaging techniques, scanning parameters, and patient preparation. Nevertheless, our initial experience shows that this is a promising, patient-friendly, economical, reliable, and easily reproducible procedure for the assessment of Crohn's disease.

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