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ORIGINAL ARTICLE

Imaging Features of Crohn's Disease in Chinese People: A Preliminary Study

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ABSTRACT

Objective: *A retrospective study to describe the imaging findings of Crohn's disease in Hong Kong Chinese patients.*

Patients and Methods: *Radiological and cross-sectional imaging studies performed in a 3-year period (1997 to 2000) on 17 patients with proven Crohn's disease were reviewed. The findings were categorised as mild, moderate, and severe by radiological grading and a novel Combined Imaging Predictive Index.*

Results: *Eleven patients (64.7%) had multifocal disease and 6 patients (35.3%) had focal disease. The terminal ileum was the most common site of involvement (70.6%). The most frequent findings were eccentric luminal change (52.9%) and thickened folds with nodularity (47.1%). By Combined Imaging Predictive Index, 11/17 patients (64.7%) had severe disease, 4/17 (23.5%) had intermediate disease, and 2/17 (11.8%) had mild disease. By radiological grading, 9/13 patients (69.2%) had severe disease, 4/13 (30.8%) had moderate disease, and none had mild disease.*

Conclusions: *Crohn's disease in Chinese patients frequently involves the terminal ileum and exhibits eccentric luminal change and nodular thickened folds. The radiological features do not appear to be substantially different from those described in the West. Combined Imaging Predictive Index may be useful in describing Crohn's disease, but further prospective study is required to confirm its clinical value.*

Key Words: *Chinese, Crohn's disease, Diagnostic imaging, Inflammatory bowel diseases*

INTRODUCTION

Crohn's disease (CD) is a disease with wide diversity in clinical expression. It is characterised by transmural granulomatous inflammation of the intestine. The inflammatory process is typically discontinuous, affecting multiple sites, and can involve any part of the bowel. Although it was previously a rare disorder in the Asian Chinese population, there has been a recent increase in hospital cases in this region.[1] CD shows a wide spectrum of radiological abnormalities, and these have been widely discussed in the literature. To date, there has been no published description of the imaging manifestations in Chinese people.

There have been many reports evaluating CD activity using various cross-sectional imaging modalities, including dynamic contrast-enhanced CT, high-resolution US (HRUS), and MRI.[2,3] However, many of these reports have focused on describing multiple features of CD in different imaging modalities. While there have been important advances in imaging techniques, barium studies are still the principal methods of evaluation.[2] To our knowledge, there is no consensus on integrating the imaging features to describe CD. Given the conflict between traditional and new methods in assessing CD, it was considered useful to establish multi-image predictive criteria.

Therefore, the primary aim of the study was to review the findings from various imaging modalities so as to

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describe the imaging features of CD in Chinese patients. The second aim was to describe imaging findings in terms of the radiological grading and a novel Combined Imaging Predictive Index (CIPI).

PATIENTS AND METHODS

Patients

Between April 1997 and October 2000, 24 patients at the Prince of Wales Hospital, and Yan Chai Hospital had proven CD. The diagnosis was based on clinical presentation, radiological, endoscopic, and pathological features, the exclusion of intestinal infection (especially tuberculosis), and response to standard therapy. Imaging studies were performed in 18 patients between April 1997 and October 2000. One patient was excluded because of confirmed enteric tuberculosis with positive stool culture. Thus, only 17 patients were included in this study, 13 males and 4 females (mean age 31.3 years [range, 15 to 67 years]). The common presenting symptoms were abdominal pain or discomfort (37.5%), or perianal symptoms (37.5%).

Technical Considerations

These 17 patients had a total of 24 imaging studies, including enteroclysis (10), transabdominal US (6), double contrast barium enema (4), CT scan (2), small bowel follow-through study (1), and MRI (1).

All fluoroscopic examinations were performed by fellows or trainees supervised by radiologists. The standard method of enteroclysis was used based on that described by Javors.[4] Briefly, a preselected amount of barium and methylcellulose was infused through a catheter positioned at the duodenojejunal junction after transnasal intubation. Intermittent fluoroscopy and compression were used to visualise all segments of the small intestine in single- and double-contrast images. Double-contrast barium enema, small bowel follow-through, and US were performed following routine protocols. All US examinations were performed with C4-2 MHz or C7-4 MHz real time curvilinear array probes (ATL HDI 3000, Bothell, Washington, USA), or 3.5 MHz real time sector array probes and 7.5 MHz linear probes (Aloka SSD 650, Aloka, Tokyo) with or without graded compression.

All CT scans were performed using a helical scanner (General Electric HSA, Milwaukee, USA). Contiguous scans were obtained with 10 mm thick sections with pitch 1-1.5 using intravenous contrast material. All patients received oral and rectal contrast agents.

MRI was performed with a 1.5-T MR imager (Philips Gyroscan, Eindhoven, The Netherlands) using a body coil. For the MRI sequences, the following parameters were used: axial T1-weighted spin echo (SE) sequences [repetition time (TR), 425 ms; effective echo time (TE), 15 ms; field of view (FOV), 344 mm; matrix, 256 x 256; slice thickness/gap, 6 mm/0.6 mm], axial T2-weighted turbo spin-echo (TSE) spectral presaturation with inversion recovery (SPIR) sequence [TR, 1900 ms; TE, 80 ms; FOV, 344 mm; matrix, 256 x 256; slice thickness/gap, 6 mm/0.6 mm] and coronal T2-weighted TSE SPIR sequence [TR, 1800 ms; TE, 90 ms; FOV, 300; matrix, 256 x 256; slice thickness/gap, 4 mm/0.4 mm].

Image Analysis

Radiological grading was based on the system of Engelholm et al,[5] and Caroline and Friedman[6] and is illustrated in Figure 1. The distribution of small bowel disease was designated as duodenal, jejunal, proximal, distal, and terminal ileal. The distribution of colorectal disease was recorded as caecum, ascending colon, transverse colon, descending and sigmoid colon, and anorectum.

The CIPI consisted of radiological and cross-sectional imaging components. In this modified classification system, the imaging findings of the 17 patients were

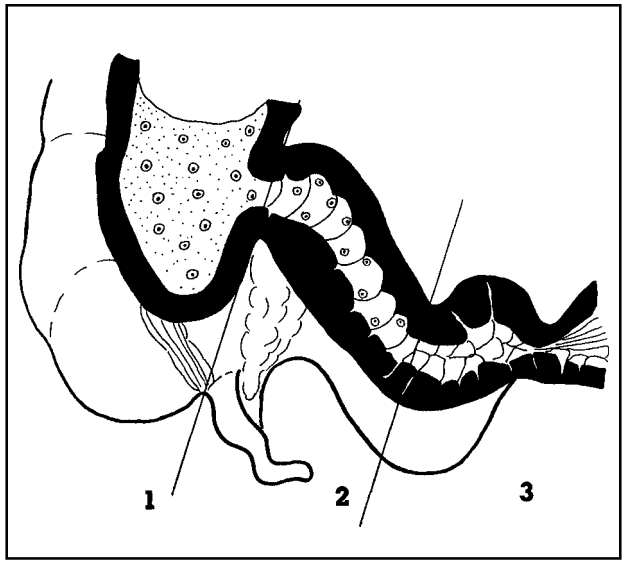

Figure 1. Composite diagram of radiological grading of severity of Crohn's disease.
1. Mild changes include smooth mucosal thickening, coarse mucosal pattern, and aphthous ulcer formation.
2. Intermediate disease consists of increased thickening of mucosal folds, ulcers, eccentric changes of lumen, and inflammatory polyps.
3. Severe changes include penetrating ulcer, stricture formation, and sinus tract or fistula formation.

Figure 2. A 44-year-old man (patient 11) who presented with a 2-day history of per rectal bleeding. Computed tomography through the lower abdomen demonstrated non-specific increased density in mesentery (open arrows) with greater attenuation than peritoneal fat. There was also wall thickening of long small intestinal segments (closed arrows). Small air loculi are attributable to deep fissural ulceration (arrowheads). Findings are compatible with grade III Crohn's disease.

grouped into 3 grades according to the degree of severity, with I indicating early or mild disease, II indicating intermediate disease, and III indicating advanced or severe disease.

On cross-sectional imaging, grade I disease is also manifested as the absence of wall thickening or mesenteric or omental fat change. Grade II disease is suggested by bowel wall thickening, focal fat alteration, mild extraluminal tissues, lymphadenopathy, non-specific mass, and fissure. In grade III disease, there is diffuse mesenteric or creeping fat in the mesentery (Figure 2), fluid-filled or dilated bowel loops, abscess or phlegmon, or Crohn's fistula (Figure 3). Other complications such as perforation, pancreatitis, or tumour may also be present in grade III disease (Table 1).

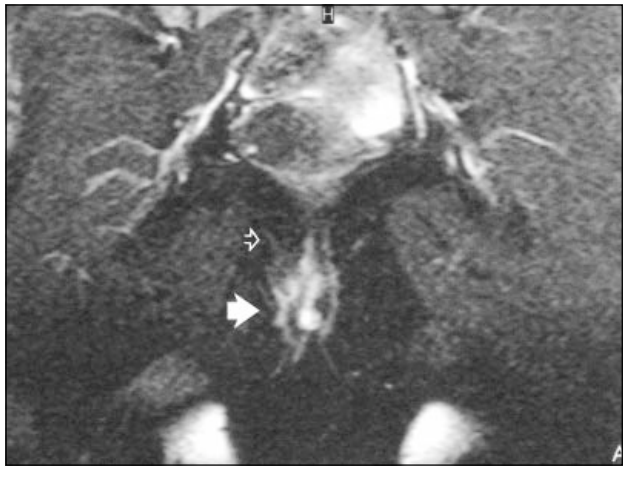

Figure 3. A 28-year-old woman (patient 1) with perianal discharge. Coronal T2-weighted spectral presaturation with inversion recovery image TR/TE, 1800/80 ms) showed fistula (closed arrow) tract extending medially to enter the anal canal well below the levator ani muscle (open arrow).

All studies were retrospectively reviewed by 2 radiologists who were not blinded to the patient's history. Interpretations were reached by consensus. When findings were tabulated, a patient was considered to have a finding if that specific finding was present at any examination within a 1-month period. Radiological findings were graded separately for comparison. The most advanced manifestation in each patient was used for classification. Classification of these criteria into lesion categories provided an objective method for determining the severity of disease, as well as for assessment of the ability of the examination to detect early manifestations of CD.

RESULTS

Patient data is summarised in Table 2. Eleven of the 17 patients (64.7%) had multifocal disease and 6 (35.3%) had focal disease. Since the oesophagus and

Table 1. Combined Imaging Predictive Index.

Grade	Radiological findings	Cross-sectional imaging findings
I	Smooth mucosal thickening Coarse villous pattern Aphthous ulcer	No fistula No fat alternation No apparent bowel wall thickening
II	Thickened folds with nodularity Frank ulcer Inflammatory polyps Eccentric luminal changes	Bowel wall thickening Focal fat alternation Mild extraluminal tissues Lymphadenopathy Non-specific mass Fissure
III	Penetrating ulcers Cobblestones Stricture	Diffuse peritoneal fat changes Fluid-filled or dilated bowel loop(s) Abscess or phlegmon Crohn's fistula Other complications*

* Perforation, pancreatitis, or tumour.

Figure 4. A 42-year-old man (patient 15) with Crohn's disease. The terminal ileum was featureless and widely separated from adjacent bowel loops due to oedematous mesentery and marked inflammation. Narrowing of the terminal ileum is due to rigidity (arrow). Haustral pattern of the caecum is nearly obliterated.

stomach are rarely involved in CD, and positive radiological findings are lacking, these regions were excluded from the study. The regions most frequently involved, in decreasing order of frequency were, the terminal ileum (12/17 [70.6%]) [Figure 4], the caecum (5/17 [29.4%]), the anorectum (5/17 [29.3%]), the distal ileum (4/17 [23.5%]), the descending colon (4/17 [23.5%]), the transverse colon (3/17 [18%]), and the ascending colon (2/17 [11.8%]). No abnormality was noted in the duodenum, jejunum, or proximal ileum. Extra-intestinal manifestations were not detected in these patients.

The most frequent radiological findings were eccentric luminal change (9/17 [52.9%]) [Figure 5], and thickened folds with nodularity (8/17 [47.1%]) [Figure 6]. The third most common feature was smooth thickened folds, inflammatory polyps (Figure 7), or 'cobblestone' pattern (Figure 8), which were present in 6 of the 17 patients (35.35%). On cross-sectional imaging, 3 patients (17.6%) had Crohn's fistula, while 2 developed abscess (11.8%). One patient (5.6%) showed diffuse mesenteric fat alteration.

No patients had complications such as pancreatitis or perforation. By CIPI, 11 patients (64.7%) had grade III disease, 4 (23.5%) had grade II disease, and 2 (11.8%) had grade I disease. Thirteen of the 17 patients underwent barium study. In contrast, by conventional radiological grading alone, 9 patients (69.2%) had grade III disease, 4 (30.8%) had grade II, and none had grade I disease.

Figure 5. A 36-year-old man (patient 4) with an acute episode of Crohn's disease. Small bowel enema showed eccentric kinks of multiple segments from adhesive disease and strictures. Fistula formation was demonstrated, associated with small ulceration (arrowheads). A focal dilated loop of the small bowel is noted (arrow).

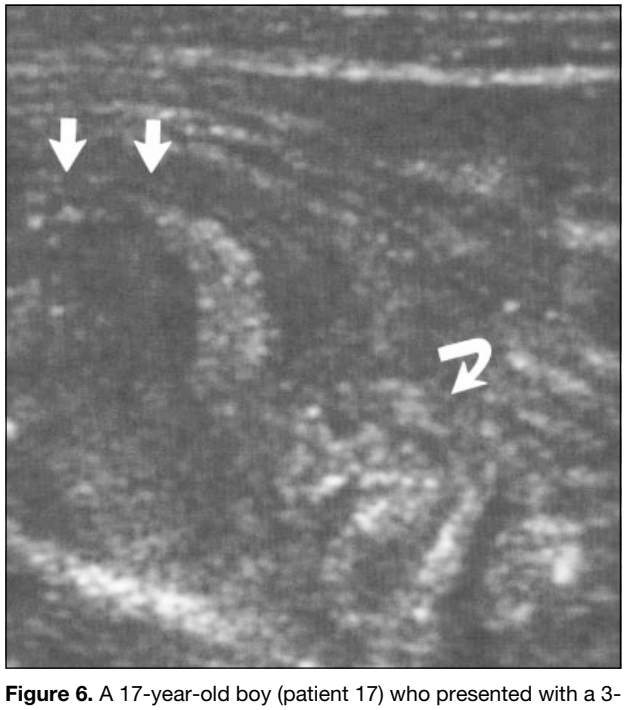

Figure 6. A 17-year-old boy (patient 17) who presented with a 3-day history of right lower quadrant pain. Axial section through inflamed terminal ileum (curved arrow) and inflamed caecum (straight arrows), revealed loss of architecture and large, non-compressible, anechoic centre in caecum. Note anechoic thickening along the walls of the terminal ileum and caecum. Real time scanning showed scarce passage of bowel contents through the lumen. Colour Doppler scan demonstrated hyperaemia of the bowel indicating active disease (not shown).

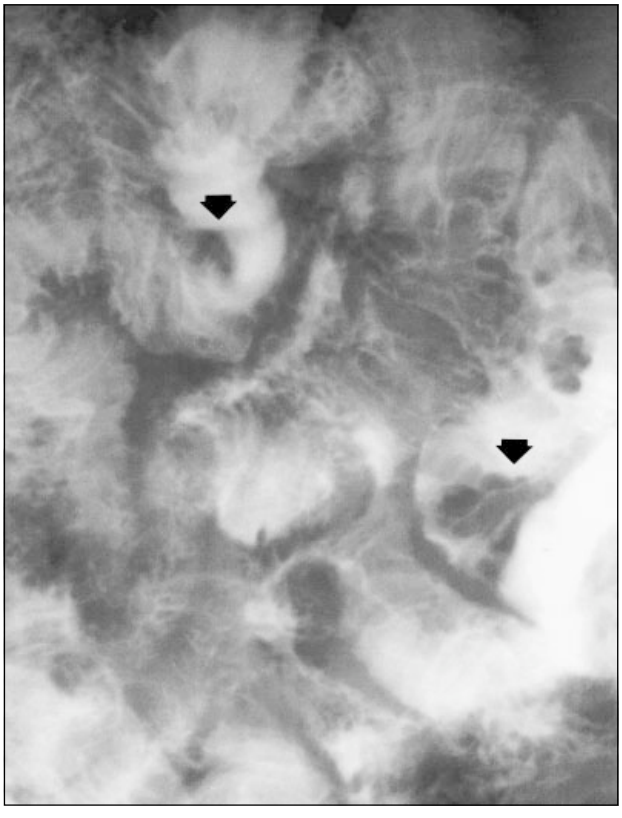

Figure 7. A 21-year-old man (patient 3) with abdominal discomfort. Double-contrast small bowel enema demonstrated multiple inflammatory pseudopolyps (arrows) within the small bowel loops.

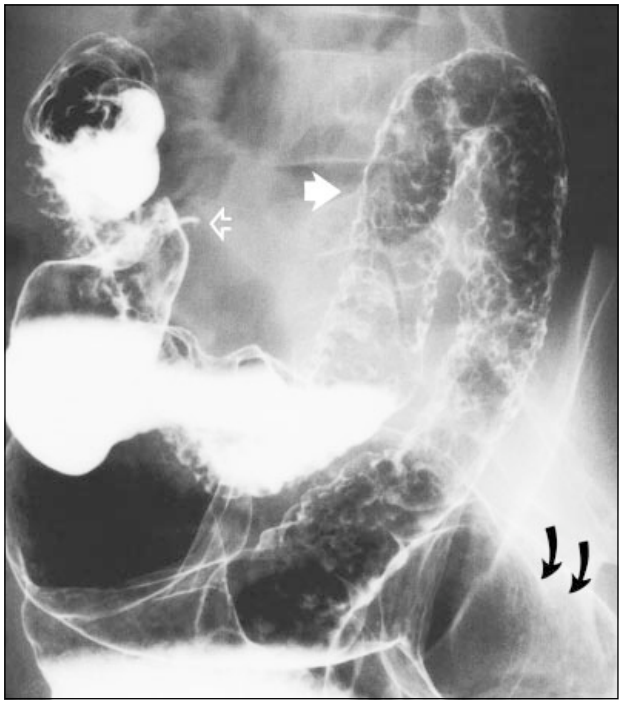

Figure 8. A 15-year-old girl (patient 16) with Crohn's disease. Cobblestone mucosa was present in transverse and proximal descending colon (closed straight arrow). Skip areas, grossly uninvolved, were present in the ascending and proximal transverse colon. Fine granular mucosal pattern (curved arrows) is noted in distended distal descending and sigmoid colon. Note 'thorn-like' deep penetrating ulcers (open straight arrow).

Table 2. Clinical data, histology, and endoscopic and imaging findings.

Patient	Age/sex	Clinical findings	Biopsy findings
1	28/F	Perianal discharge	Anal ulceration, fibrosing granulation tissues
2	21/M	Abdominal pain	Terminal ileum, caecum, and anorectum positive
3	21/M	Abdominal discomfort	Terminal ileal inflammation and ulceration, mild diffuse colonic inflammation
4	36/M	Per rectal bleeding	Small bowel ulceration and fissures
5	67/M	Epigastric pain	Terminal ileal inflammation (gallstones)
6	23/M	Perianal discharge	Small bowel inflammation and granulation
7	26/M	Abdominal pain	None
8	32/F	Abdominal pain	Mild colitis
9	34/M	Loose stool	None
10	23/M	Proctitis	Rectal inflammation and ulceration
11	44/M	Per rectal bleeding	Rectosigmoid inflammation
12	24/M	None	None
13	33/M	Perianal discharge	Severe ileal and colonic inflammation
14	46/F	Pallor	None
15	42/M	Diarrhoea	Severe colitis, severe ulceration in ileocaecal valve and anorectum
16	15/F	Abdominal pain	Active chronic colitis with ulcers
17	17/M	Abdominal pain	Colitis, cobblestoning

* MRI
† US

DISCUSSION

Worldwide, CD is more common among Caucasians than among black and Asian people.[2] The highest rate of occurrence of CD is in northern Europe and the USA, and the lowest in South America, Africa, and Asia. In the past decade, there has been a rising prevalence of CD in some countries of Southeast Asia.[1] Accurate epidemiological figures are not available for Hong Kong, with only 1 published report of 3 suspected cases of CD between 1954 and 1979 in a district hospital.[7] However, there is evidence of a recent increase in incidence of CD in Hong Kong and Singapore.[1,8] The present series reflects a similar trend in the Chinese patients studied. Changes in awareness of CD, physician practice, the organisation of the health care system, and population levels (particularly a marked increase) do not provide a satisfactory explanation for this increase in prevalence of CD.[9,10] Dietary and environmental factors may also contribute.[1]

The present study confirms earlier findings that the terminal ileum is the most common site of involvement.[11-13] It also confirms reports that a multiplicity of affected sites is a common manifestation in CD.[12] 76.5% of patients in the present study had ileocaecal disease, 35.2% had disease involving only the large bowel, and 29.4% had disease limited to the small intestine. Of patients with disease limited to the large bowel, 50% had disease confined to the anorectal region. These findings are generally similar to those described in the Western literature.[14]

Since the disease was first described by Crohn in 1932, traditional barium studies have become the primary method of demonstrating abnormalities in the intestinal tract involved in CD.[6,15] The value of double contrast studies is in their ability to depict normal and abnormal mucosal patterns clearly. Aphthous or deep ulcers, cobblestoning, fissures, sinus tracts, fistulae, luminal narrowing, and discontinuous patchy and asymmetric involvement may be discerned.

Imaging of CD has been the subject of much research in the past few decades. Several modalities have been used with varying success. Cross-sectional imaging modalities such as CT, US, and MRI are becoming increasingly important in characterisation of CD, because they are able to depict extraluminal soft tissues, and do not wholly depend on filling the tracts with contrast agent for visualisation. A high degree of correlation between CT and clinical findings has been reported.[3,16] By demonstrating abnormalities in the bowel wall, mesentery,

Radiographical sites/findings	CT/MRI/US findings	Endoscopic findings
None	Fistula-in-ano, anal muscle oedema*	None
Terminal ileum, caecum and anorectum, eccentric narrowing and cobblestoning	None	Extensive colitis and perianal disease
Distal and terminal ileum, frank ulcers, inflammatory polyps	None	Terminal ileal lesion
Proximal, distal, and terminal ileum, smooth thickened folds, frank ulcers, inflammatory polyps	None	Blood clot from terminal ileum and caecum
Distal and terminal ileum, frank ulcers, inflammatory polyps	None	Atrophic gastritis
Terminal ileum, frank ulcers, stricture	None	None
Terminal ileum and colon, inflammatory polyps, cobblestoning	None	None
Colon, frank ulcers, inflammatory polyps,	None	Quiescent colitis and pseudopolyps
Splenic flexure, inflammatory polyps	None	Multiple colonic polyps
Terminal ileum, aphthous ulcers	None	Gastritis and inflamed rectal canal
Distal and terminal ileum and anorectum, thickened folds	Thickened sigmoid wall	Inflamed rectal canal
Distal and terminal ileum and caecum, thickened folds	None	None
Anal canal, sinus	Fistula-in-ano	Severe ileal inflammation and colonic colitis
Terminal ileum, thickened folds	None	None
Distal and terminal ileum, colon, anorectum, penetrating ulcers, cobblestoning	None	Inflamed ileocaecal valve, colorectal inflammation and ulcers
Transverse and descending colon, cobblestoning and stricture	None	Colitis, cobblestoning
Colon, ulceration	Inflamed terminal ileum and caecum†	Active colitis with ulcers

abdominal and pelvic organs, and soft tissue as well as intraosseous structures, CT plays a crucial role in evaluating patients with CD. The pattern of dynamic bowel wall enhancement has been described as a sensitive indicator of disease activity.[3] CT often reveals complications such as abscesses and fistulae, or suspected secondary malignancy as a result of the disease.

Special MRI techniques show promise in assessing disease activity by determining various bowel changes: — these techniques include using half-Fourier rapid acquisition with relaxation enhancement (RARE), and gadolinium-enhanced standard and fat-suppressed spoiled gradient echo (SGE) sequences.[17,18] The multiplanar capability and high inherent soft tissue contrast in MRI has been reported as being clinically useful in distinguishing Crohn's specific fistulae from nonspecific cryptoglandular fistulae.[19]

The ability of US to depict bowel wall thickening, phlegmons, and abscesses without the use of irradiation, has been emphasised by some authors as a potential advantage in the management of patients with CD.[20,21] Although Doppler assessment of the superior mesenteric arterial flow and transabdominal hydrocolonic US have been advocated as a means of assessing CD activity, their use is not common practice.[2,22]

Radionuclide imaging such as ^{99m}Tc- and ^{111}In-leucocyte scanning is complementary to other imaging techniques, and is useful for patients with active disease who may be unable to tolerate more invasive procedures. This sensitive technique is useful for determining the extent and activity of newly diagnosed or residual disease and complications.[2,6,23]

Faced with new imaging features of CD not previously described, an integrated means of interpreting findings from different modalities is important for overall disease grading. Complementary imaging modalities may optimise detection of all mucosal and extraluminal lesions of CD. Hence, the Combined Imaging Predictive Index (CIPI) was formulated. The severity of disease does not correlate directly with the extent of bowel involvement. Indeed, the 3 main disease patterns (namely, inflammatory, stricturing, or fistulising forms) rather than the extent primarily determine the disease course and the nature of the associated complications.[15] Therefore, instead of documenting the region of bowel involvement, these 3 main patterns of disease were incorporated into the novel classification system.

There are several methodological limitations in this preliminary study. The sample was small and heavily weighted towards patients with advanced disease. The number of patients who had undergone sectional imaging was limited in this retrospective study. Potential referral bias cannot be excluded. In addition, the radiologists were not blinded to the patient's clinical history. This bias would tend to increase the frequency and severity of radiological and sectional imaging findings.

The extraluminal lesions of CD such as mesenteric fat alteration, inflammatory masses, and lymphadenopathy are more adequately represented in the CIPI. Furthermore, complications such as abscess formation, pancreatitis, and tumours, undiagnosed by fluoroscopic means, are better described by the new index. Additional research is now required to correlate the imaging and pathological findings using a controlled prospective study.

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