Radiology

8

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8.1 Radiological Features of Inflammatory Bowel Disease

8.1.1 Crohn's Disease

Crohn's disease tends to be transmural, segmental, and usually discontinuous. Multifocal small bowel diseases may present with areas of different activity, some areas with acute inflammatory, and others with fibrostenosing disease [1–3]. The characteristic radiological features of Crohn's disease on barium study include aphthoid or deep ulcerations, cobblestone appearance, sinus tract, and fistula with discontinuous and asymmetric involvement (Figs. 8.1, 8.2, and 8.3).

Crohn's disease also has a variety of appearances at CT or MR depending on whether the activity is acute inflammatory or chronic fibrostenosing and whether there are complications such as fistula or abscess. The optimal distension of the small bowel loops is important for the accurate evaluation of the bowel wall because collapsed bowel can hide or mimic disease. CT or MR which is performed after oral contrast ingestion to achieve small bowel distension is called CT or MR enterography. The negative oral contrast agents, such as polyethylene glycol solution (PEG), suspension of 0.1 % barium sulfate (Volumen), and water-methylcellulose solution, are preferred because they allow better depiction of bowel wall enhancement [1].

On CT or MR, enteric findings such as mural hyperenhancement, bowel wall thickening, mural stratification, and extraenteric findings such as engorged vasa recta ("comb sign") [4] and increased attenuation of the mesenteric fat are features of active inflammatory small bowel Crohn's disease (Figs. 8.4 and 8.5) [3, 5]. Among these findings, combinations of mural hyperenhancement and bowel wall thickening are the most sensitive findings suggesting the presence of active inflammation [5]. It is important to differentiate active inflammatory small bowel strictures from fibrotic strictures in patients with Crohn's disease because the former are mostly managed medically, whereas the latter may require endoscopic or surgical interventions (e.g., balloon dilation, strictureplasty, or bowel resection) [6]. In fibrostenosing Crohn's disease (Figs. 8.6 and 8.7), mural stratification may be absent because of the transmural fibrosis and/or muscular hypertrophy and collagen deposition leading to a homogeneous and less-intense enhancement [7] (Table 8.1). Low-signal intensity of the stricture site on T2-weighted MR imaging may be helpful for diagnosing fibrostenotic Crohn's disease [8]. However, active inflammation and fibrosis often coexist in the same patient or even in the same affected bowel segments in Crohn's disease.

CT or MR has an important role in evaluating extraenteric complications of Crohn's disease. The most common extraenteric complications include fistula, sinus tract, and abscess [9–11]. On CT or MR, sinuses or fistulas are demonstrated as tethering of bowel loops and visualization of linear enhancing tracts with or without communication with adjacent structures such as peritoneal or retroperitoneal spaces, skin or adjacent organs, or bowel, respectively (Figs. 8.8, 8.9, and 8.10) [12]. Abscesses are usually contiguous to the diseased bowel segment and are seen in the mesentery or retroperitoneal space (Fig. 8.11) [3]. The accurate detection of abscesses and fistulas has high importance because it affects the decision to treat medically or surgically. Particularly, in the identification of perianal fistula tracts, MR imaging is useful because of its better multiplanar imaging capability and soft tissue contrast than those of CT (Fig. 8.10). Bowel perforation can be developed in Crohn's disease. It is associated with bowel distension with increased intraluminal pressure proximal to an obstruction or ischemic hypothesis (Fig. 8.12) [13]. Other extraenteric manifestations of Crohn's disease, such as mesenteric lymphadenopathy, cholelithiasis, nephrolithiasis, sacroiliitis, and primary sclerosing cholangitis, can also be evaluated [3].

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Radiation concern is an important issue in CT because patients with Crohn's disease are relatively younger and are expected to undergo multiple follow-up CT studies [14]. In terms of radiation issue, MR enterography is an emerging diagnostic tool for evaluating patients with known or suspected Crohn's disease by virtue of its ability to help physician confirm the diagnosis, assess its extent and inflammatory activity, and detect extraintestinal complications (Figs. 8.9 and 8.10). Major MR enterographic findings of Crohn's disease are not different from those of CT. The two diagnostic modalities appear to be similar in terms of detecting active inflammation, fibrosis, and extraenteric complications [15]. However, CT is preferred in elderly patients because MRI is more time consuming and sometimes requires breath-holding technique [16]. Moreover, CT should be preferred in emergency settings such as suspicious bowel perforation or obstruction.

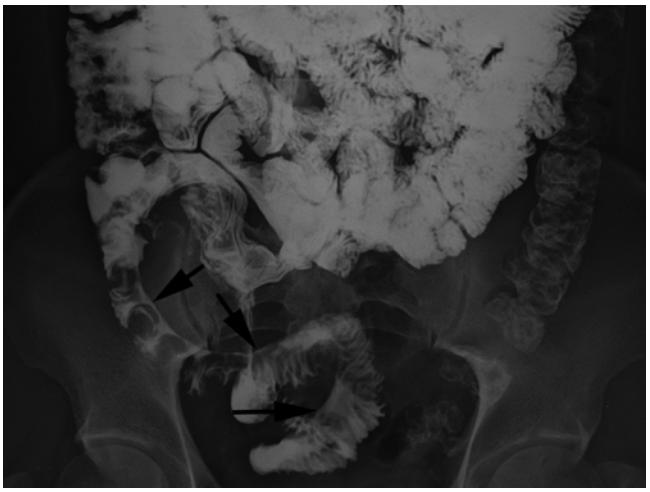

Fig. 8.1 Barium study for Crohn's disease. Multisegmental longitudinal ulcers (*arrows*) are seen in the mesenteric side throughout ileal loops with discontinuous and asymmetric pattern

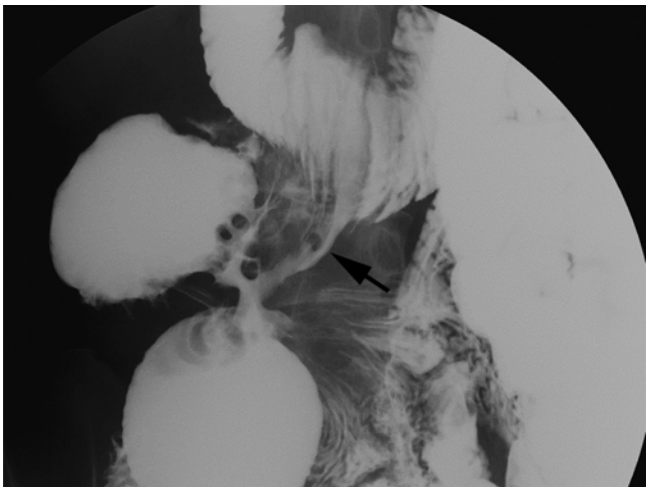

Fig. 8.3 Barium study for Crohn's disease. Fistula (*arrow*) between the duodenum and ascending colon is demonstrated

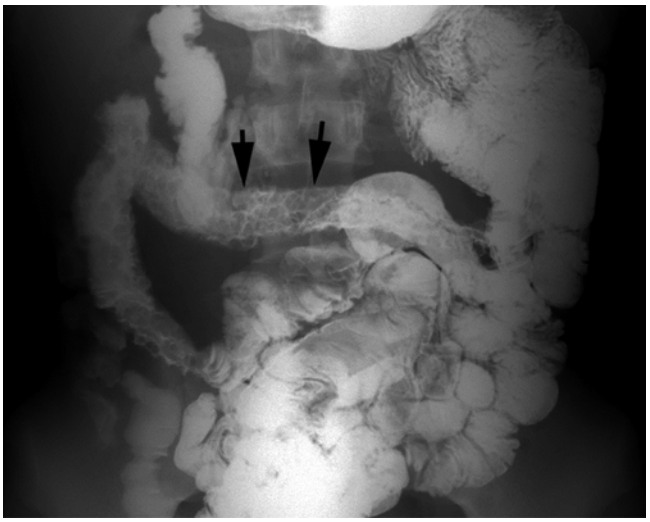

Fig. 8.2 Barium study for Crohn's disease. Longitudinal and transverse ulcers of the distal ileal loop produce a cobblestone appearance (*arrows*)

Fig. 8.4 Active Crohn's disease. Coronal CT image demonstrates multifocal segmental mural hyperenhancement and layered mural stratification in the ileum (*arrows*), suggesting active disease. Increased perienteric fat attenuation is also seen

Fig. 8.5 Active Crohn's disease. Axial CT image demonstrates multifocal segmental mural thickenings with hyperenhancement (*arrows*) with engorged vasa recta (positive comb sign) (*arrow heads*)

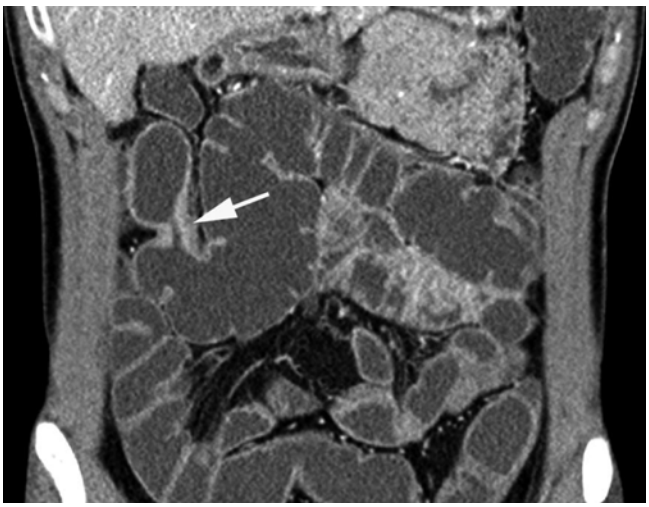

Fig. 8.6 Fibrostenotic Crohn's disease. Coronal CT image shows segmental stricture with homogeneous mural thickening at anastomosis site of right hemicolectomy. Less-intense enhancement without stratification is characteristic of fibrostenosing disease

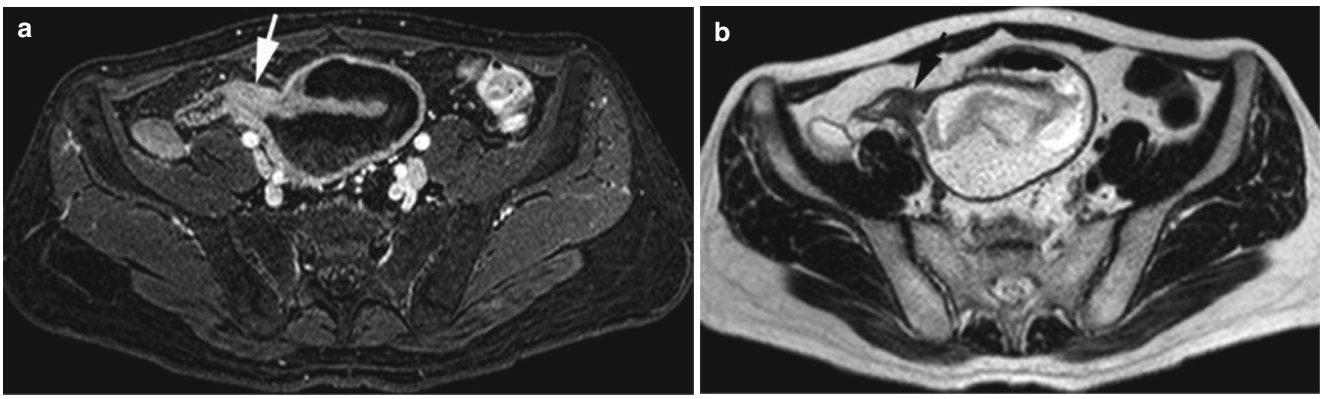

Fig. 8.7 Fibrostenotic Crohn's disease. MR image shows a homogeneous, less-enhancing strictured bowel segment (*arrow*) on T1-weighted contrast-enhanced axial image (**a**) and low signal intensity of the corresponding segment (*arrow*) on T2-weighted axial image (**b**)

Table 8.1 Differential diagnosis of inflammatory stricture and fibrotic stricture in Crohn's disease on cross-sectional imaging

	Inflammatory stricture	Fibrotic stricture
Mural thickening	More severe	Less severe
Mural hyperenhancement	More strong	Less enhancement
Mural stratification	Frequent	Homogeneous without stratification
Submucosal fat deposition	Rare	More frequent
Signal intensity on T2-weighted MR imaging	Mild to moderate high SI	More low signal intensity

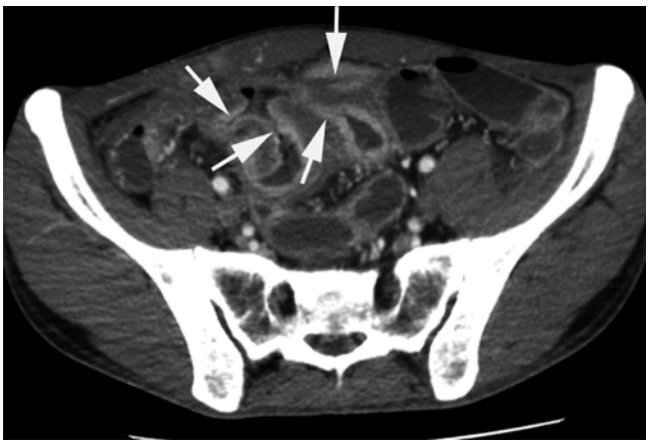

Fig. 8.8 Fistula. Axial CT image shows multiple enteroenteric fistulas (*arrows*) between the ileal loops

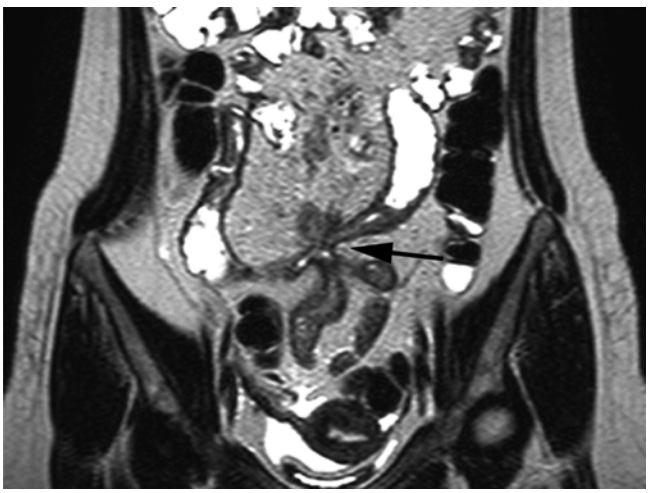

Fig. 8.9 Fistula. Coronal single shot FSE T2-weighted MR image shows multiple enteroenteric fistulas (*arrows*) between the ileal loops

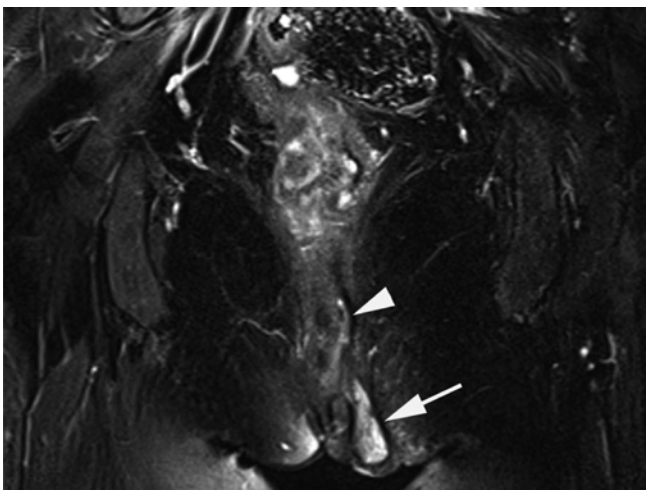

Fig. 8.10 Perianal fistula with abscess. Coronal T2-weighted fat-suppressed MR image shows intersphincteric type fistula (*arrowhead*) with abscess (*arrow*) in the perianal area

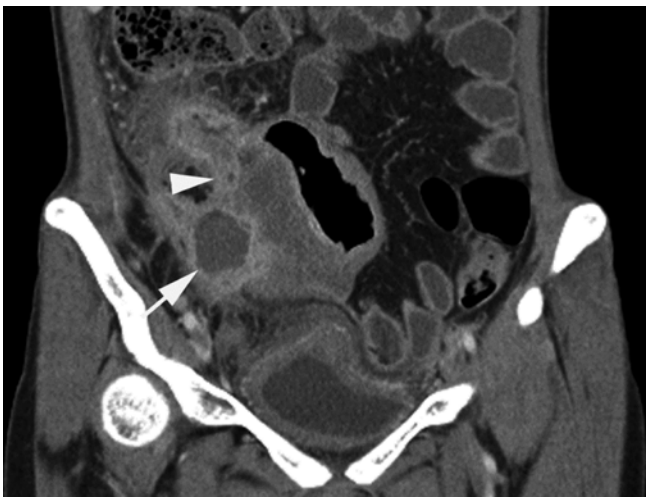

Fig. 8.11 Abscess. Coronal CT image demonstrates a mesenteric abscess (*arrow*) adjacent to the terminal ileum. Fistula (*arrowhead*) is seen between the cecum and abscess

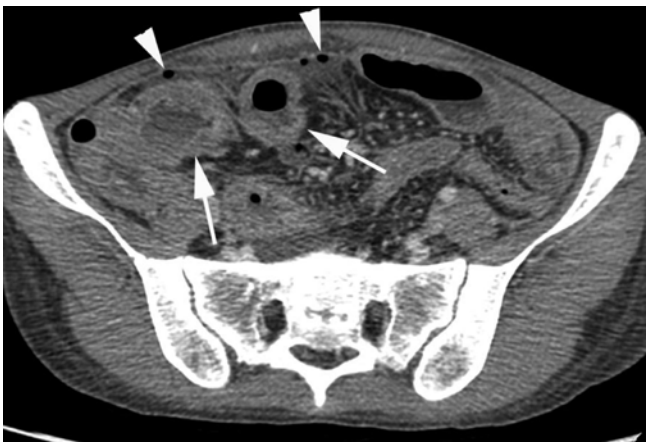

Fig. 8.12 Small bowel perforation. Several focal-free air foci are noted within the peritoneal cavity on axial CT image (*arrowheads*), suggesting intestinal perforation. Inflamed ileal loops are also seen (*arrows*)

8.1.2 Intestinal Tuberculosis

The most frequent site of intestinal tuberculosis involvement is the ileocecal area (approximately 90 % in case of gastrointestinal tuberculosis) (Figs. 8.13 and 8.14). Barium study may show contour deformity involving the ileocecal valve with stellate ulcers. In advanced stage, the cecum becomes conical and shrunken with wide opening of the ileocecal valve and the narrowed terminal ileum [17]. CT findings may show short segmental circumferential wall thickening related with the circumferential distribution of superficial ulcers in the cecum and terminal ileum (Figs. 8.14, 8.15, and 8.16) [18]. Central necrotic lymph nodes on CT are a specific finding for tuberculosis (Fig. 8.15).

CT findings that may be helpful for differentiating intestinal tuberculosis from Crohn's disease include short segmental enhancing wall thickening in tuberculosis, while Crohn's disease demonstrates relatively long segmental wall thickening (Table 8.2). In addition, incompetence of the ileocecal valve appears to be common in tuberculosis but uncommon in Crohn's disease. Mural stratification is known to be more frequent in Crohn's disease [19]. Among extraintestinal findings, fibrofatty proliferation, positive comb sign by increased mesenteric vascularity, and internal/perianal fistula suggest the possibility of Crohn's disease rather than intestinal tuberculosis. However, the differentiation between intestinal TB and Crohn's disease may be difficult because they sometimes share similar radiologic findings.

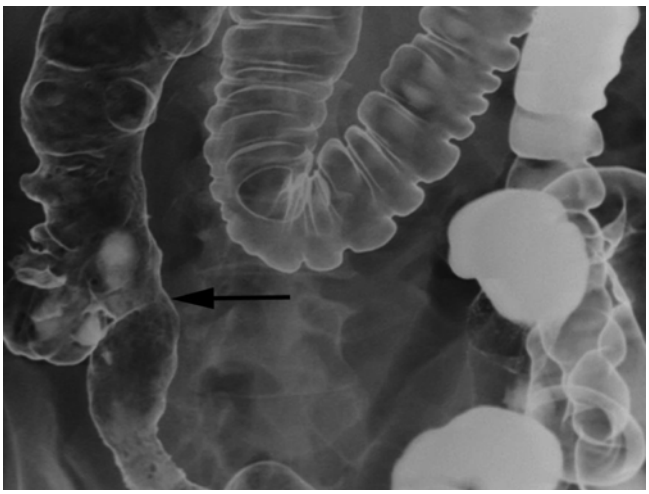

Fig. 8.13 Barium study of ileocecal tuberculosis. Barium study shows the characteristic abnormality of ileocecal tuberculosis such as loss of anatomic demarcation between the terminal ileum and the contracted cecum (*arrow*) and gapping of the ileocecal valve

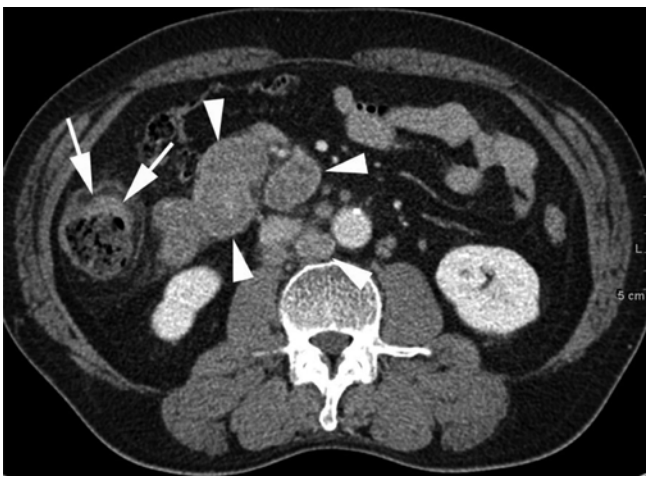

Fig. 8.14 CT findings of ileocecal tuberculosis. CT shows circumferential enhancing wall thickening in the cecum (*arrows*). Multiple low-attenuated lymph node enlargements, suggesting caseous necrosis, are seen in the ileocecal mesentery (*arrowhead*)

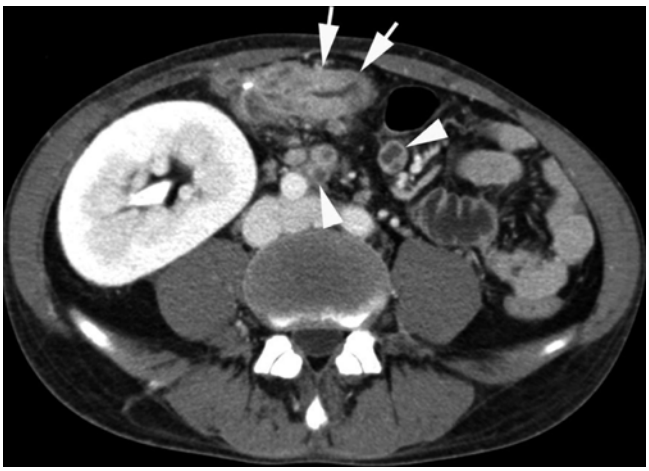

Fig. 8.15 CT findings of intestinal tuberculosis. Short segmental mural wall thickening with homogeneous mural enhancement is noted in the terminal ileum without mural stratification (*arrows*). Multiple central necrotic lymph node enlargements are seen in the mesentery (*arrowheads*)

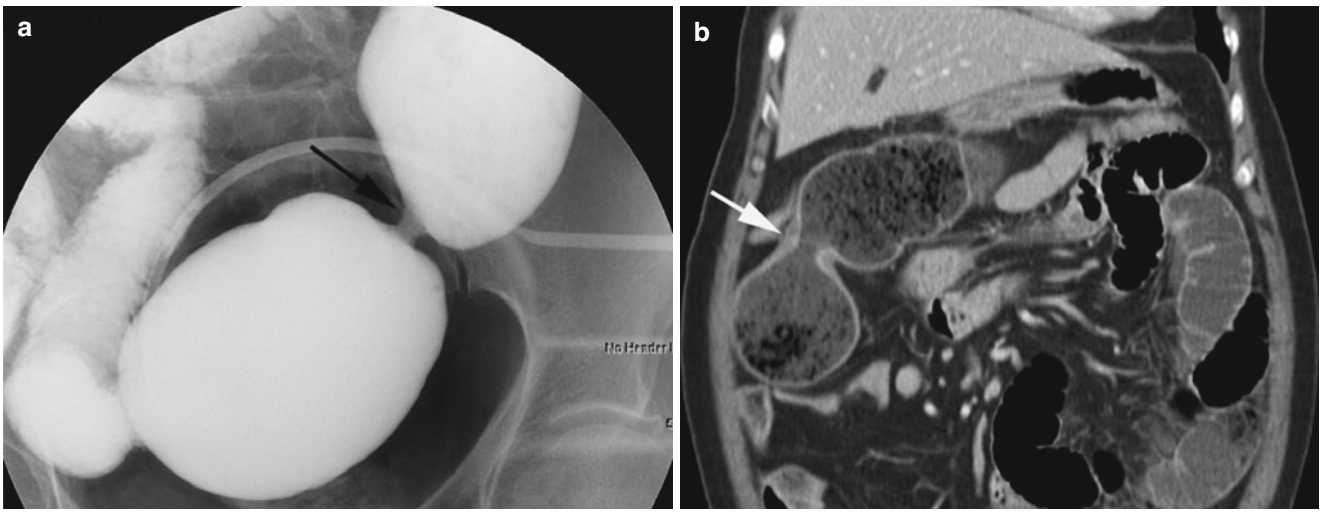

Fig. 8.16 Small bowel tuberculosis. Barium study (**a**) and CT (**b**) show short segmental bowel stricture at the level of the distal jejunal loop (*arrows*). Associated prestenotic bowel dilatation is also seen

Table 8.2 Differential diagnosis of Crohn's disease, intestinal tuberculosis, and intestinal Behçet's disease by radiologic imaging studies

	Crohn's disease	Intestinal tuberculosis	Behçet's disease
Involvement of ileocecal area	May spare	Common	Common
Stratification	Frequent	Rare	Possible
Distribution pattern and symmetry	Long eccentric involvement of thickening (mesenteric border) with antimesenteric pseudosacculation	Short circumferential thickening	Single or multiple deep penetrating ulcers (larger and deeper)
Mesenteric fibrofatty proliferation	Frequent	Rare	Rare
Positive comb sign	Frequent	Rare	Possible
Central necrosis of lymphadenopathy	–	Possible and specific	–
Complications	Frequent perianal internal fistula	Rare perianal internal fistula	Common perforation, fistula, and thrombophlebitis

8.1.3 Behçet's Disease

The most common site of involvement in the small intestine is the terminal ileum, and there is often simultaneous involvement of the proximal cecum (Figs. 8.17, 8.18, and 8.19). Behçet's disease involving the ileocecal region is commonly manifested as geographic, relatively large, and deep penetrating ulcers with bowel wall thickening and mural hyperenhancement (Table 8.1) [20]. The frequency of postoperative recurrence is high, and the most common type of the recurrent pattern is one or two deep ulcers at or near the anastomosis site (Fig. 8.20).

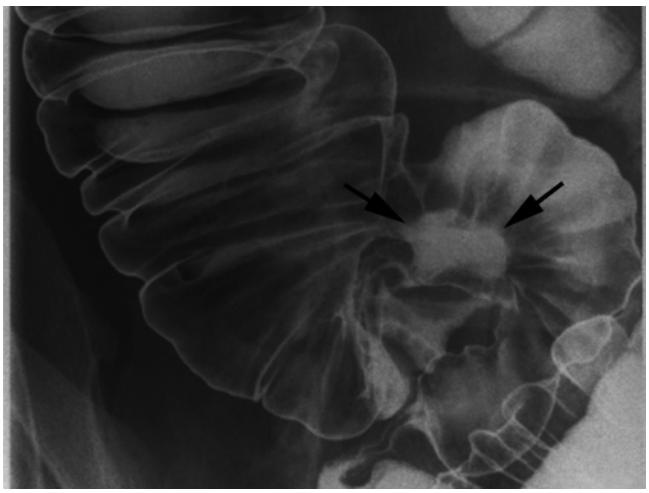

Fig. 8.17 Barium study of intestinal Behçet's disease. Image from a double-contrast barium enema study shows a large geographic ulcer (*arrows*) in the terminal ileum with convergence of thickened mucosal folds

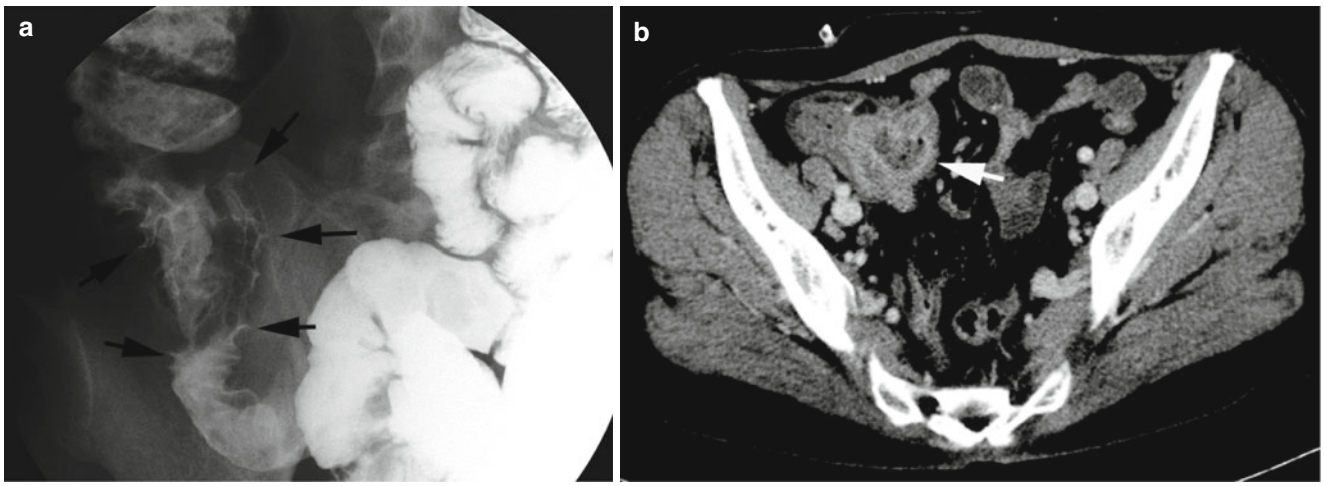

Fig. 8.18 Behçet's disease. Mucosal fold thickening is seen in the cecum and terminal ileum with multiple small penetrating ulcers in the terminal ileal loop (*arrows*) (**a**). After 3 years, large penetrating ulcer developed in the terminal ileal loop (*arrow*) (**b**)

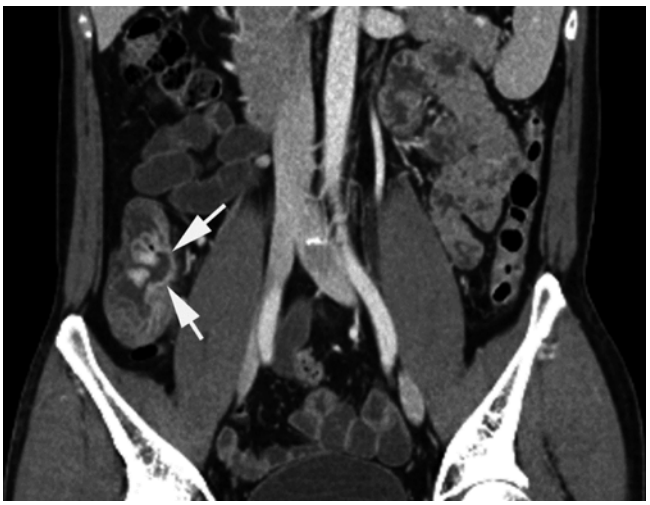

Fig. 8.19 CT of intestinal Behçet's disease. CT shows a penetrating ulcer with mural enhancement (*arrows*) in ileocecal area

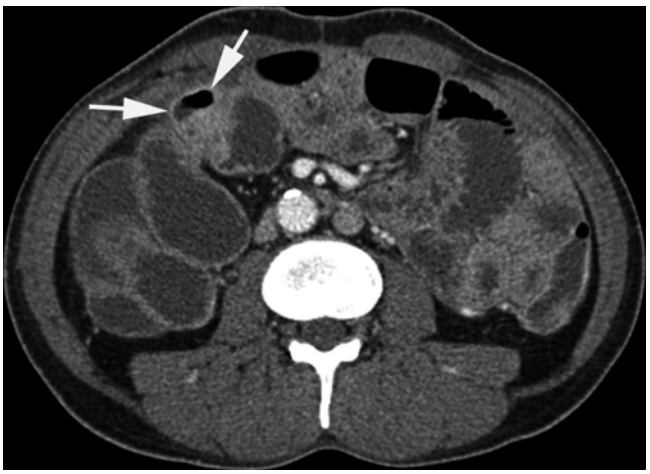

Fig. 8.20 Recurrent intestinal Behçet's disease. Axial CT image shows a penetrating ulceration with peripheral enhancement at the anastomosis of right hemicolectomy

8.1.4 Ulcerative Colitis

Rectal involvement is present in 95 % of cases, with variable degrees of contiguous, circumferential, and proximal extension throughout the large intestine. Small-bowel disease is rare. Barium study shows mucosal granularity/stippling, collar button ulcers, haustral thickening/loss, and inflammatory polyps on acute phase (Fig. 8.21) and luminal narrowing, loss of rectal valves, widened presacral space, and postinflammatory polyps on chronic phase (Figs. 8.22 and 8.23) [21]. Diffuse symmetric colonic mural thickening on CT is a common finding with target or halo sign (Fig. 8.24). Generally, ulcerative colitis produces less wall thickening than does Crohn's disease [22]. Toxic megacolon is the most severe life-threatening complication of inflammatory bowel disease and an indication for emergency surgery. It occurs more commonly in ulcerative colitis rather than Crohn's disease (Fig. 8.25). Ulcerative colitis is also associated with primary sclerosing cholangitis, a chronic cholestatic liver disease characterized by inflammation and scarring of the bile ducts (Fig. 8.26) [23].

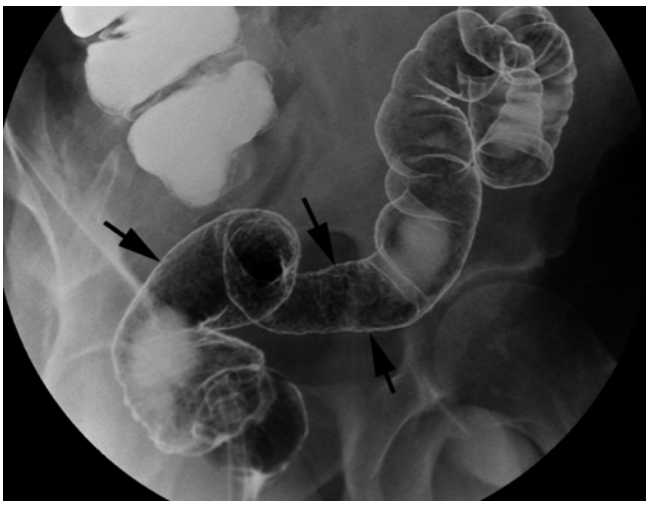

Fig. 8.21 Acute phase of ulcerative colitis. Double-contrast barium enema study shows mucosal granularity and stippling (crypt abscess) (*arrows*) in the rectum and sigmoid colon, suggesting early stage of ulcerative colitis

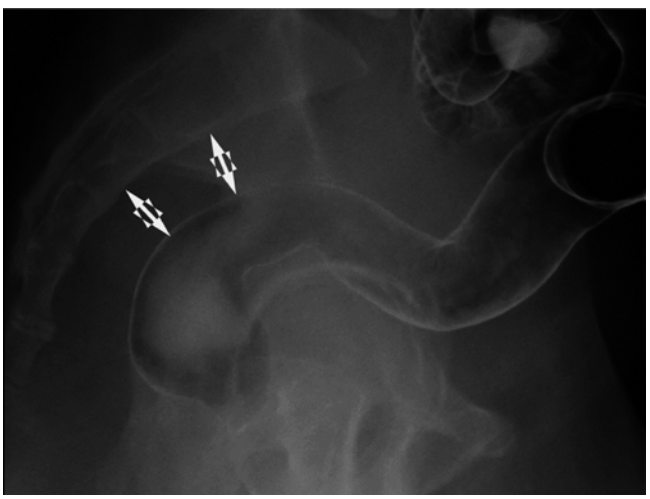

Fig. 8.22 Chronic phase of ulcerative colitis. Lateral rectal view shows widened presacral space (*arrows*). A distance greater than 1.5 cm is considered abnormal. The rectal lumen is also narrowed with the absent valves of Houston

Fig. 8.23 Chronic phase of ulcerative colitis. Barium study shows chronic ulcerative pancolitis with diffuse luminal narrowing, blunting, and lost haustra in the near entire colon and rectum

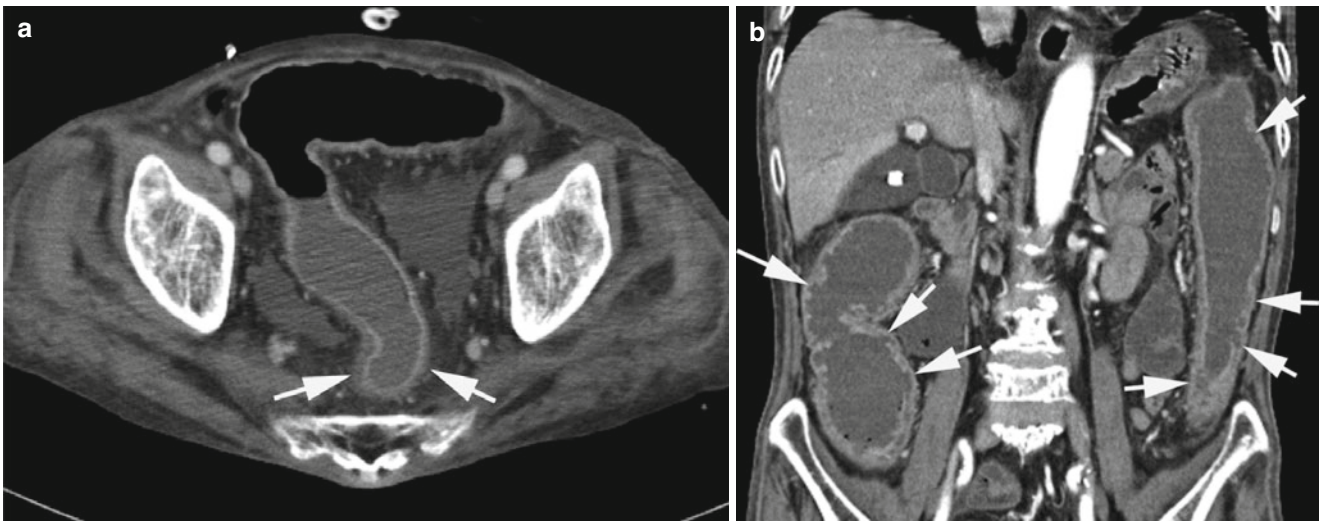

Fig. 8.24 CT of ulcerative colitis. (**a**) Axial CT image shows mural thickening with stratification in the rectum and sigmoid colon, suggesting acute inflammation. (**b**) Coronal CT image shows multiple ulcerations, corresponding to collar button ulcers in the ascending and descending colon with layered mural thickening

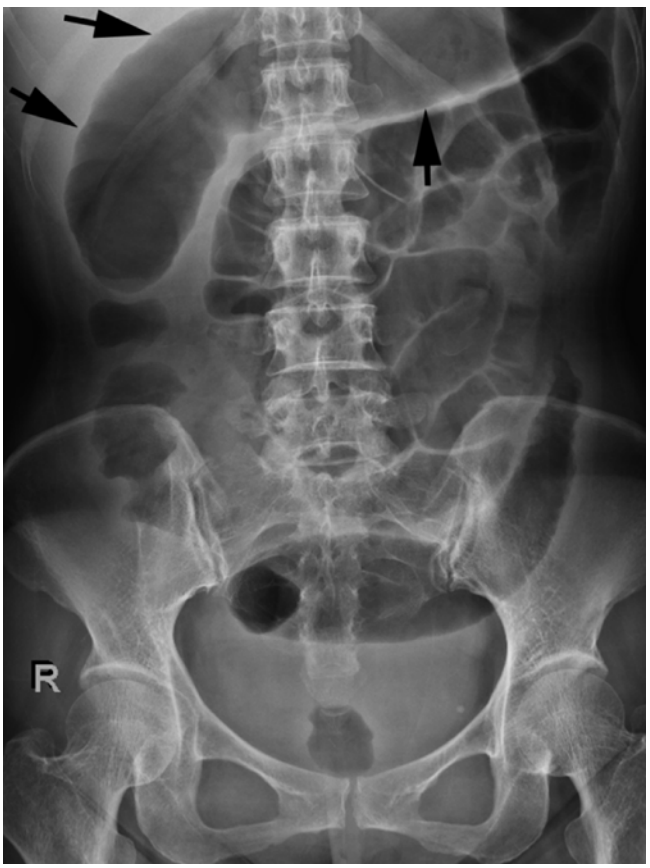

Fig. 8.25 Toxic megacolon. Toxic megacolon is the most severe life-threatening complication of inflammatory bowel disease. It occurs more frequently in ulcerative colitis than in Crohn's disease. It is an indication for emergency surgery. Simple abdomen film shows prominent dilatation of the transverse colon (*arrows*). Dilatation greater than 5 cm is considered abnormal

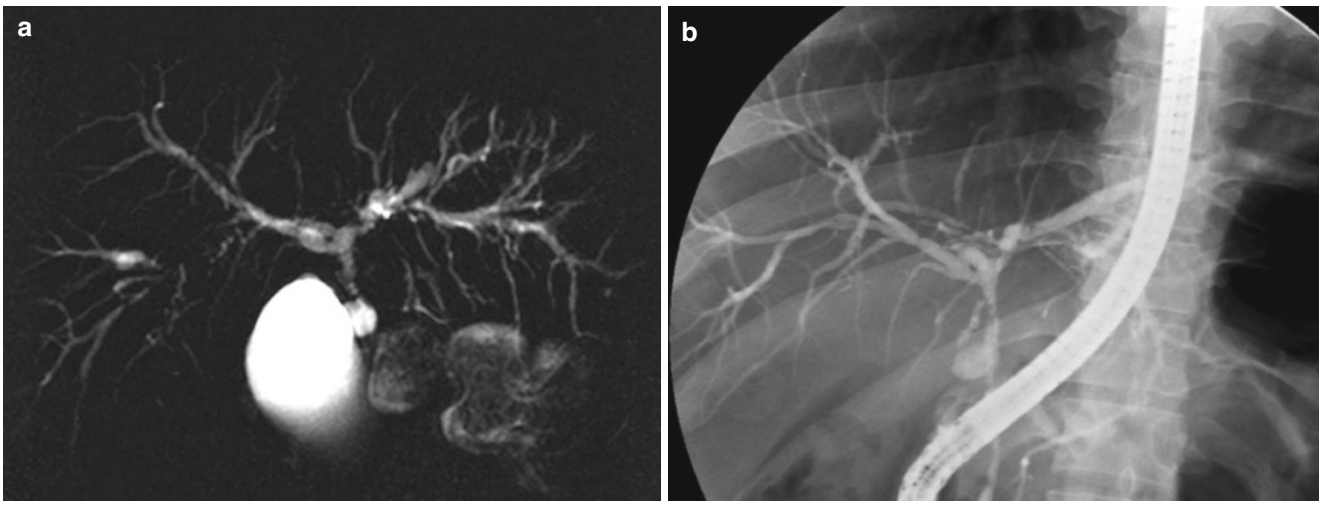

Fig. 8.26 Primary sclerosing cholangitis. Two-dimensional MR cholangiography (**a**) and endoscopic retrograde cholangiography (**b**) show intrahepatic biliary ducts with irregular and multifocal strictures with alternating segments of dilation, creating a beaded appearance of bile ducts

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