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REVIEW

Radiological diagnosis of large-bowel obstruction: nonneoplastic etiology

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Abstract Large-bowel obstruction (LBO) is a relatively common abdominal emergency. Computed tomography (CT) diagnosis of LBO is often easy, but it is essential to clarify LBO etiology and to decide how to treat it. Therefore, it is important for the radiologist to become familiar with the imaging findings of LBO, including plain radiography and CT, to determine its various causes, as well as the many diseases mimicking LBO. In this article, we show the characteristics of radiological findings of plain radiograph, barium study, and CT and their correlations with pathologic findings. LBO etiology comprises two main categories: neoplastic and nonneoplastic disease. However, the primary causes of LBO are neoplastic etiologies, and nonneoplastic causes are relatively uncommon and unfamiliar to many radiologists in clinical practice. Therefore, in this review, we present nonneoplastic etiology of LBO and diseases simulating LBO and provide critical information concerning the causes of LBO and viability of the involved bowel loops.

Keywords Acute abdomen · Large-bowel obstruction · MDCT · Nonneoplastic · Colonic volvulus

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Introduction

Large-bowel obstruction (LBO) is a critical clinical condition that may present as an emergency that requires early and accurate diagnosis for a prompt treatment. The first-line imaging modality for acute abdomen is abdominal ultrasonography (US) and plain radiography. The problem-solving role of computed tomography (CT) in diagnosing and assessing LBO has expanded because of its feasibility, short examination time, and a large volume of information. Nowadays, CT can determine whether there is a mechanical obstruction, the level of obstruction, and whether obstruction is associated with bowel ischemia, and finally help recommend LBO management: medical or surgical, and if surgical, whether laparotomy or laparoscopy [1–3].

Colorectal cancer, diverticulitis, and volvulus account for approximately 80–85 % of LBO cases [2]. Most cases are of neoplastic etiology, with nonneoplastic causes being relatively uncommon. Therefore, in this review, we focus on the nonneoplastic etiology of LBO, presenting radiological findings by plain radiography, barium enema, and CT, as well as diseases mimicking LBO, with special emphasis on CT findings due to the importance of radiologists becoming familiar with such findings. The following contents are presented:

1. Nonneoplastic causes:
   - Diverticulitis
   - Endometriosis
   - Inflammatory bowel disease
   - Colonic volvulus
2. Diseases simulating LBO
   - Toxic megacolon
   - Paralytic ileus

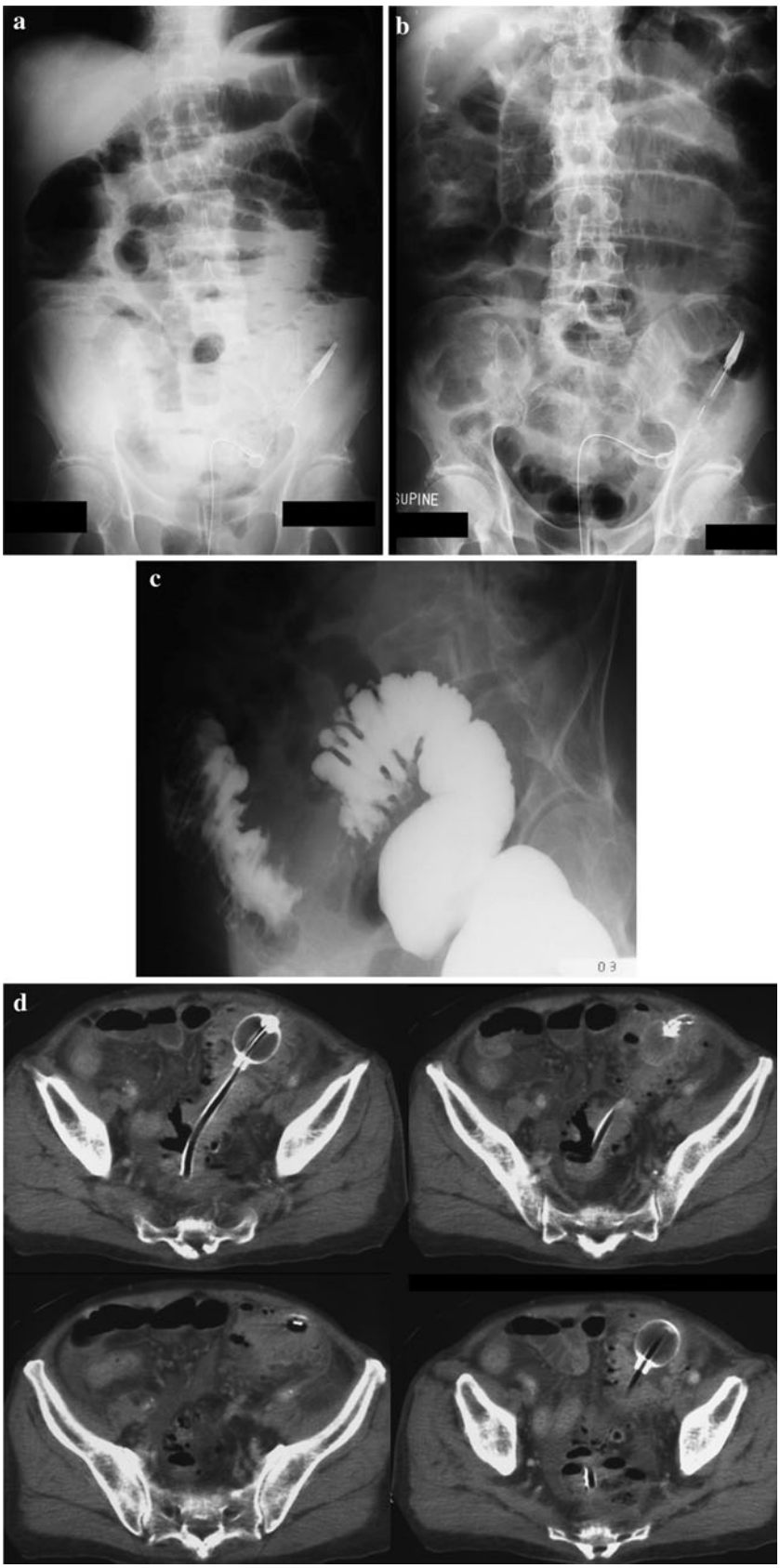

Fig. 1 An elderly man presented with small- and large-bowel obstruction (**a**, **b**) and was initially treated by per-anal long-tube insertion and decompression. Barium enema revealed short-segment stenosis in the sigmoid colon (**c**). Subsequent computed tomography (CT) study (**d**) shows pericolic and colic inflammation around the sigmoid colon and many adjacent diverticuloses. Note the absence of endoluminal tumor mass or lymphadenopathy, which is the important point for differentiation from colon cancer

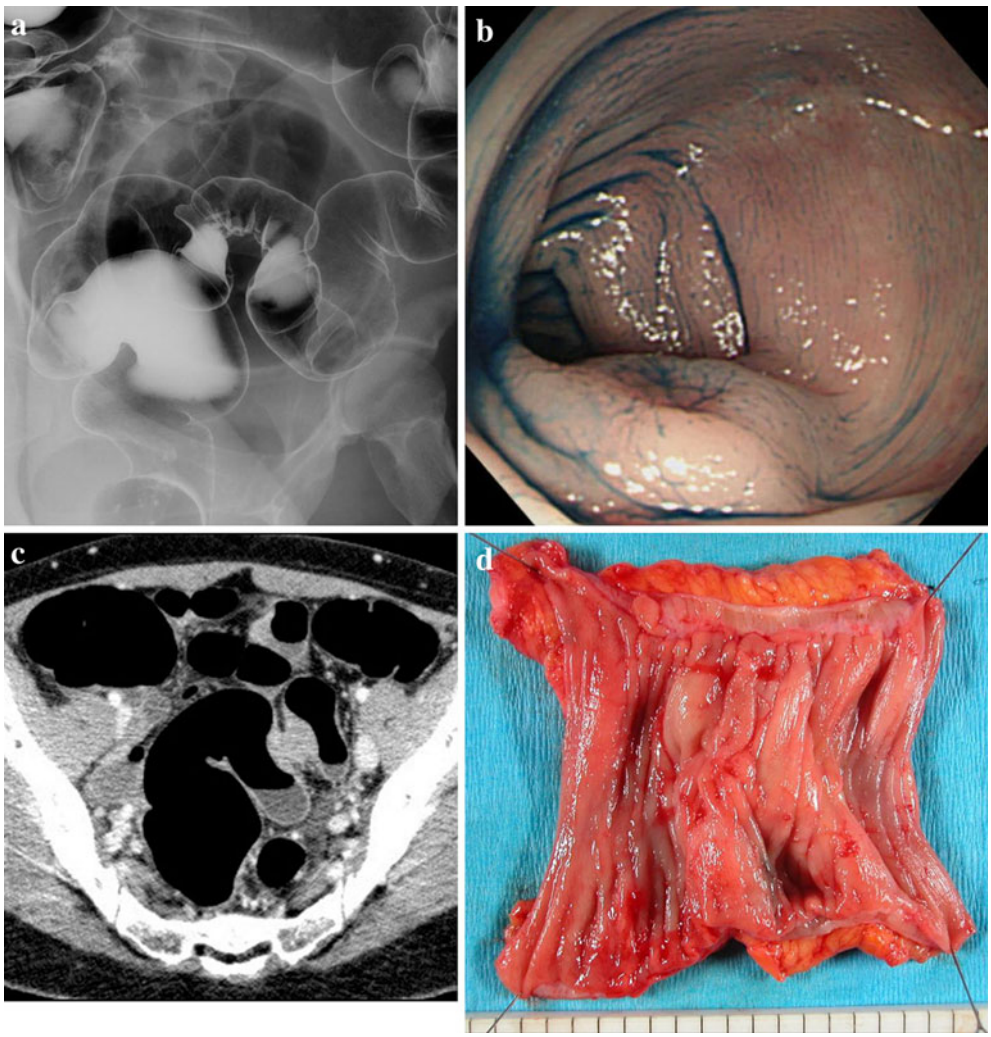

Fig. 2 A 39 year-old woman presented with abdominal pain and rectal bleeding. She was diagnosed with uterine adenomyosis. The rectal bleeding began at the menstrual cycle 1 year earlier. Barium enema (**a**) shows serrated appearances along the inferior border of the sigmoid colon. Colonoscopy shows submucosal tumor with small central depression in the sigmoid colon (**b**). Computed tomography (CT) revealed smooth-wall thickening in the sigmoid colon (**c**). Sigmoidectomy specimen (**d**) shows mucosal swelling with fold convergence without any epithelial mass lesion, which was confirmed as ectopic endometriosis

Nonneoplastic causes of LBO

Diverticulitis

Diverticulitis accounts for approximately 10 % of LBO [2]. High-grade colonic obstruction, which is relatively uncommon, may result from abscess formation, edema, or stricture formation after recurrent attacks of diverticulitis [4, 5]. Barium enema examination shows annular stenosis of the colon segment caused by intramural abscess, which is difficult to differentiate from neoplastic stenosis (Fig. 1). Absence of the diverticula near the lesion and irregularity of the contours, an eccentric lumen, ulcerated mucosa, overhanging margins, and an irregular edge favor the diagnosis of a carcinoma. CT signs helpful in differentiating between diverticulitis and colon cancer are pericolic inflammation, segmental involvement >10 cm for diverticulitis, and pericolic lymph node swelling and luminal mass for colon cancer [6].

Endometriosis

The incidence of bowel involvement with endometriosis is 3–34 % [7, 8]. The most frequent location of endometriosis implant is rectosigmoid, followed by small bowel, cecum, and appendix [7, 8]. However, many patients with intestinal endometriosis are either asymptomatic or have nonspecific gastrointestinal symptoms. Reports of bowel

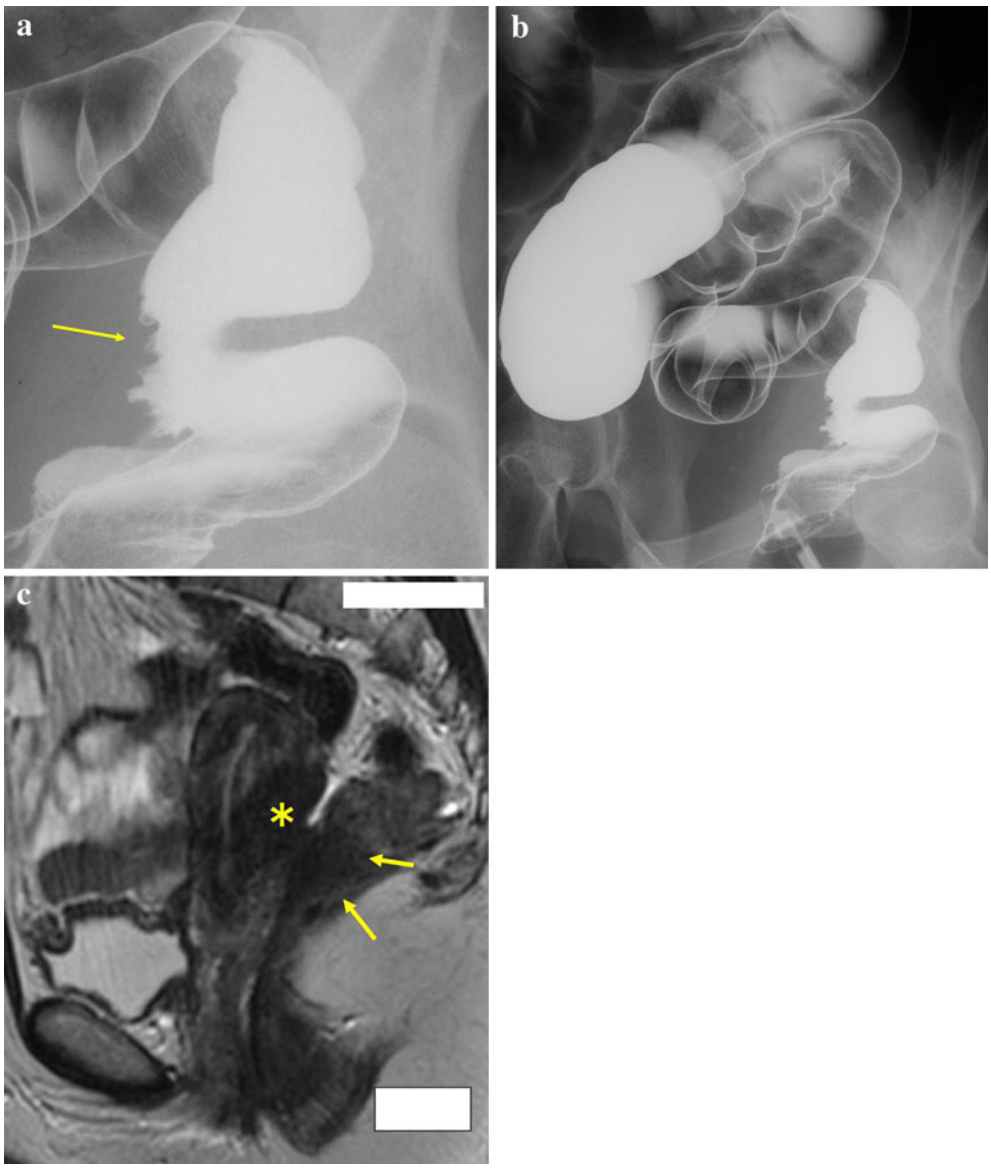

Fig. 3 Another case of rectal endometriosis. Barium enema (**a**, **b**) shows localized tethering (*arrow* in **a**) and poor expansion of the anterior wall of the rectum. T2-weighted sagittal magnetic resonance (MR) image of the pelvis (**c**) revealed a focal, low-signal-intensity area in the uterine body, suggesting uterine adenomyosis (*asterisk* in **c**), as well as in the anterior rectal wall (*arrows* in **c**). Dense adhesion of the uterine body to the rectal wall is well depicted on this MR image

obstruction in the colon secondary to endometriosis are rare. However, sigmoid endometriosis may produce colonic obstruction and bleeding without obvious pelvic disease. Characteristically, on barium enema examination, an endometrioma appears as an intramural defect or a broad-based mass (Fig. 2). Occasionally, pleating of the adjacent mucosa is seen due to secondary fibrosis (Fig. 3). When endometriosis exhibits a more annular circumferential appearance, it may be confused with a primary colon carcinoma [9]. Cross-sectional imaging, particularly magnetic resonance imaging (MRI) helps identify the causative lesion in the pelvic region and plays an indispensable role in detecting pelvic endometriosis (Fig. 3).

Inflammatory bowel disease

The large bowel may become obstructed due to inflammatory bowel disease, such as ulcerative colitis, Crohn's disease, or tuberculosis. Ulcerative colitis is more common than Crohn's disease in the colon, but both disorders rarely cause colonic obstruction [2, 10]. Crohn's disease may cause bowel obstruction from an inflammatory stricture

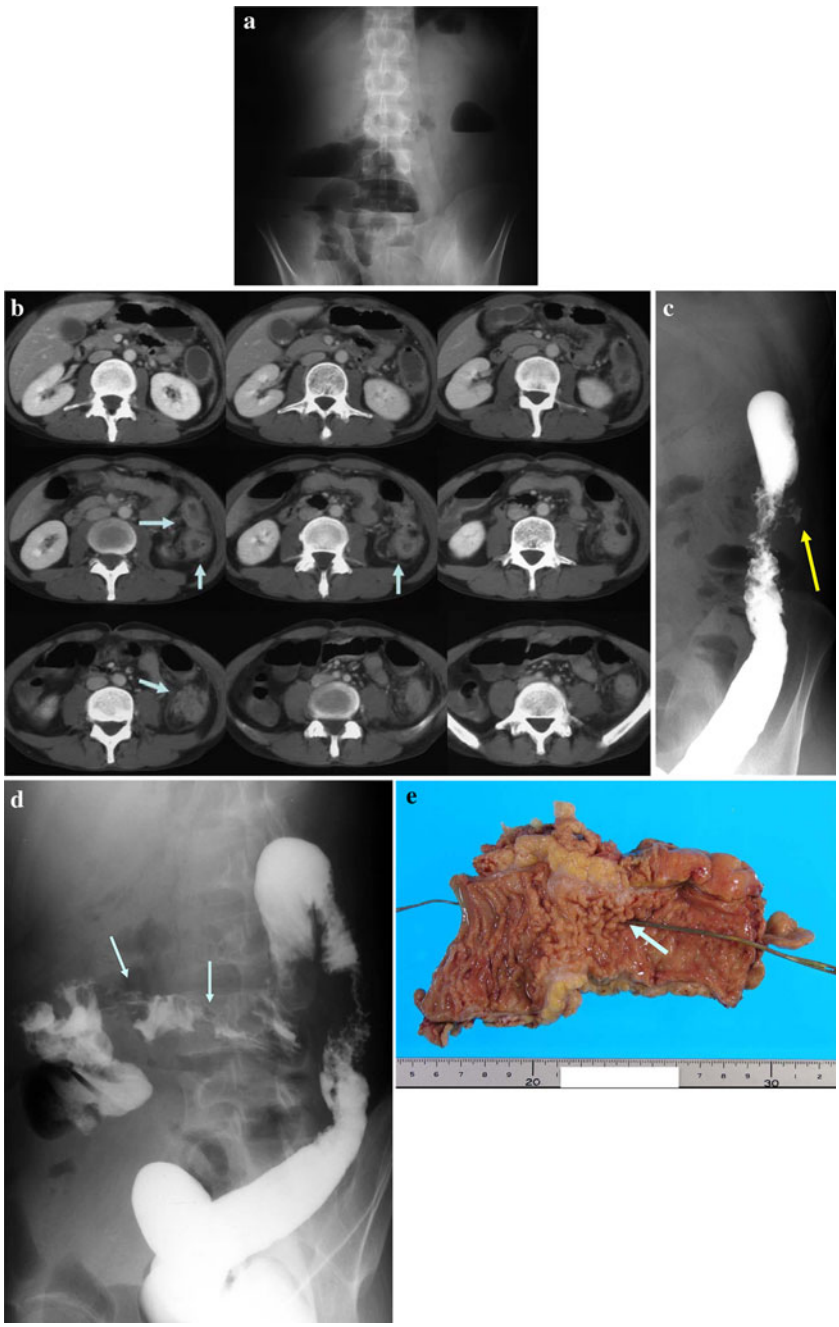

Fig. 4 A 40-year-old man with >10-year history of Crohn's disease, with small-bowel resection 3 years earlier, presented with colonic obstruction. Abdominal radiograph shows air–fluid levels in the right colon and ileal loops (**a**). Postcontrast computed tomography (CT) shows splenic flexure dilation and descending colon wall thickening (*arrows*), with pericolic inflammatory shadows (*arrows*) (**b**). Contrast enema shows an annular circumferential stenosis with fistulous tract (*arrow* in **c**) and several mild narrowings (*arrows*) in the transverse colon (skip lesion) (**d**). Histopathological specimen shows a cobblestone appearance of the stenotic descending colon; fistula to the retroperitoneal space is shown by the probe (*arrow*) (**e**)

during prolonged disease course more frequently in the small bowel than in the large bowel, according to a large series [11] (Fig. 4).

Although in developed countries mycobacterium tuberculosis is a vanishing disease, colonic tuberculosis may cause LBO. The most frequent segment of colonic involvement with tuberculosis is the cecum, followed by ascending and transverse colons. On barium enema, the cecum becomes distorted, rigid, and shortened. The terminal ileum loses the normal mucosal pattern, and the ileocecal valve is often deformed (Fig. 5). Multiple stenoses with skip lesions may be seen in the right colon (Fig. 5). Ring-type concentric narrowing with fibrosing stricture may simulate a neoplastic stenosis [12, 13]. The differential point is the absence of a shoulder with overhanging edge (Fig. 6). On CT, differential diagnosis between colon tuberculosis and carcinoma is usually difficult (Fig. 5). Cases of intestinal tuberculosis are not uncommonly associated with a normal chest X-ray. Therefore, a normal chest X-ray does not exclude the possibility of intestinal tuberculosis.

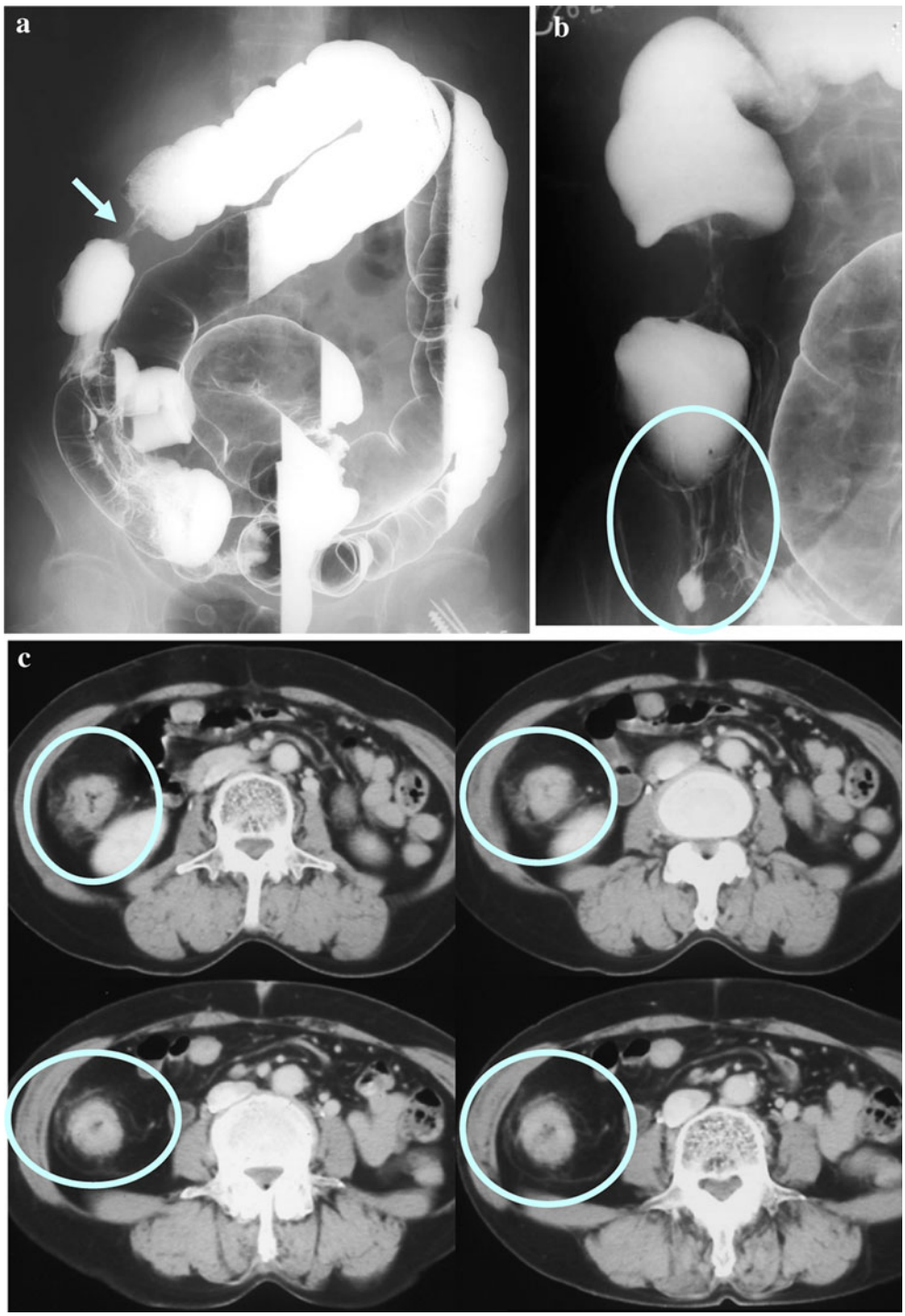

Fig. 5 Barium enema of intestinal tuberculosis in a 56-year-old woman shows not only annular stenosis (*arrow*) in the ascending colon (**a**) but deformed cecum (*circle*) (**b**). Postcontrast computed tomography (CT) shows a well-enhanced mass lesion (*circles*) in the ascending colon mimicking cancer of the ascending colon (**c**)

Colonic volvulus

Volvulus is the second most common cause of LBO, representing approximately 10–15 % of cases [2]. Colonic volvulus requires a segment of redundant mobile colon and relatively fixed points around which the volvulus can occur. The sigmoid colon is the most common site of volvulus (70 %), followed by the cecum (25 %) and the transverse colon (5 %) [2].

Sigmoid volvulus

The sigmoid colon is the most common site of colonic volvulus and accounts for 60–75 % of all cases of colonic

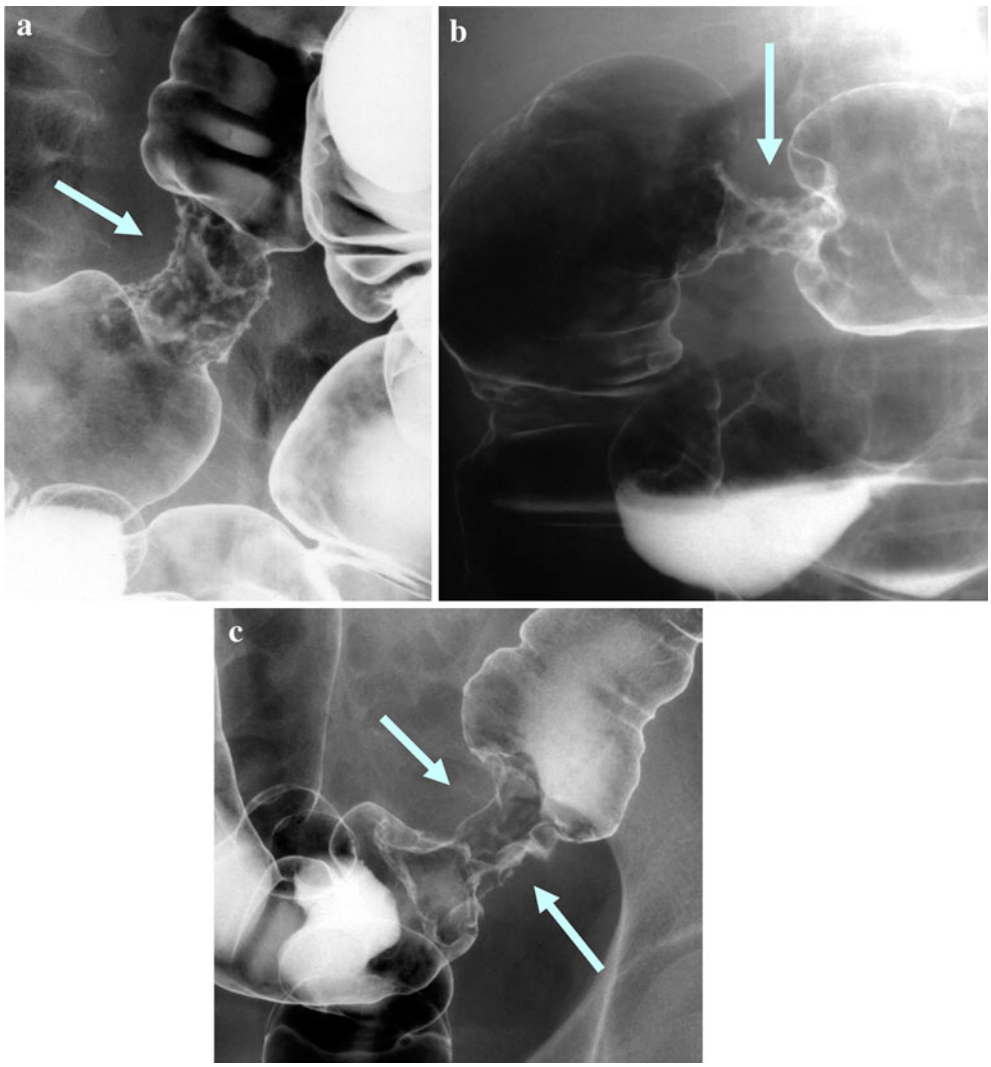

Fig. 6 Two cases of colonic tuberculosis: Barium enema depicts annular stenosis (*arrow*) in the sigmoid colon of a 58-year-old man (**a**); hepatic flexure (*arrow*) in a 72-year-old woman (**b**) mimicks neoplastic stenosis. Note the absence of the overhanging edge at either side of the stenosis. Compare neoplastic stensosis (*arrows*) with overhanging edges in the both sides in the other sigmoid colon patient (**c**)

volvulus [14]. Radiographic features include the "northern exposure" sign—a large air-filled bowel loop (sigmoid colon) arising from the pelvis and extending cranially beyond the level of the transverse colon; and the "coffee-bean" sign, which involves a coffee-bean-like shape assumed by the dilated sigmoid colon (Figs. 7 and 8). CT, particularly multidetector CT (MDCT) identifies sigmoid volvulus relatively easily. The "whirl sign," indicating twisting of the sigmoid mesentery, could be depicted on coronal and sagittal reformatting (Fig. 9). New CT signs have also been described: "X-marks-the spot" sign and "split-wall" sign in sigmoid volvulus [15]. They identify the presence of two crossing sigmoid transition points projecting from a single location in the X-marks-the spot sign, and they show apparent separation of the sigmoid walls by adjacent mesenteric fat secondary to incomplete twisting or folding in the split-wall sign. The role of CT is not only to confirm the diagnosis but to assess viability of the involved bowel loops using contrast enhancement.

Cecal volvulus

Cecal volvulus accounts for 25–40 % of all cases of colonic volvulus [14]. Cecal volvulus has a characteristic appearance on radiography; a dilated, gas-filled viscus is usually located ectopically in the left upper quadrant or mid abdomen. Two types of cecal volvulus have been described [16, 17]. In axial volvulus, the cecum twists in the axial plane, rotating clockwise or counterclockwise around its long axis and appearing in the right lower quadrant. In the other type, known as loop-type cecal volvulus, the cecum both twists and inverts, occupying the

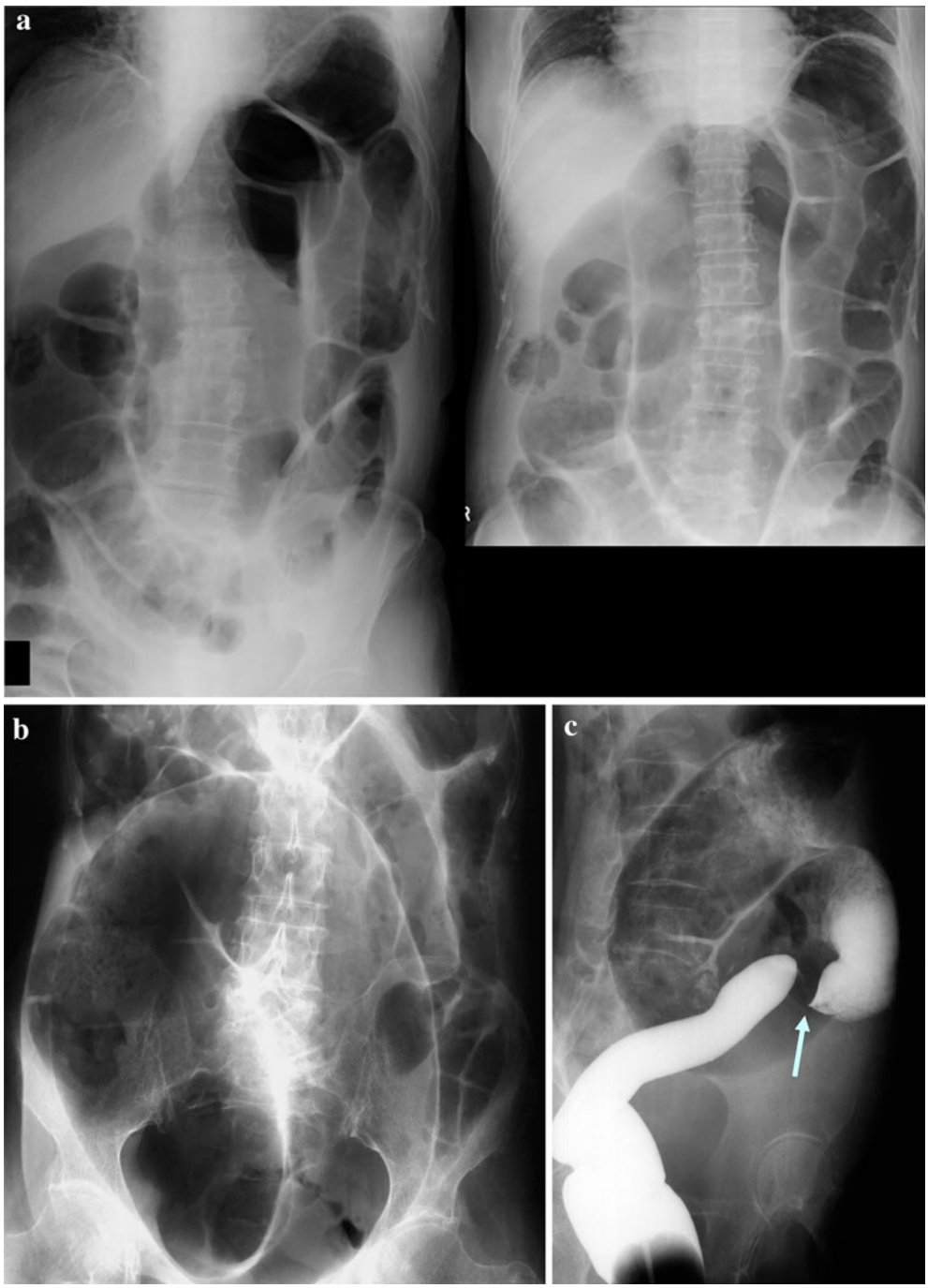

Fig. 7 In two cases of sigmoid volvulus, typical abdominal X-rays show "northern-exposure" sign (cephalad extension of the sigmoid colon in relation to the transverse colon) in lateral decubitus and supine films (**a**) of a 76-year-old woman and a "coffee-bean" sign (**b**) in an 84-year-old woman. Barium enema of the latter patient depicts twisting and beaking (beak sign; *arrow*) at the volvulus site (**c**)

left upper quadrant of the abdomen (Fig. 10). A diagnosis of cecal volvulus is confirmed with a contrast enema or CT. Contrast enema depicts a beak-like tapering (beak sign) at the level of the volvulus (Fig. 10). CT scan, especially using multiplanar reconstruction (MPR; three-dimensional displays), shows the abnormal position of the cecum in the upper mid and left abdomen and identifies the twisting point and the whirl sign, an area of swirling of the bowel and its mesentery. The role of CT is not only to confirm the volvulus but also to assess the viability of the involved bowel loop. Diagnosis of cecum volvulus is often delayed, resulting in a high frequency of bowel necrosis, which may necessitate an emergent operation more frequently than in sigmoid volvulus.

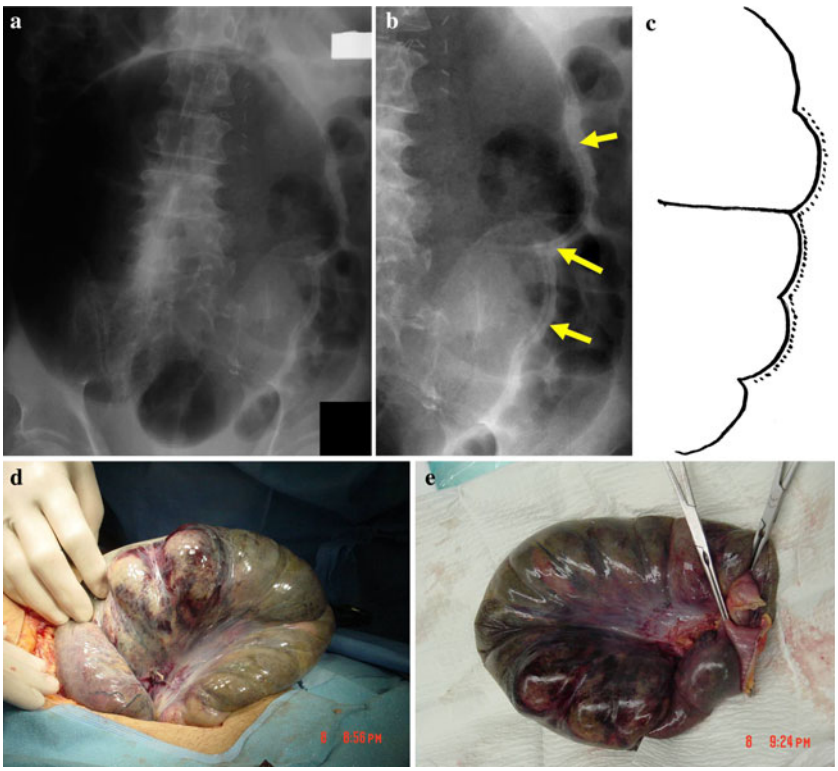

Fig. 8 An elderly man presented with worsening of lower abdominal pain. Abdominal radiography shows the "coffee-bean" sign (**a**). A magnified view shows linear air-lucency (*arrows*) along the sigmoid wall, suggesting pneumatosis (**b**). Schematic representation of **b** (**c**). *Dots* represented pneumatosis along the sigmoid colonic wall. Intraoperative photograph (**d**) reveals necrosis of the twisted sigmoid colon. Histopathological specimen confirms complete necorosis of the sigmoid colon (**e**)

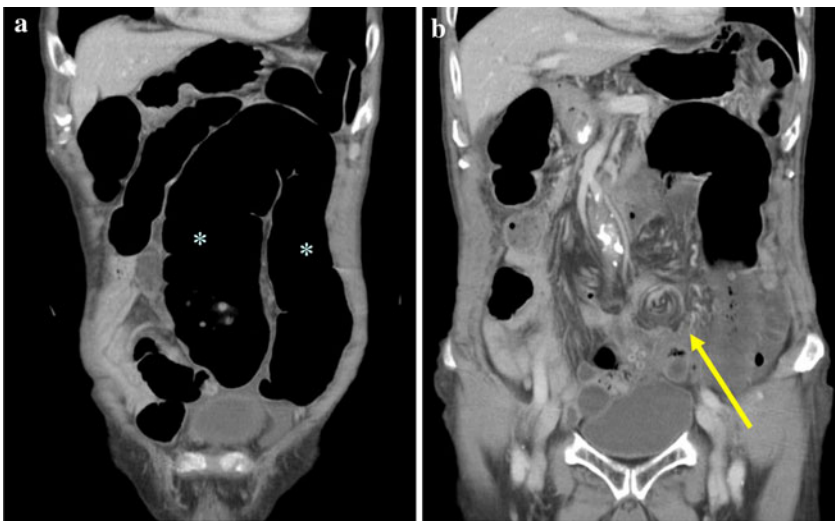

Fig. 9 Computed tomography (CT) of sigmoid colon volvulus in a 69-year-old man. Coronal reformatting shows not only markedly gaseous dilation of the sigmoid colon (*twisted loops*, *asterisks*) (**a**) but the "whirl sign" (*arrow*) of the sigmoid mesentery (**b**)

Disorders simulating LBO

Many disorders simulate LBO, including toxic megacolon (Fig. 11), chronic meteorism in patients with progressive systemic sclerosis (Fig. 12), paralytic ileus, and Ogilvie's syndrome [18, 19]. Many of these disorders can cause paralytic ileus (adynamic ileus). The common causes of paralytic ileus include laparotomy (Fig. 13) peritonitis such

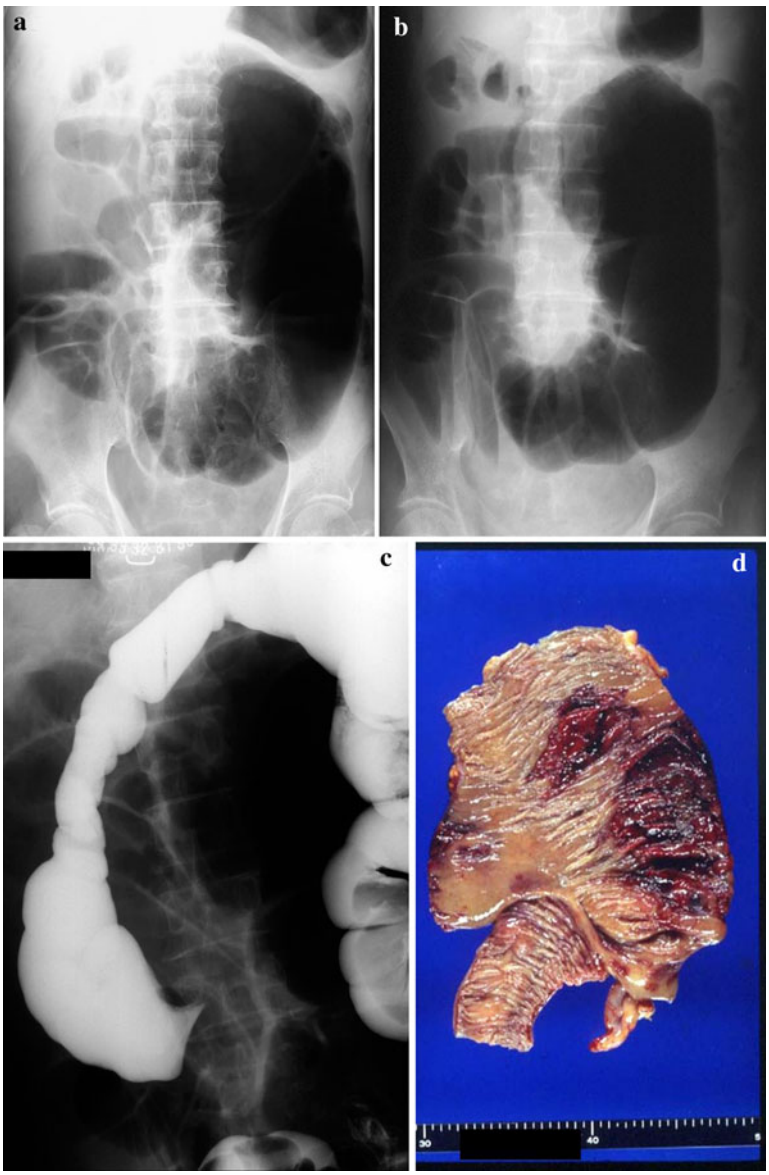

Fig. 10 An elderly man presented with gradual abdominal fullness and pain. The abdominal radiographs show marked dilated colonic gas simulating sigmoid volvulus (**a**) and air–fluid level formation on the left lateral decubitus film (**b**). Barium enema reveals the "beak sign" on the middle of the ascending colon (**c**). The operative specimen shows patchy mucosal necrosis in the cecum and the ascending colon (**d**)

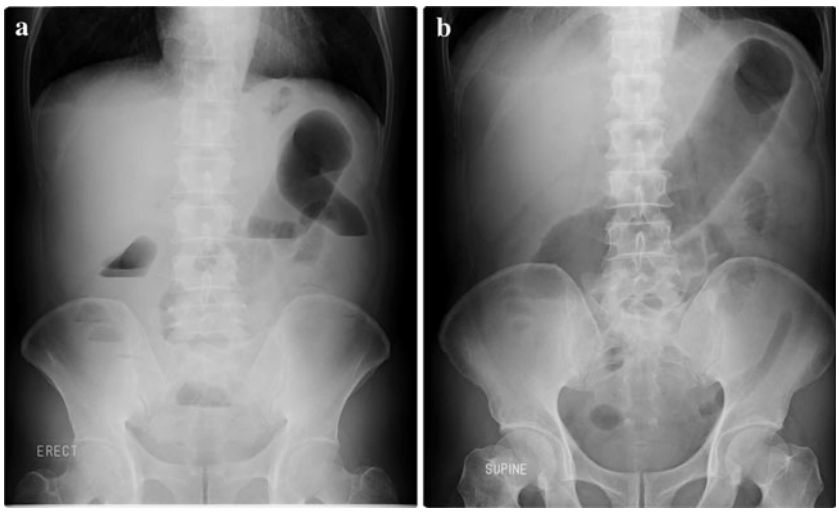

Fig. 11 Toxic megacolon in a 60-year-old patient with long-standing ulcerative colitis. The erect abdominal film shows the colonic dilatation with several air–fluid levels (**a**). The supine abdominal radiograph (**b**) shows prominent dilatation of the transverse colon, the so-called "lead-pipe" appearance, with loss of haustral coli markings

as cholecystitis and pancreatitis, intestinal ischemia (Fig. 14), certain drugs, spinal injury, diabetic ketoacidosis, and so forth (Fig. 15).

Conclusion

Accurate and early definitive diagnosis may reduce morbidity and mortality among patients with LBO. MDCT is a reliable tool for predicting the presence of associated strangulation and bowel ischemia, which require urgent surgical intervention. MPR images help assess lesion identification and involvement of adjacent structures. The faster imaging time allows acquisition of diagnostic images, even in critically ill and uncooperative patients. Radiologists should be

Fig. 12 Abdominal radiograph of a 61-year-old woman with long-standing, progressive systemic sclerosis shows chronic meteorism of the entire colon

Fig. 14 An elderly patient with superior mesenteric artery thrombosis. Abdominal portable X-ray shows small-bowel dilation

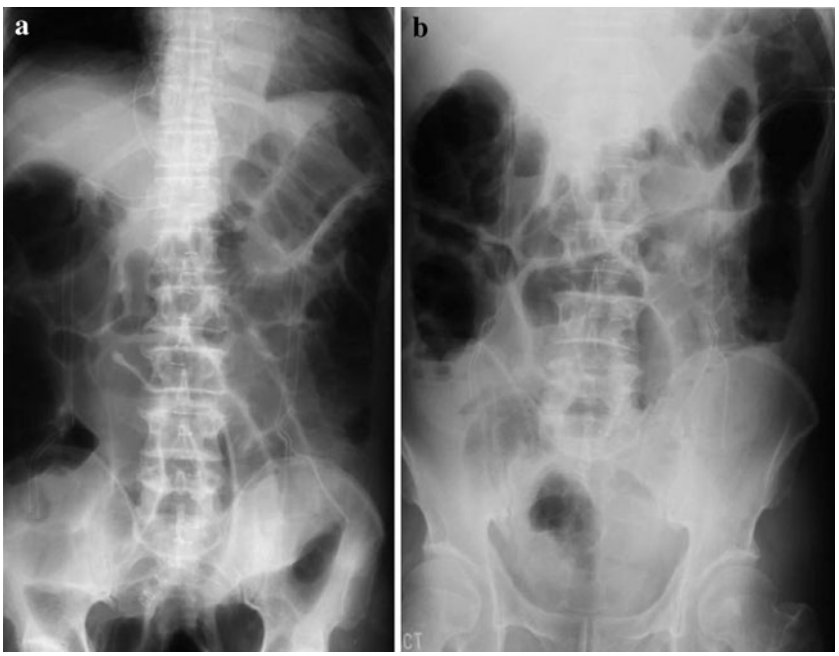

Fig. 13 Paralytic ileus following laparotomy for gastric cancer of a 70-year-old man (**a**, **b**). Many drainage tubes were inserted into the peritoneal cavity

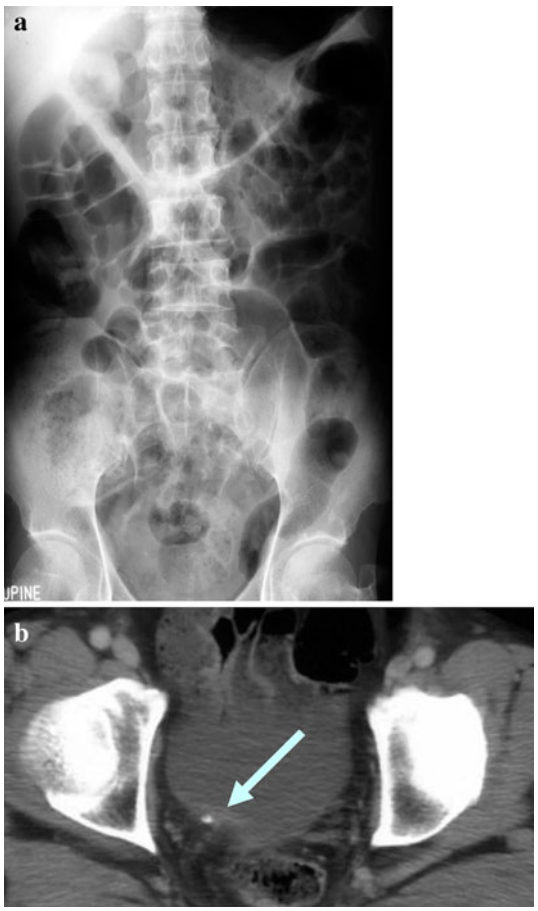

Fig. 15 Abdominal radiogram of a 39-year-old man with acute abdomen shows diffuse gaseous dilation of the stomach and small and large bowel (**a**). Postcontrast computed tomography (CT) reveals ureteral stone (*arrow*) impacted at the ureterovesical junction (**b**). This type of paralytic ileus is sometimes called reflex ileus

familiar with CT features of various causes of LBO so that appropriate treatment decisions can be made.

References

1. Sinha R, Verma R. Multidetector row computed tomography in bowel obstruction. Part 2. Large bowel obstruction. Clin Radiol. 2005;60:1068–75.
2. Taourel P, Kessler N, Lesnik A, Pujol J, Morcos L, Bruel JM. Helical CT of large bowel obstruction. Abdom Imaging. 2001;28:267–75.
3. Aufort S, Charra L, Lesnik A, Bruel JM, Taourel P. Multidetector CT of the bowel obstruction: value of pos-processing. Eur Radiol. 2005;15:2323–9.
4. Jacobs DO. Diverticulitis. N Engl J Med. 2005;357:2057–66.
5. Salem TA, Molloy RG, O'Dwyer PJ. Prospective study on the management of patients with complicated diverticular disease. Colorectal Dis. 2006;8:173–6.
6. Chintapalli KN, Chopra S, Ghiatas AA, Esola CC, Fields SF, Dodd GD III. Diverticulitis versus colon cancer: differentiation with helical CH findings. Radiology. 1999;210:429–36.
7. Kupersmith JEE, Catania JJ, Patil V, Herz BL. Large bowel obstruction and endometriosis. Hosp Physician. 2001;37:46–8.
8. Macafee CH, Greer HL. Intestinal endometriosis. J Obstet Gynaecol Br Emp. 1960;67:539–55.
9. Woodward PJ, Sohaey R, Mezzetti TP Jr. From the archives of the AFIP. Endometriosis: radiologic–pathologic correlation. RadioGraphics. 2001;21:193–216.
10. Horton KM, Corl FM, Fishman EK. CT evaluation of the colon: inflammatory disease. RadioGraphics. 2000;20:399–418.
11. Michelassi F, Balestracci T, Chappell R, Block GE. Primary and recurrent Crohn's disease: experience with 1379 patients. Ann Surg. 1991;214:230–8.
12. Jadvar H, Mindelzum RE, Olcott EW, Levitt DB. Still the great mimicker: abdominal tuberculosis. AJR Am J Roentgenol. 1997;168:1455–60.
13. Harisinghani MG, McLoud TC, Shepard JO, Ko JP, Shroff MM, Mueller PR. Tuberculosis from head to toe. RadioGraphics. 2000;20:449–70.
14. Peterson CM, Anderson JS, Hara AK, Carenza JW, Menias CO. Volvulus of the gastrointestinal tract: appearances at multimodality imaging. RadioGraphics. 2009;29:1281–93.
15. Levsky JM, Den EI, DuBrow RA, Wolf EL, Rozenbilt AM. CT findings of sigmoid volvulus. AJR Am J Roentgenol. 2010;194:136–43.
16. Perret RS, Kunberger LE. Cecal volvulus. AJR Am J Roentgenol. 1998;171:860.
17. Moore CJ, Corl FM, Fishman EK. CT of cecal volvulus: unravelling the image. AJR Am J Roentgenol. 2001;177:95–8.
18. Gay SB, Shaffer HA Jr, Futterer SF, Aitchison PM, Patel SJ. Gastrointestinal case of the day. Toxic megacolon with underlying ulcerative colitis. AJR Am J Roentgenol. 1996;167:240.
19. Choi JS, Lim JS, Kim H, Choi J-Y, Kin M-J, Kim NK, et al. Colonic pseudoobstruction: CT findings. AJR Am J Roentgenol. 2008;190:1521–6.