Imaging of Acute Colonic Disorders

6

Ajay Singh

Acute Diverticulitis

A diverticulum is a sacculation of mucosa and submucosa through the muscularis layer of the colonic wall, where the taeniae and mesentery are absent [1, 2]. The occlusion of the neck of the diverticulum may lead to inflammation, mucosal erosions, and microperforation. Although the inflamed diverticula are most commonly seen in the sigmoid and descending colon, less commonly they may be present in the transverse or ascending colon [3].

Approximately 80 % of patients with diverticulitis are more than 80 years old [2, 4]. The patients typically present with left lower quadrant pain, nausea, vomiting, fever, and leukocytosis.

Imaging

Contrast-enhanced CT is the imaging modality of choice in the evaluation of acute left lower quadrant pain. The CT can be performed with oral and/or rectal contrast and has sensitivities as high as 99 % for diagnosing acute diverticulitis. CT is not only helpful in triaging the patients into surgical and nonsurgical groups, but it is also the primary imaging modality during placement of pigtail drainage catheter in patients with abscess. The CT findings of acute diverticulitis include demonstration of inflamed, fluid-filled diverticulum with mild wall thickening and disproportionately severe surrounding inflammation (Fig. 6.1). There may be fluid in the root of sigmoid mesocolon (comma sign), engorged mesenteric vessels (centipede sign), abscesses, extraluminal air, and reactive lymphadenopathy [1–5].

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Although graded compression ultrasound has been shown by some to have a sensitivity of 90 % for the diagnosis of diverticulitis, it has not gained widespread acceptance in the USA. Ultrasound is however considered the most appropriate test in the evaluation of left lower quadrant pain in women of childbearing age.

Complications

The complications of acute diverticulitis include abscess, perforation, and colovesical fistula. An uncommon complication of recurrent diverticulitis of the colon is giant colonic diverticula. A giant colonic diverticulum is more than or equal to 4 cm in diameter and is believed to result from narrowing of the diverticular neck, creating ball-valve mechanism where air can enter the diverticula but cannot escape out (Fig. 6.2).

Diverticulitis accounts for two-thirds of the vesicoenteric fistulas. Inflamed colon may adhere to the urinary bladder wall and may cause a fistula. These patients may have pneumaturia and fecaluria. The flow through the fistula predominantly occurs from the large bowel to the urinary bladder and is often indicated by the presence of air in the urinary bladder lumen (Fig. 6.3).

Treatment

The treatment of acute diverticulitis is most often conservative with antibiotic therapy. Image-guided pigtail catheter drainage is used to treat abscess and avoids the need for multistage surgery for acute diverticulitis. CT-guided catheter drainage has a 70–90 % success rate in treating a post-diverticulitis abscess. Abscess less than 3 cm in diameter may be managed conservatively, without drainage or surgery. When a collection is more than 4 cm in diameter, CT-guided catheter drainage is often preferred, followed by referral for surgical treatment (Fig. 6.4). Eventual surgical resection of the segment of colon is recommended in all patients who develop abscess.

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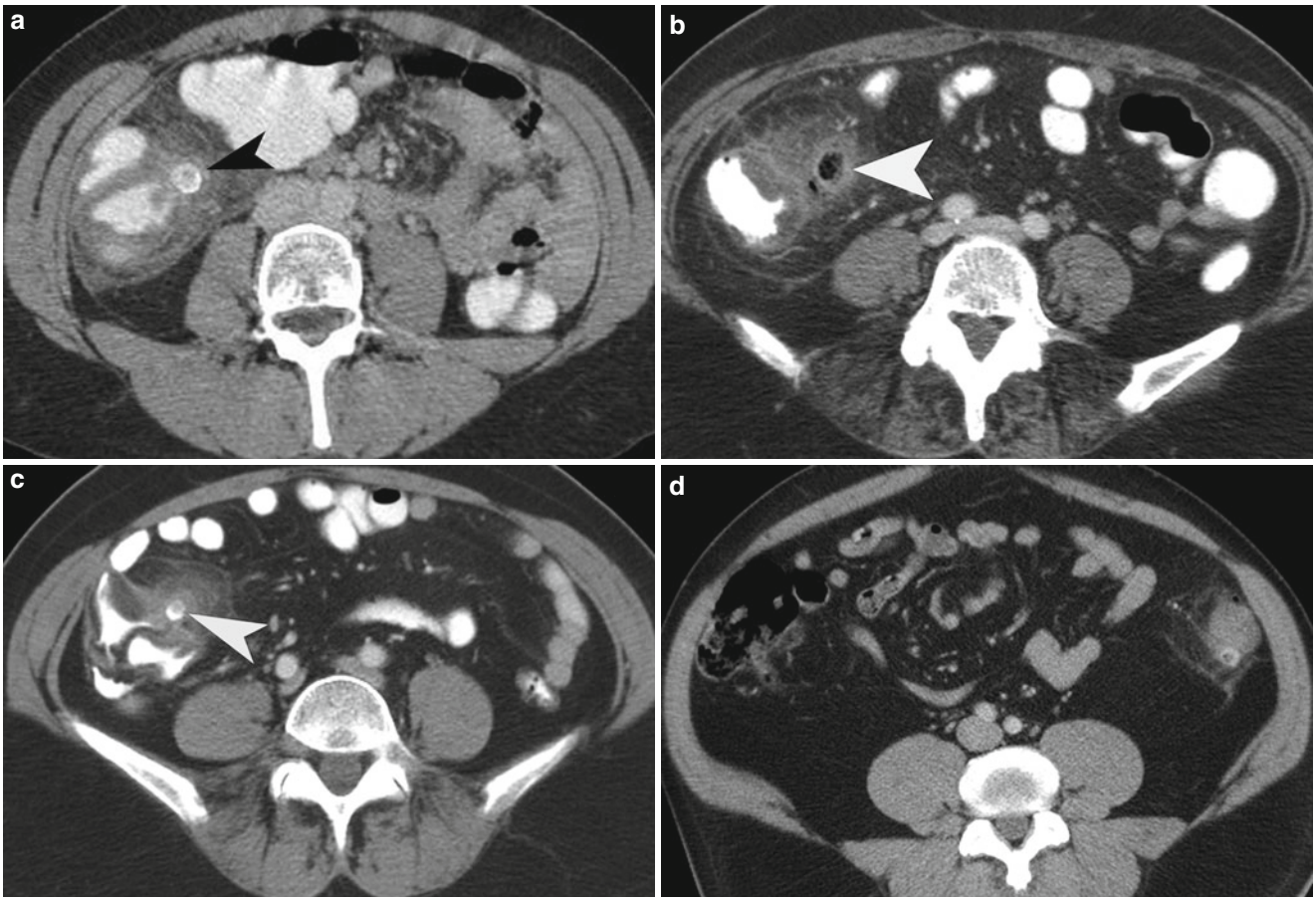

Fig. 6.1 Acute diverticulitis (**a**–**c**) Contrast-enhanced CT scan study of the abdomen demonstrates inflamed diverticulum (*arrowheads*) arising from the ascending colon. There are pericolonic inflammatory changes seen around the inflamed colonic diverticulum. (**d**) Contrast-enhanced CT scan study of the abdomen demonstrates inflamed diverticulum arising from the distal descending colon. There is colonic wall thickening and pericolonic inflammatory changes

Segmental Omental Infarction

Omental infarction is a rare cause of acute abdomen, which most often simulates acute appendicitis on clinical exam. It is seen in younger age group patients than acute epiploic appendagitis. Segmental omental infarction is the result of vascular compromise, either due to torsion or vascular thrombosis. It typically occurs on the right side of the omentum due to embryologic variation in the blood supply.

Omental torsion may result from conditions which cause sudden increase in intra-abdominal pressure such as coughing, sneezing, Valsalva, or heavy meal. Although most cases of segmental omental infarction is idiopathic, it can be associated with adhesions, hernias, surgery, intra-abdominal inflammation, congestive heart failure, obesity, strenuous exercise, digitalis administration, recent Whipple surgery/splenectomy surgery, and trauma.

The typical CT findings of omental infarction include a cake-like inflammatory fatty mass or whirled fatty structure, most commonly in the right lower quadrant (Fig. 6.5a, b) [6]. Unlike acute epiploic appendagitis, omental infarction is most commonly on the right side, may or may not about the colon, and does not demonstrate ring sign around the inflamed fat. While typical acute epiploic appendagitis is less than 3.5 cm in diameter, omental infarctions are much larger (typically >5 cm) [7].

Segmental omental infarction is a self-limited condition which is best managed conservatively using Motrin. Majority of the patients are asymptomatic within 10 days of the treatment.

Acute Epiploic Appendagitis

Epiploic appendages are finger-shaped fat-containing pouches which arise off the surface of the colon and are surrounded by the visceral peritoneum. The most common location of inflammation of an epiploic appendage is adjacent the sigmoid colon and usually affects adult people in fifth to sixth decades [5]. The reason for the presence of epiploic appendagitis in the left abdomen in 80 % of cases is because of the higher number of epiploic appendages present adjacent to the sigmoid colon.

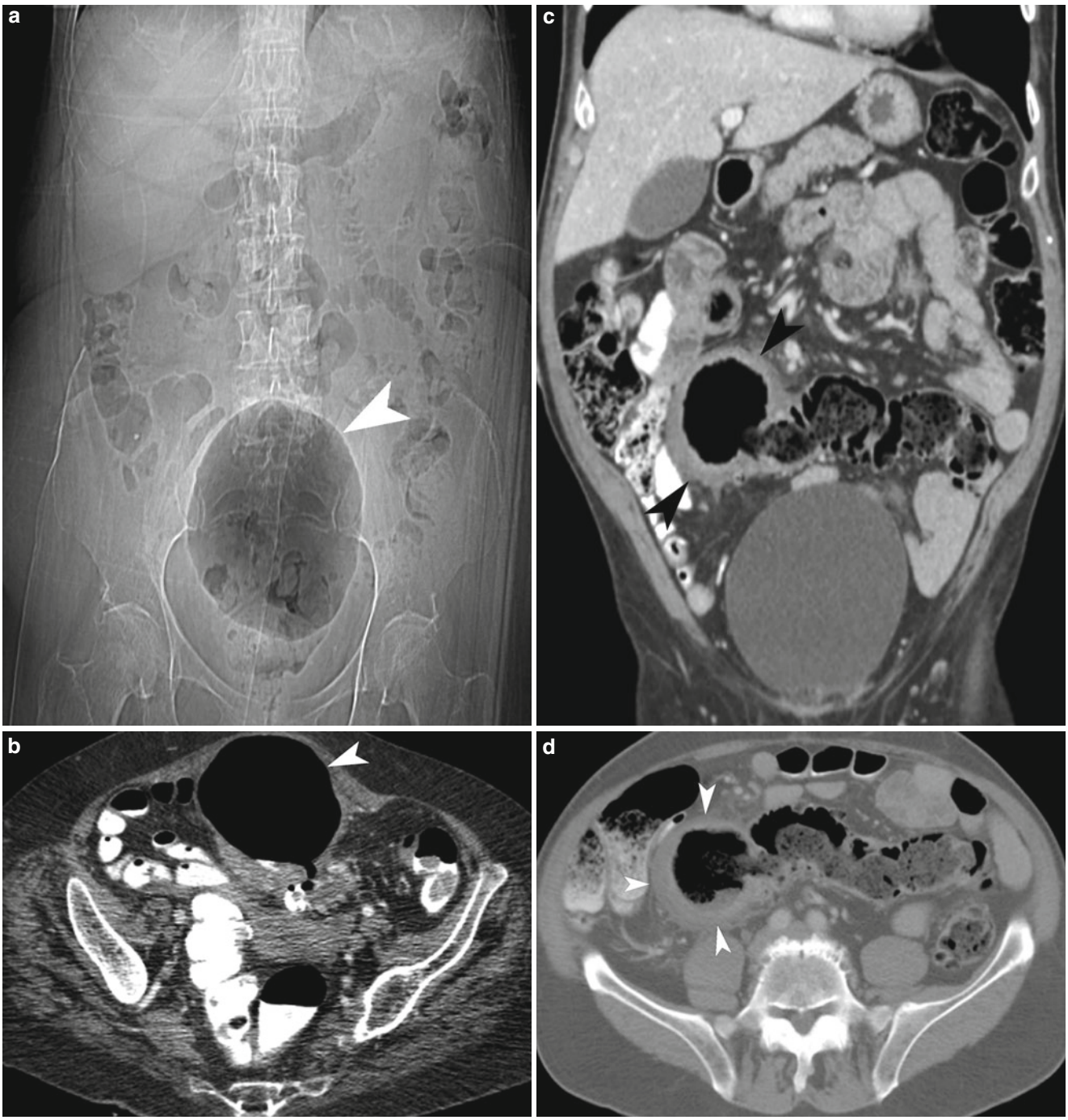

Fig. 6.2 Giant sigmoid diverticulum. (**a**) Scout film of the abdomen demonstrates a 10-cm-diameter air-containing cavity in the pelvis which corresponds to a giant sigmoid diverticulum (*arrowheads*) in a patient with recurrent episodes of diverticulitis. (**b**) Contrast-enhanced CT scan study of the pelvis demonstrates a giant sigmoid diverticulum arising from the sigmoid colon. Small amount of rectal contrast is present within the lumen of the large diverticulum. (**c**, **d**) Contrast-enhanced CT scan study demonstrates inflammatory thickening of the wall of a giant sigmoid diverticulum (*arrowheads*), arising from sigmoid colon

Torsion of epiploic appendages can lead to vascular occlusion and infarction. Inflamed epiploic appendage can cause bowel obstruction from adhesions and can get detached from colon to produce intraperitoneal loose body [5, 8]. It has also been rarely reported to cause intussusception and abscess formation.

Clinically, the patients may present with acute left lower quadrant pain, nausea, fever, and diarrhea or constipation [5]. When it involves the left lower quadrant, it is clinically most often mistaken for sigmoid diverticulitis. When it affects the cecum, it is clinically most often mistaken for acute

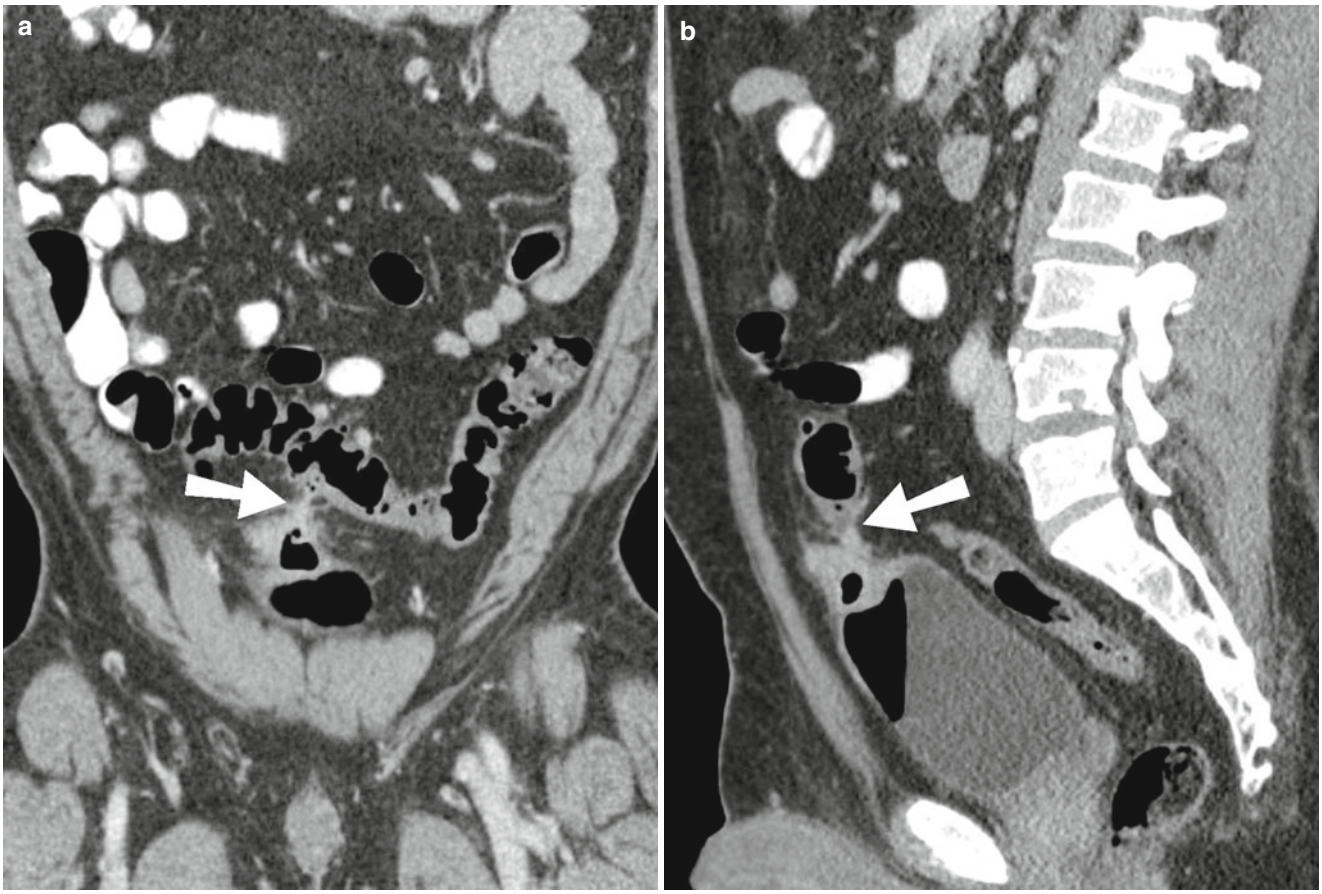

Fig. 6.3 Colovesical fistula. (**a**, **b**) Coronal and sagittal reformations of the abdomen demonstrate colovesical fistula (*arrow*) extending from the sigmoid colon to the urinary bladder dome. There is air identified within the urinary bladder lumen, secondary to the fistulous communication with the colon

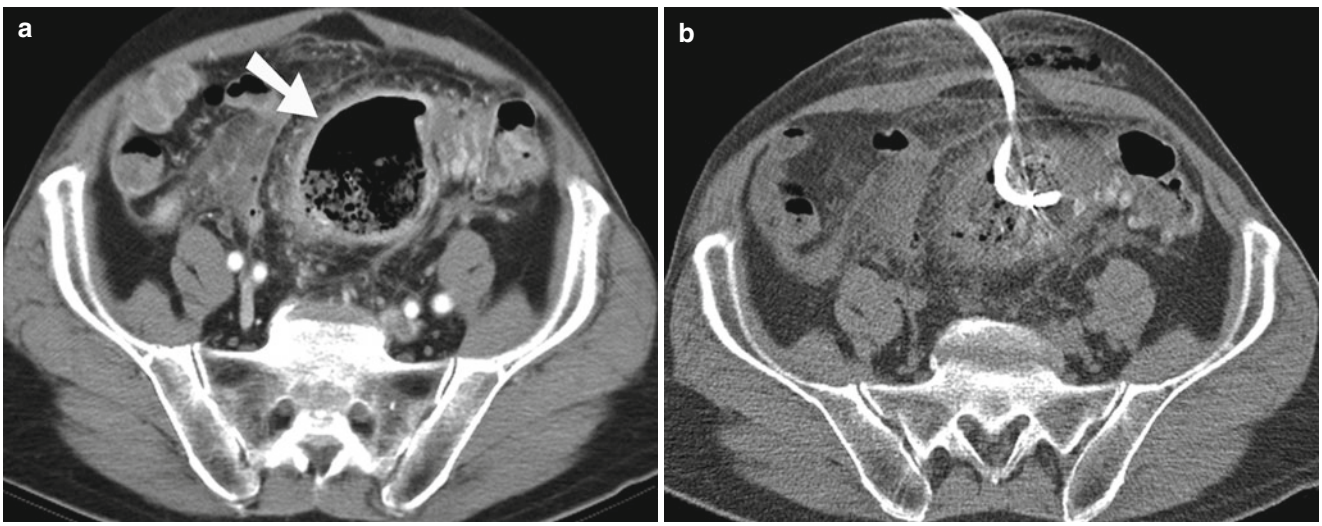

Fig. 6.4 Diverticulitis abscess. (**a**) Contrast-enhanced CT scan study of the pelvis demonstrates a well-defined abscess cavity (*arrow*) in the sigmoid mesocolon with surrounding inflammatory changes. (**b**) Contrast-enhanced CT scan study demonstrates decrease in the size of the pelvic abscess after placement of a pigtail drainage catheter

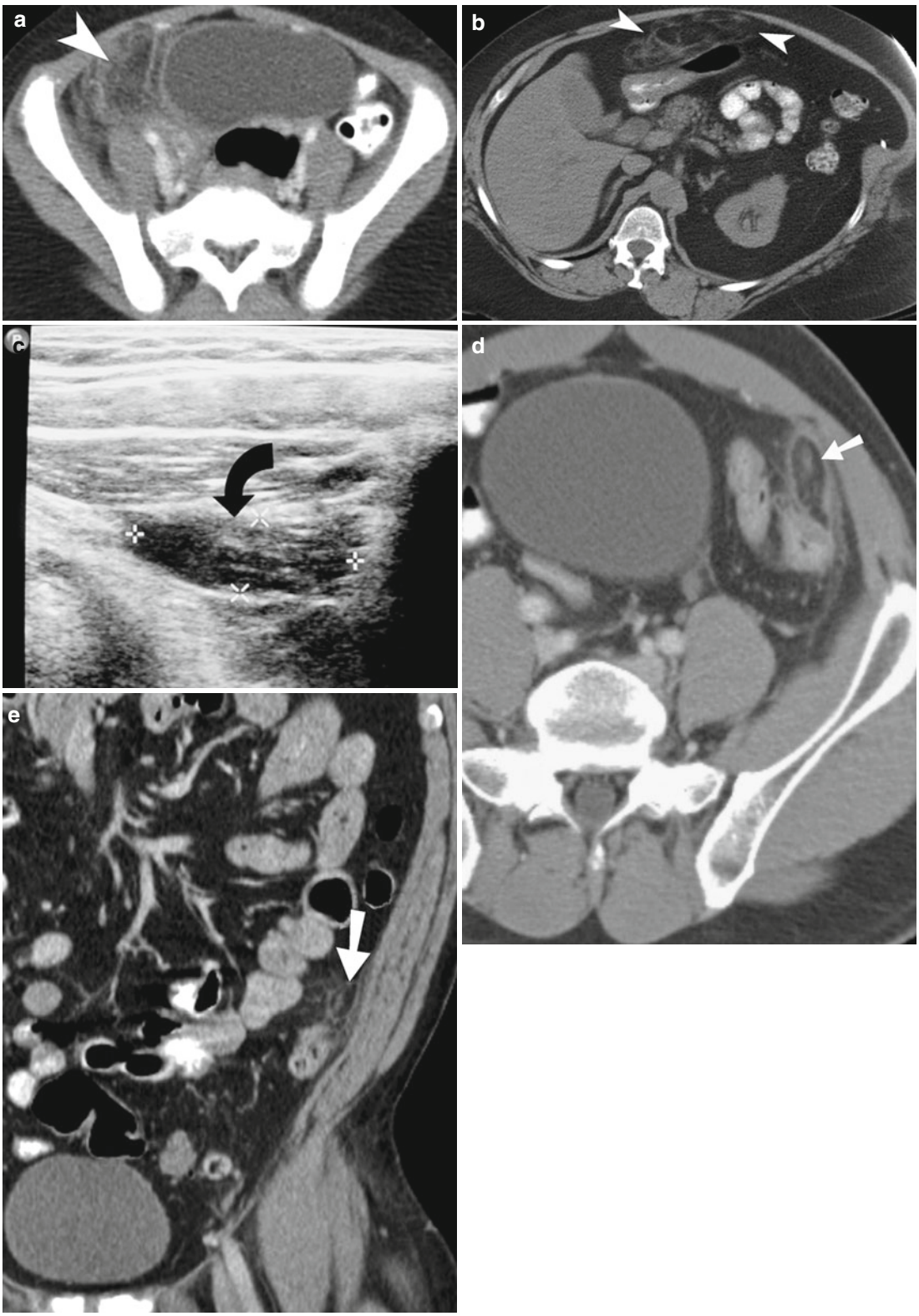

Fig. 6.5 Segmental omental infarction (**a**, **b**) and acute epiploic appendicitis (**c**–**e**). (**a**) Contrast-enhanced CT scan study demonstrates a 7-cm-diameter omental fat density inflammatory lesion (*arrowhead*) in the upper right lower quadrant of the abdomen of a 6-year-old patient. (**b**) Noncontrast CT of a patient with segmental omental infarction demonstrates a midline inflammatory fatty lesion anteroinferior to the left lobe of the liver. (**c**) Ultrasound of a patient with acute epiploic appendagitis demonstrates a focal heterogeneously hypoechoic lesion (*curved arrow*) located just deep to the left anterior abdominal wall musculature. (**d**, **e**) Axial and coronal contrast-enhanced CT scan study demonstrates an oval, fat density lesion (*straight arrow*) in relation to the sigmoid colonic wall with surrounding inflammatory changes. The high-density central dot corresponds to thrombosed or congested vessel within the torsed epiploic appendage. Omental infarction

appendicitis. Because of the clinical misdiagnoses, patients with primary epiploic appendagitis can get unnecessary hospitalization and treatment. The clinical management of acute appendagitis includes conservative treatment with pain medication.

Imaging

Although ultrasound has been occasionally used in diagnosing acute epiploic appendagitis, CT is the imaging tool of choice in making the diagnosis. The CT findings include a pedunculated fatty lesion, 1.5–3.5 cm in length, and associated with surrounding inflammatory stranding, hyperdense ring, high-attenuating central dot, and less commonly adjacent thickening of the colon wall (Fig. 6.5c–e) [5]. The parietal peritoneum deep to the anterior abdominal wall may be thickened. The ultrasound findings are similar to CT study and may include hypoechoic rim surrounding a hyperechoic focal lesion.

A central high-attenuation focus within the fat is a helpful finding which is believed to represent a thrombosed or congested vessel. Since it is seen in 54 % of the cases, its absence does not rule out the diagnosis of acute epiploic appendagitis. There is usually no colonic wall thickening [7]. The CT changes of acute epiploic appendagitis tend to resolve in all patients within 6 months.

The differential diagnosis of an inflammatory fat-containing lesion on CT includes acute epiploic appendagitis, mesenteric panniculitis, acute diverticulitis, trauma, omental contusion, omental metastases, and liposarcoma. Although omental infarction can have an appearance similar to that of epiploic appendagitis, it lacks the hyperdense ring that is seen in all patients with epiploic appendagitis. Majority of the cases of acute epiploic appendagitis are self-limited and can be treated with pain management using analgesics.

Inflammatory Bowel Disease

Crohn's disease is a chronic granulomatous inflammatory disease that involves the entire gastrointestinal tract with transmural and discontinuous lesions which most often affects the distal ileum and right colon [9]. The transmural inflammation is commonly associated with deep ulceration and sinus/fistula formation.

Ulcerative colitis is an idiopathic chronic inflammatory disease that most often demonstrates continuous involvement of the rectum and distal colon and rectum mucosa [10].

The common modes of presentation of inflammatory bowel disease include abdominal pain, diarrhea, weight loss, vomiting, and fever. The patients with Crohn's disease may have associated arthritis, ocular inflammatory diseases, gallstones, and skin lesions [11].

Table 6.1 Imaging findings of ulcerative colitis (Fig. 6.6)

1. Continuous involvement from rectum to colon
2. Mucosal granularity and stippling
3. Indistinctness of haustral folds
4. Collar button ulcers
5. Inflammatory pseudopolyps
6. Backlash ileitis
7. Presacral space widening (>1.5 cm)

Table 6.2 Imaging findings of Crohn's colitis (Fig. 6.7)

1. Lymphoid hyperplasia: 2 mm filling defects in the wall
2. Aphthoid ulceration: small, 1 mm diameter superficial ulcerations with radiolucent halo
3. Deep ulcerations, sinuses, and fistulas
4. Colonic wall thickening: more with Crohn's disease
5. Bowel strictures: often asymmetrical
6. Anorectal fissures, abscess, and fistulas: more commonly with Crohn's disease

Imaging

For the initial presentation of suspected Crohn's disease in patients with abdominal pain, fever, and diarrhea, CT enterography is considered the most appropriate imaging modality. The second-line imaging test for suspected Crohn's disease is small bowel follow-through study. For adult and pediatric patients with known Crohn's disease, presenting with fever, abdominal pain, and leukocytosis, routine contrast-enhanced CT is considered the imaging modality of choice. CT enterography involves the use of neutral oral contrast and imaging performed 45 s after intravenous contrast.

The CT findings include bowel wall enhancement, wall thickening, mural stratification, prominent vasa recta, and mesenteric inflammation. The mural stratification (Target or halo sign) is produced by soft tissue density mucosa, low-density submucosa (edema or fatty infiltration), and soft tissue density muscularis propria. Imaging also allows differentiation between Crohn's disease and ulcerative colitis (Tables 6.1 and 6.2).

In pediatric patients with Crohn's disease with mild symptoms, MR enterography is considered the most appropriate imaging modality because of its high sensitivity and specificity, similar to CT enterography. Ultrasound is the second-line imaging modality in similar clinical scenario and suffers from the disadvantage of operator dependence. Ultrasound may be useful in diagnosing colonic inflammatory diseases, in particular when equivocal results are obtained by other imaging techniques, because of its ability to see wall thickening (≥4 mm), target sign, sluggish peristalsis, and pericolonic extension of the disease. MR imaging may be also used, in particular when recurrent studies are needed, and allows excellent soft tissue contrast without radiation exposure [10].

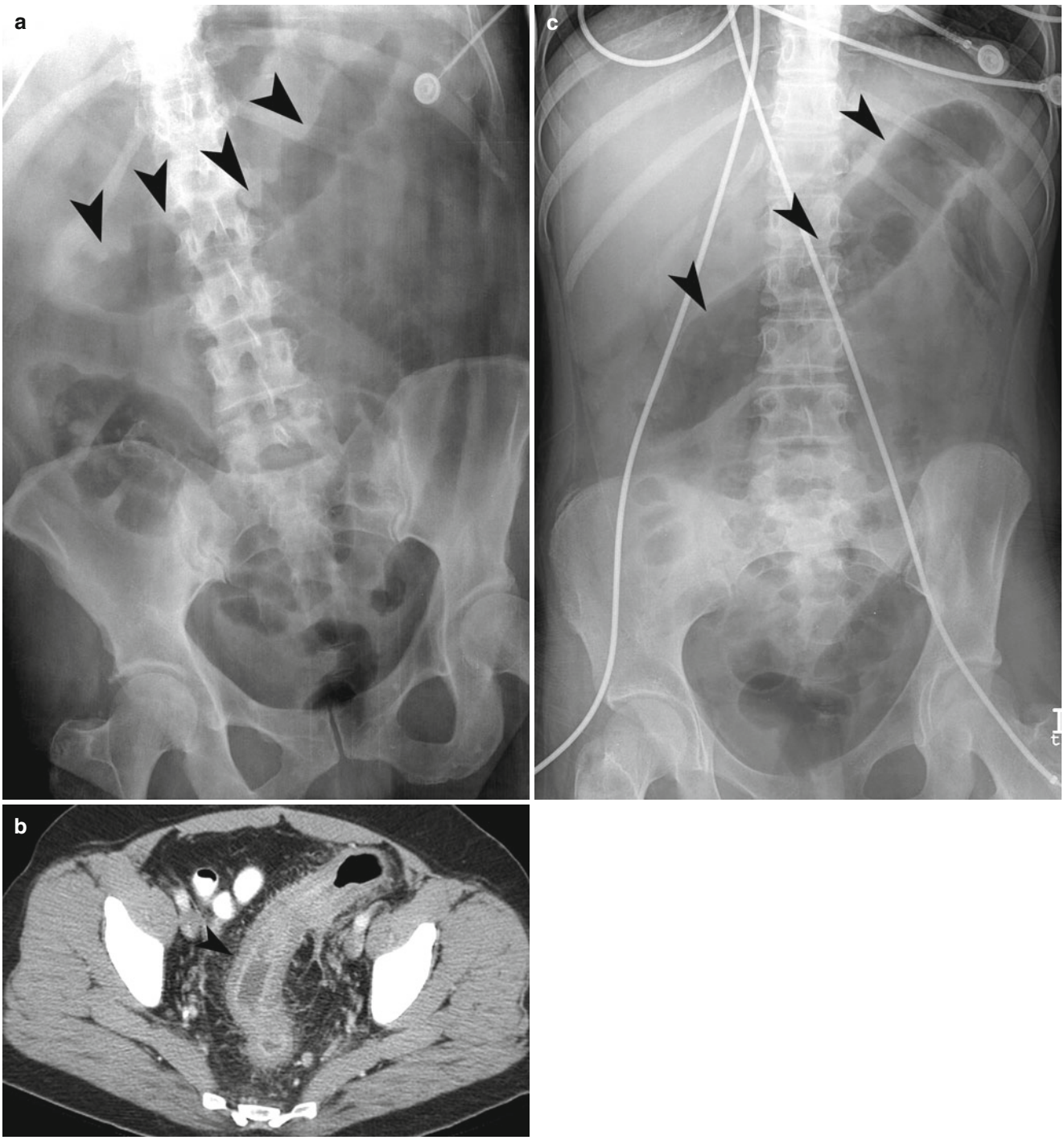

Fig. 6.6 Inflammatory bowel disease. (**a**) Plain radiograph of the abdomen demonstrates thumbprinting (*arrowheads*) involving the transverse colon in a patient with ulcerative colitis. (**b**) Contrast-enhanced CT in a patient with ulcerative colitis shows symmetrical and continuous involvement of the entire rectum and sigmoid colon by inflammatory proctocolitis (*arrowhead*). There is sigmoid wall thickening, mucosal enhancement, and pericolonic inflammatory densities. (**c**) Plain radiograph of the abdomen in a patient with Crohn's colitis demonstrates a featureless segment of the transverse colon

Complications and Treatment

The complications of inflammatory bowel disease include abscess, fistulas, and bowel obstruction [2]. Acute flare-up of Crohn's disease is usually treated with anti-inflammatory drugs and steroids. Surgery is the therapeutic tool which is reserved for nonresponsive disease, complications, and very ill patients.

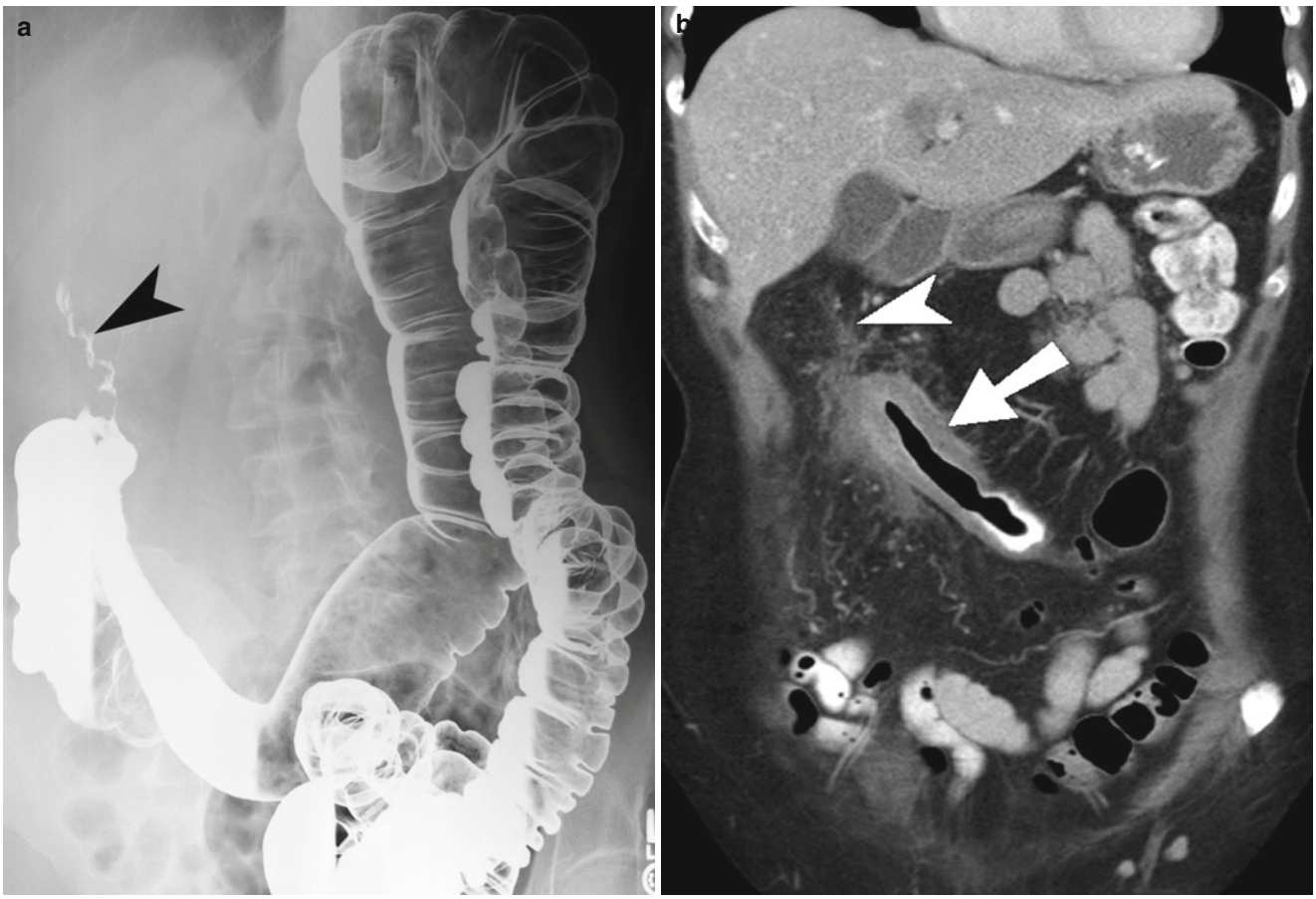

Fig. 6.7 Crohn's colitis. (**a**) Double-contrast barium enema examination demonstrates a sinus tract arising off the hepatic flexure (*arrowhead*). (**b**) Coronal CT reformation demonstrates inflammatory thickening of right transverse colon (*arrow*), secondary to Crohn's colitis. A sinus tract (*arrowhead*) is seen extending from the splenic flexure to the right subhepatic location

Pseudomembranous Colitis

Pseudomembranous colitis, also called *C. difficile* colitis, is a life-threatening condition caused by *Clostridium difficile* that produces two exotoxins and leads to colonic mucosa to generate a protein-rich membrane (pseudomembrane). Toxin A is responsible for colitis and allows Toxin B to enter the cell. The bacterium has a widespread presence in the hospitals and is the cause of up to 20 % of diarrhea associated with antibiotic therapy [12].

The disease may be asymptomatic at the beginning but then becomes clinically evident with watery diarrhea, abdominal pain and tenderness, fever, dehydration, and leukocytosis. In the life-threatening cases lethargy, tachycardia, and toxic megacolon or perforation due to necrosis may be associated. Cytoxan assay is the gold standard in detection of Toxin B and has more than 90 % sensitivity. Majority of cases in clinical practice are detected by colonoscopy and positive toxin B assay.

The CT findings include extensive mural thickening with prominent haustral folds (Fig. 6.8). In decreasing order of frequency, there is involvement of entire colon (most common), right colon, and left colon (least common). The barium enema findings include thumbprinting and small nodular or plaque-like filling defects.

While the mortality of *Clostridia difficile* infection is only 2 %, the cost of managing the patients in hospital is more than three billion dollars per year. The medical treatment involves the use of metronidazole for mild infection and vancomycin with or without metronidazole for severe infection. In resistant patients with elevated lactate levels and elevated WBC levels (>50,000/mm^3), surgical intervention (partial colectomy with preservation of rectum) is needed.

Typhlitis

Typhlitis is characterized by inflammation of the cecum and ascending colon in immunocompromised patients. It is also called neutropenic colitis and is most often seen in patients with leukemia, lymphoma, aplastic anemia, AIDS, renal transplantation, or other immunocompromised conditions.

CT is considered the imaging modality of choice. The CT imaging features include cecal distension, circumferential

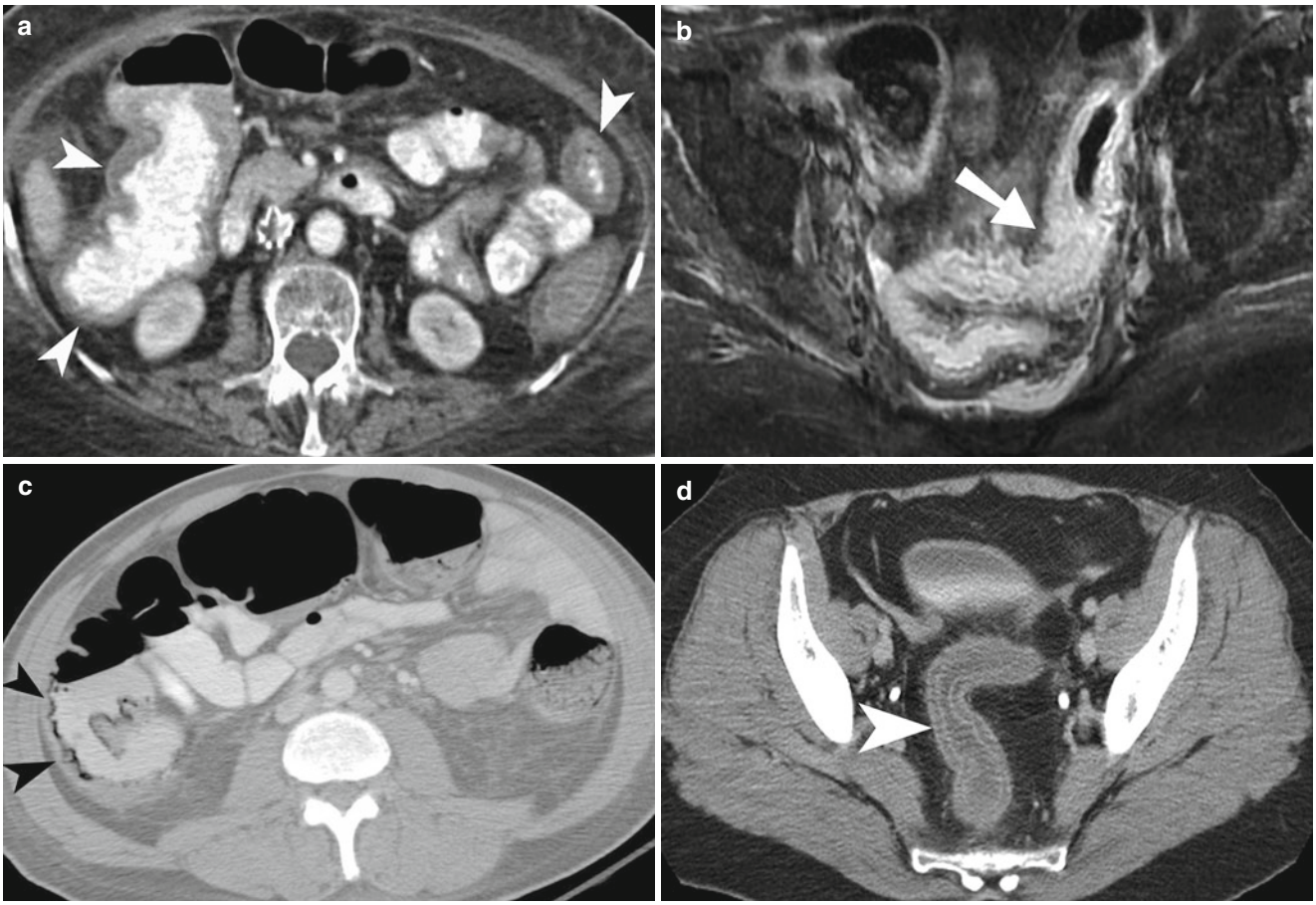

Fig. 6.8 Pseudomembranous colitis. (**a**) Contrast-enhanced CT scan study of the abdomen demonstrates diffuse thickening of the colonic wall (*arrowheads*), more prominent on the right side. (**b**) Gadolinium-enhanced T1-weighted axial image of the pelvis demonstrates enhancement and thickening of the rectal as well as sigmoid colonic wall with surrounding inflammatory changes. (**c**) Contrast-enhanced CT shows the infectious colitis affecting the right colon. There is ascending colonic wall thickening (*arrowheads*) and pneumatosis. (**d**) Contrast-enhanced CT of the pelvis shows rectosigmoidal wall thickening (*arrowhead*) from proctocolitis. The bowel wall thickening is produced by submucosal edema sandwiched between mucosal and serosal enhancements

colonic wall thickening, and pericolonic wall thickening (Fig. 6.9). The other findings include pericolonic fluid, free air, and pneumatosis.

Colonic Volvulus

Volvulus refers to torsion of a tract of free-moving bowel along its axis, usually because of a point of traction. It is more frequent in the small bowel, but may occur in the colon. Sigmoid volvulus accounts for 75 % and cecal volvulus accounts for 20 % of large bowel obstructions.

Cecal volvulus is a potentially life-threatening condition which accounts for up to 2 % of cases of bowel obstruction, 11 % of cases of intestinal volvulus, and 25–40 % of colonic volvulus [13, 14]. Cecal volvulus occurs most commonly in 20–40 years and is a misnomer as the torsion occurs in the ascending colon. The two types of cecal volvulus include the axial torsion which is characterized by 180–360° twist along the long axis of the ascending colon and cecal bascule which is characterized by cecum folding anteromedially, leading to luminal occlusion. It is often predisposed by abnormal fixation of the right colon to the retroperitoneum and abnormal motility of the right colon. Other predisposing factors include prior surgery, recent colonoscopy, recent enema, pregnancy, congenital duplication cyst, and mesenteric mass.

Transverse colonic volvulus is a rare site of colonic volvulus but most likely to be life-threatening. Sigmoid volvulus usually occurs in elderly patients (>70 years) and is the most frequent type of colonic volvulus (60–75 %). Main predisposing factors are high-fiber diet, pregnancy, hospitalization or institutionalization, and Chagas disease [14].

Imaging

Cecal volvulus demonstrates a dilated gas-filled colonic segment projecting in the left upper quadrant or mid-abdomen, single air-fluid level, and small bowel dilatation. On barium enema there is a beak-like tapering at the level of

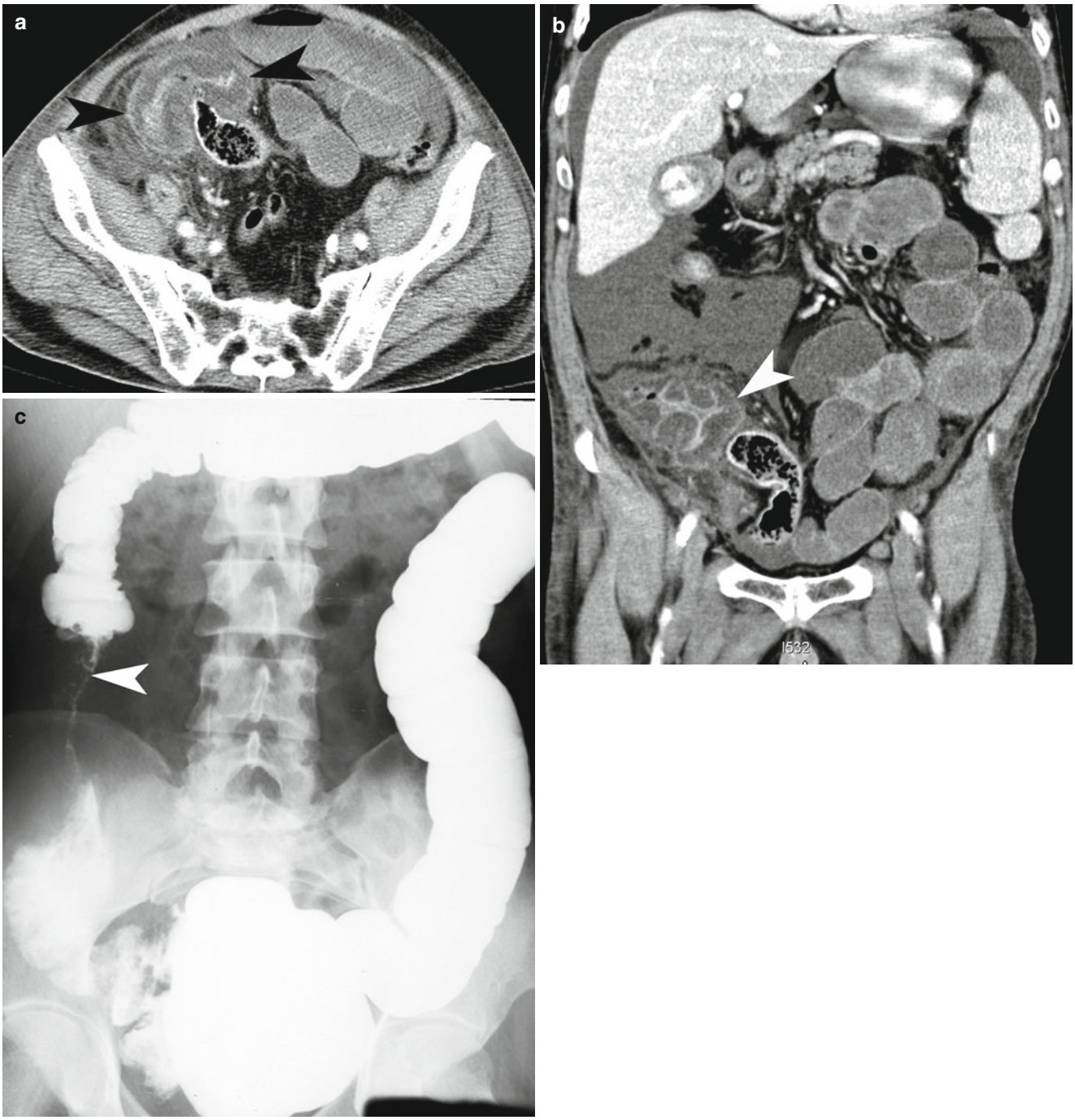

Fig. 6.9 Typhlitis (**a**, **b**) and ileocecal tuberculosis (**c**). (**a**, **b**) Axial and coronal CT images of the abdomen in a patient with chronic lymphocytic leukemia demonstrate inflammatory thickening of the cecal wall (*arrowheads*), secondary to typhlitis. (**c**) Single-contrast barium enema examination of a patient with ileocecal tuberculosis demonstrates chronic ileocecal stricture (*arrowhead*) and cranial migration of the ileocecal junction

the volvulus, adjacent to a dilated cecum. On CT, the "whirl sign" is the main finding, referring to the twisted appearance of the mesenteric vessels, afferent bowel, and efferent bowel loops (Figs. 6.10 and 6.11). The other signs include an abnormally enlarged cecum with decompressed distal colon.

For transverse colonic volvulus, conventional radiology is rarely useful. Barium enema or CT is frequently used to show the twist in the colon. On barium enema, a beak-shaped narrowing is seen at the level of the colonic twist (Fig. 6.12a, b).

On plain radiography, sigmoid volvulus is seen as a large air-filled bowel loop extending cranially from the pelvis to beyond the level of the transverse colon (northern exposure sign). Other radiological findings include the "coffee bean"

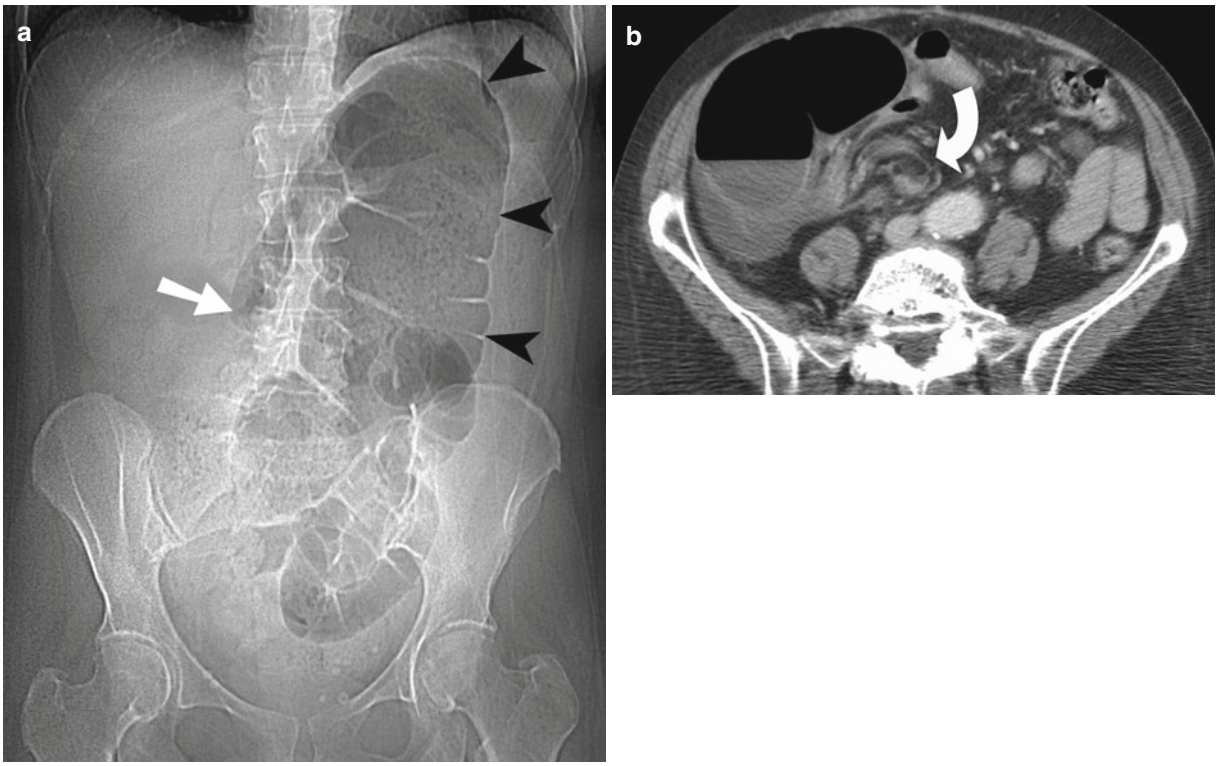

Fig. 6.10 Cecal volvulus. (**a**) Plain x-ray of the abdomen demonstrates dilatation of the cecum (*arrowheads*) which extends to the left upper quadrant. The bowel gas transition is present in the ascending colon (*arrow*). (**b**) Contrast-enhanced CT scan study of the pelvis demonstrates whirl sign in the right lower quadrant (*curved arrow*). The cecum is dilated and there is free fluid present posterior to it

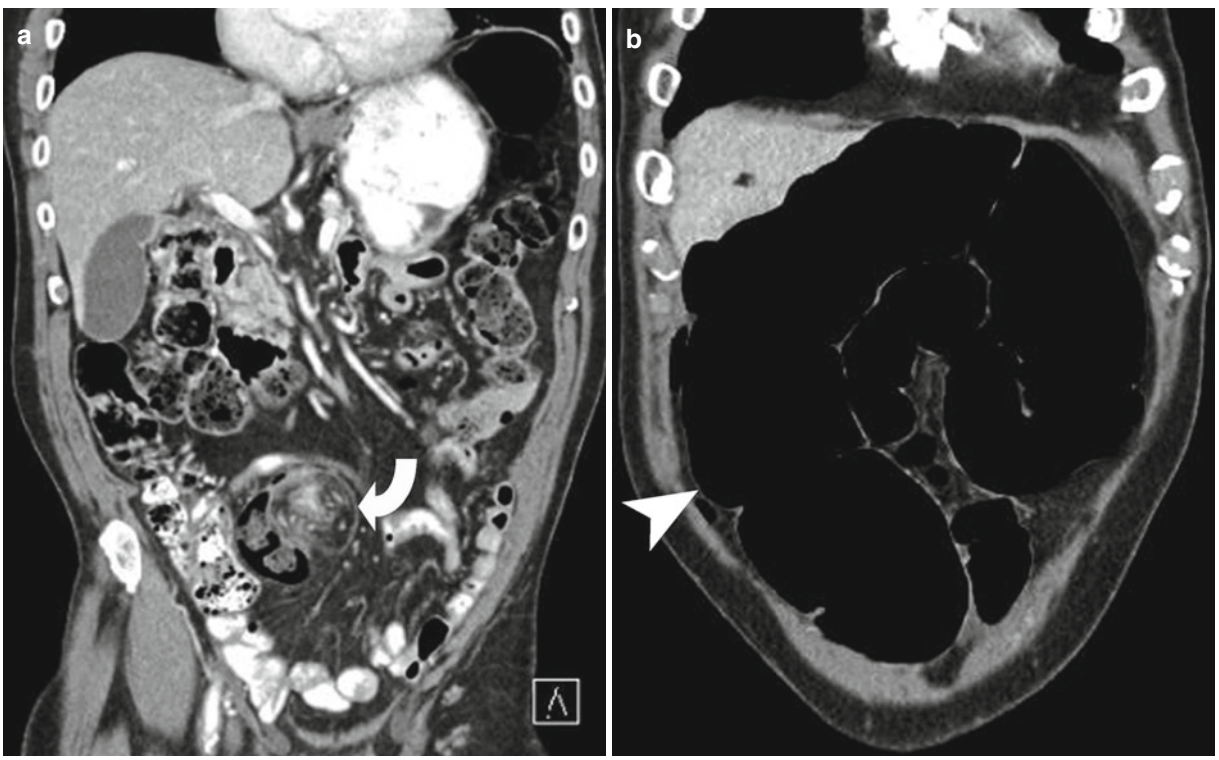

Fig. 6.11 Cecal volvulus. (**a**) Coronal CT reformation demonstrates whirled appearance of the mesentery as well as a segment of the right colon in this patient with cecal volvulus. (**b**) Coronal CT reformation demonstrates dilated sigmoid colonic loops (*arrowhead*) in this closed-loop obstruction

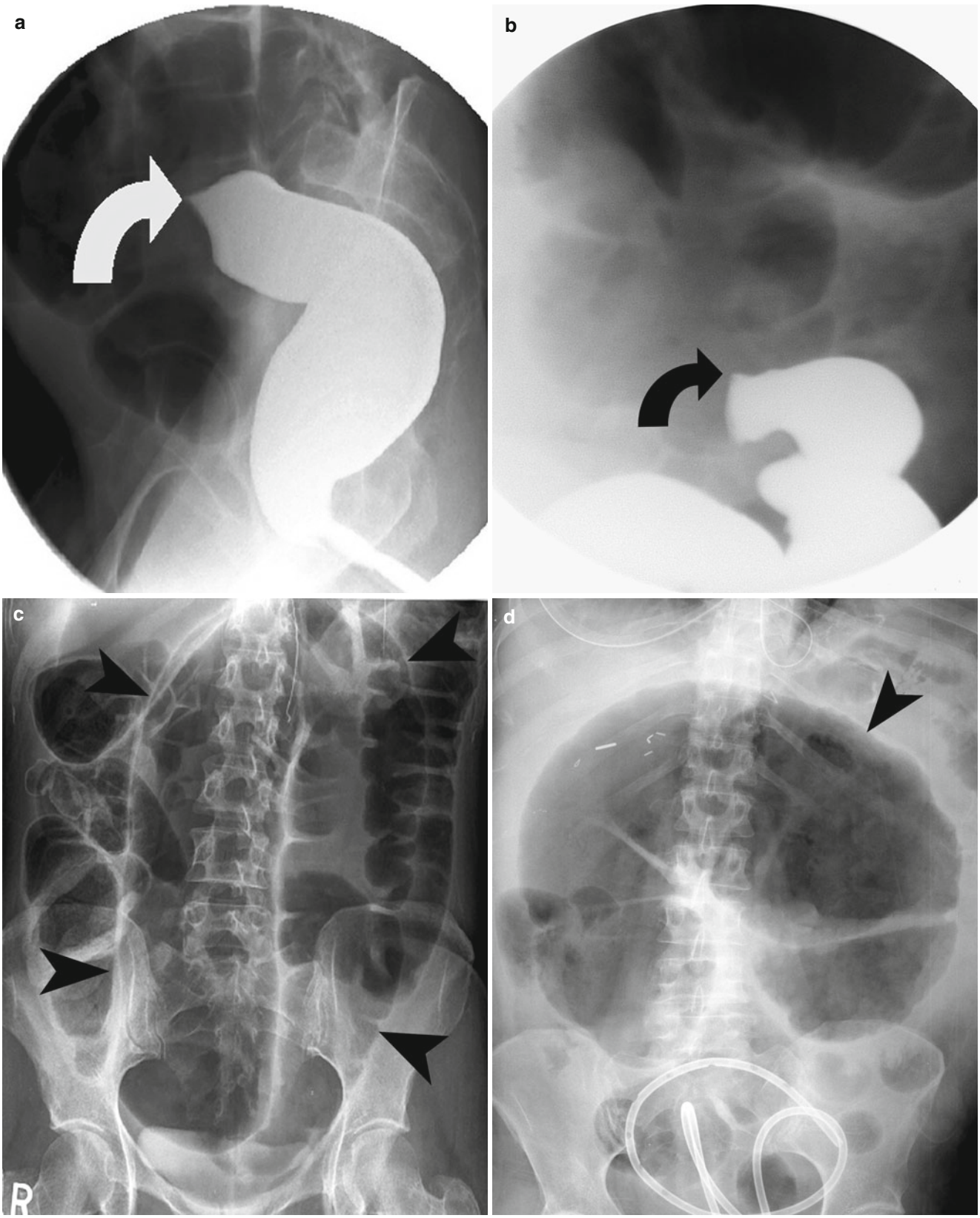

Fig. 6.12 Sigmoid volvulus. (**a**, **b**) Single-contrast barium enema examination in two patients with sigmoid volvulus demonstrates beak-like narrowing (*curved arrow*) at the rectosigmoid junction. (**c**, **d**) Plain x-ray of the abdomen demonstrates dilated loops of sigmoid colon in a coffee bean configuration (*arrowheads*) in two patients with sigmoid volvulus

sign, "closed-loop," and "three-line" or "white-stripe" signs (describing the U-shaped closed-loop appearance of the colon, between the two points of obstruction and the obliquely oriented vertical white line of the opposed walls and the space within them) (Fig. 6.12c, d) [14]. Coffee bean sign refers to a dilated C-shaped sigmoid colonic loop, extending cranial to the transverse colon and separated by a linear vertical density produced by opposing walls of sigmoid colon. CT can demonstrate the radiographic findings and few other signs (Table 6.3).

The complications of colonic volvulus include bowel wall infarction, gangrene, and perforation. Symptomatic colonic obstruction in patients with splenic volvulus is characterized by 180–720° twisting around the mesentery. Lesser degree of twisting may be asymptomatic. Although the treatment options include detorsion, cecopexy, cecostomy, and partial colectomy, if gangrenous changes are encountered, then resection of the necrotic bowel is performed.

Table 6.3 CT findings of volvulus

1. Coffee bean sign
2. Whirl sign (twisting or swirling mesenteric fat and vessels)
3. X-marks-the-spot sign (crossing transition points)
4. Split-wall sign (invagination of pericolic fat giving the impression split in twisted bowel loop)

Intussusception

Intussusception is typically seen in the pediatric age group (2 months to 6 years), accounting for up to 90 % of bowel obstruction in infants. Unlike in adults, in children majority of cases are idiopathic. Intussusception is characterized by a segment of proximal bowel and its mesentery (intussusceptum) prolapsing into a segment of contiguous distal bowel (intussuscipiens) due to peristalsis. The most frequent type of intussusception in childhood is the ileocolic intussusception and in adults is ileocolic or colocolic [15, 16]. The lead point, which is more frequent in adults than in children, can be a lipoma, adenomatous polyp, leiomyoma, or villous adenoma. Lead point is also more common in adults than in children. Majority of intussusceptions seen in small bowel on CT are transient and are idiopathic.

In plain radiograph, a crescent-shaped collection of air outlining the intussusceptum head is called "crescent sign." On barium enema, contrast trapped between intussusceptum and intussuscipiens gives a coiled spring appearance (Figs. 6.13 and 6.14). On ultrasound assessment, there is a target appearance produced by the edematous hypoechoic wall of intussuscipiens and concentric hyperechoic rings produced by layers in the wall of intussusceptum (Fig. 6.15).

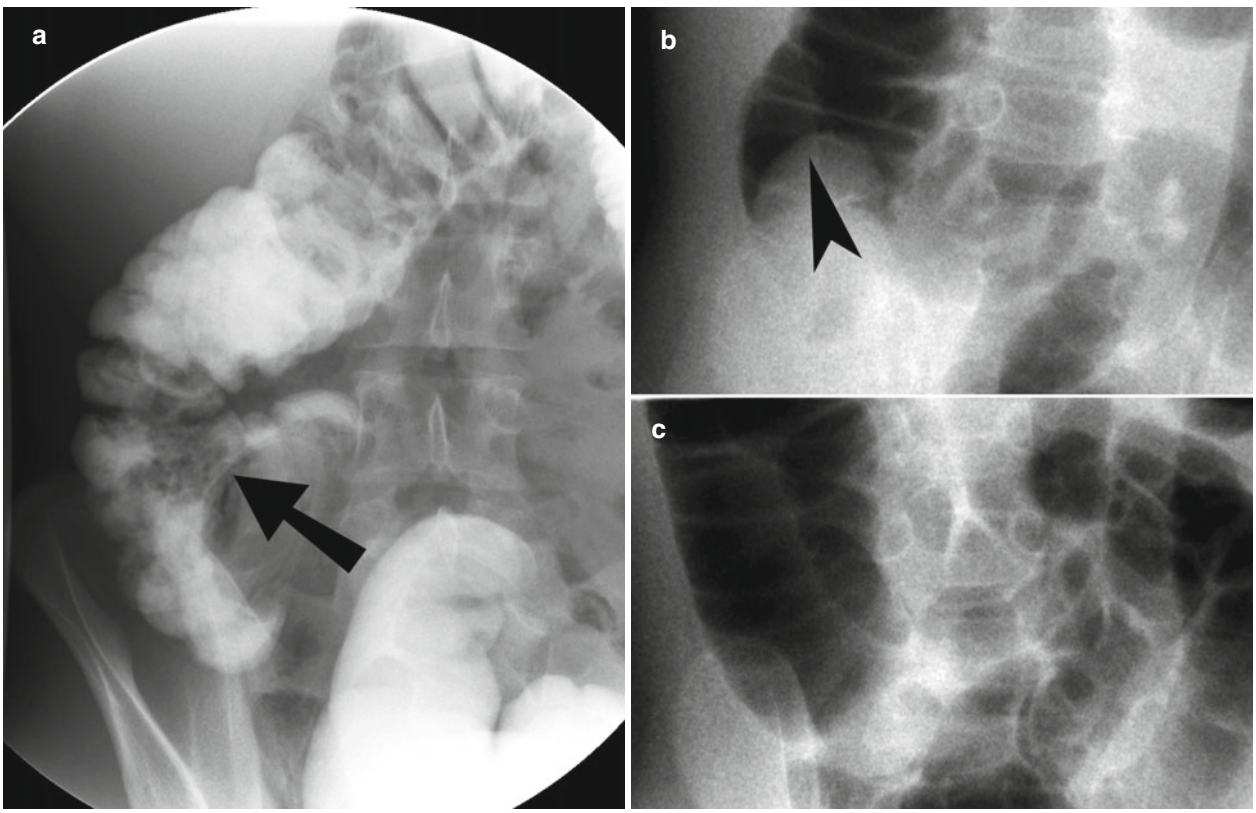

Fig. 6.13 Colonic intussusception reduction on contrast enema. (**a**) Single contrast barium enema demonstrates a large filling defect (*arrow*) in the cecal lumen due the presence of the intussusceptum. (**b**) Air enema demonstrates the tip of the intussusceptum (*arrowhead*) outlined by air introduced for reduction of intussusception. (**c**) The follow up image demonstrates resolution of the ileocolonic intussusception

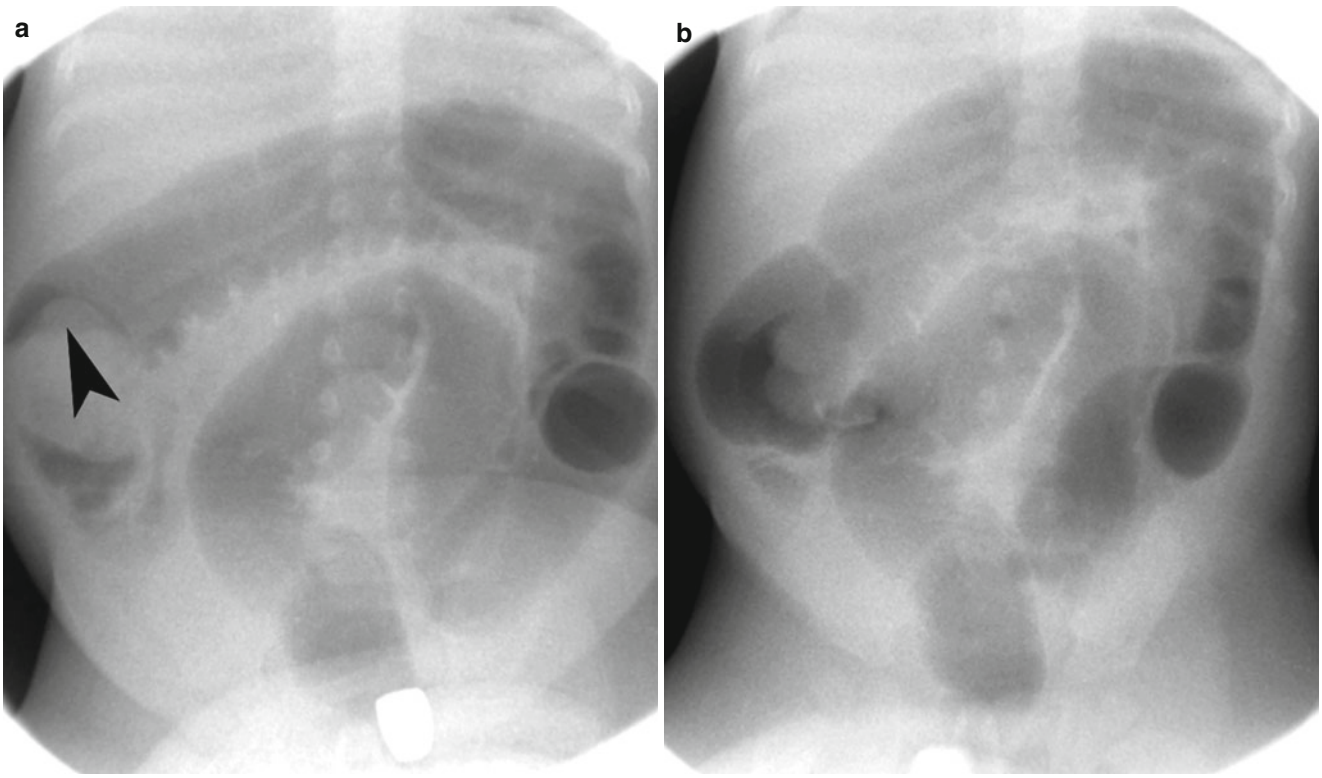

Fig. 6.14 Colonic intussusception reduction on contrast enema. (**a**, **b**) Spot images before and after contrast reduction shows the intussusceptum (*arrowhead*) outlined by air, followed by resolution of the ileocolonic intussusception

Contrast enema is used in children, more for treatment than diagnosis of intussusception. Today the main diagnostic tool is ultrasound, particularly in young patients. It allows a correct diagnosis and may find and alternative one when intussusception is not present. CT is also used in doubtful cases and in adult patients.

The CT findings include the central intussusceptum, surrounded concentrically by mesenteric fat or vessels and finally intussuscipiens (Fig. 6.16). The concentric structures may produce a target- or sausage-shaped mass. A reniform-shaped mass is seen on CT in late stages and produced by progressive wall edema and vascular compromise.

The treatment of intussusception includes radiological enema (with air, water-soluble material, or barium). The injection of liquid (water or saline) or air under US control is another technique that reduces radiation exposure of young patients. If no results are obtained or perforation is present, surgical resection is indicated [15]. Surgical treatment is the main therapy for adult intussusception, because of the high frequency of an underlying pathologic lead point.

Colonic Ischemia

Ischemic colitis is the most frequent type of ischemic disease of the gastrointestinal tract (50 %), most commonly involving the splenic flexure and the descending colon [13]. It mainly affects the elderly people and may manifest with reversible ischemia to irreversible ischemia (transmural infarction, gangrene, perforation, and stricture). The underlying cause of ischemia is insufficient vascular supply to the colonic wall which has the highest propensity to initially affect the mucosa. Although mucosal ischemia is reversible in the majority, it can also progress to transmural infarction.

The causes of bowel ischemia include thromboembolism, nonocclusive causes, colonic obstruction, tumors, vasculitis, radiation, and trauma [17]. Major vascular occlusion is seen on angiography in less than a tenth of the cases. Today the definitive diagnosis is usually made by colonoscopy. The plain radiograph may be normal or may show submucosal hemorrhage or edema (thumbprinting), ileus, transverse ridging, or ahaustral bowel pattern. Thumbprinting is most suggestive of colonic ischemia and is seen as thumb-shaped smooth projections into the colonic lumen (Fig. 6.17a). The initial diagnosis is most often suspected based on the CT imaging findings, most commonly in inferior mesenteric artery distribution (Table 6.4).

For mild cases the treatment is conservative with two-thirds of all patients recovering spontaneously within 24–48 h. In patients who do not respond to conservative treatment or those who have clinical signs of frank peritonitis or bowel perforation, surgical intervention is indicated.

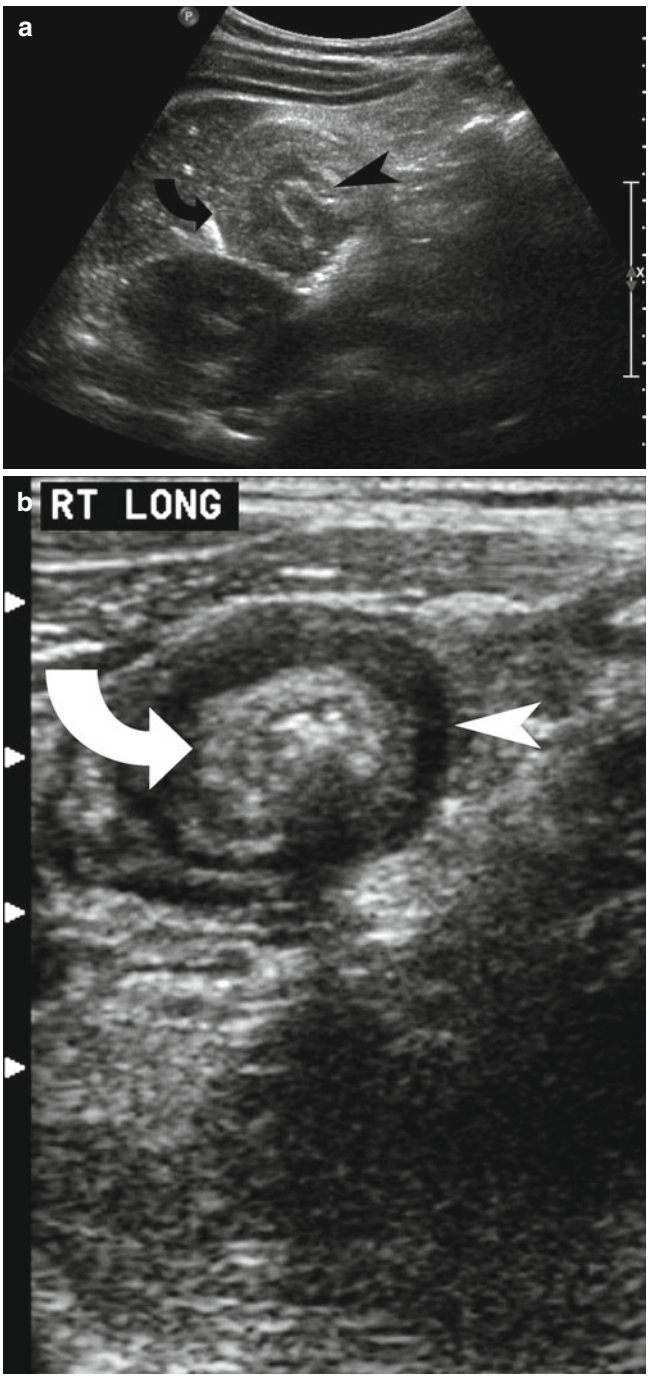

Fig. 6.15 Colonic intussusception on ultrasound and CT. (**a**) Ultrasound demonstrates concentric layers of the intussusceptum (*arrowhead*) and intussuscipiens (*curved arrow*). (**b**) Contrast-enhanced CT shows the centrally located intussusceptum (*arrowhead*), surrounded by air and intussuscipiens (*curved arrow*)

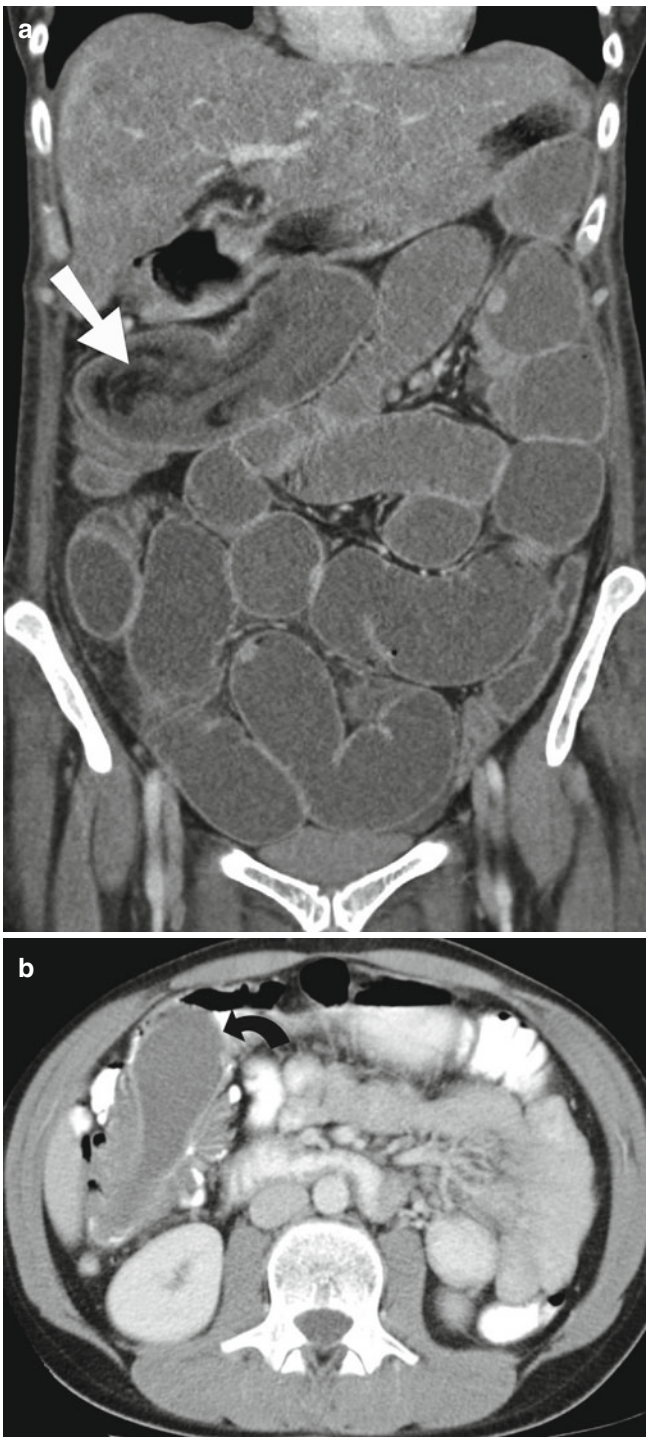

Fig. 6.16 Intussusception. (**a**) Coronal CT scan reformation demonstrates colocolonic intussusception in the hepatic flexure of the colon. The intussusceptum (*straight arrow*) is causing high-grade bowel obstruction. (**b**) Axial contrast-enhanced CT demonstrates colocolonic intussusception due to a duplication cyst (*curved arrow*)

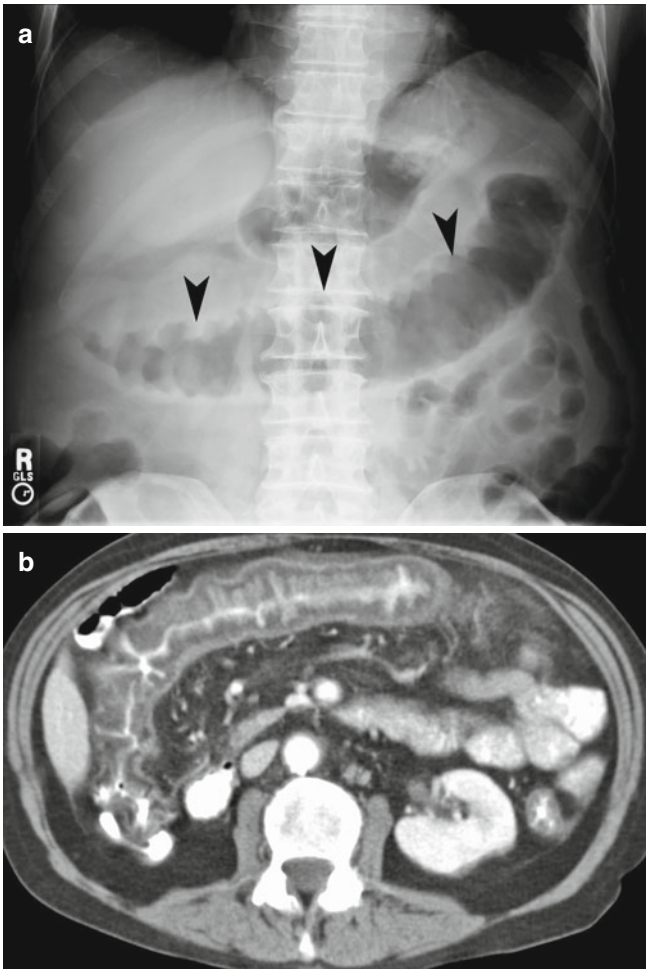

Fig. 6.17 Ischemic colitis. (**a**) Plain x-ray of the abdomen demonstrates thumbprinting and mucosal edema (*arrowheads*) in the transverse colon of a patient with ischemic colitis. (**b**): Contrast-enhanced CT scan study of the abdomen demonstrates thickening of the transverse colonic wall with stratification, secondary to mucosal and serosal enhancement. The histopathology findings were consistent with ischemic colitis

Table 6.4 CT findings of colonic ischemia

1. Symmetric bowel wall thickening (Fig. 6.17b)
2. Most commonly involving the inferior mesenteric artery territory
3. Double halo sign due to submucosal edema
4. Colonic pneumatosis (Fig. 6.18)

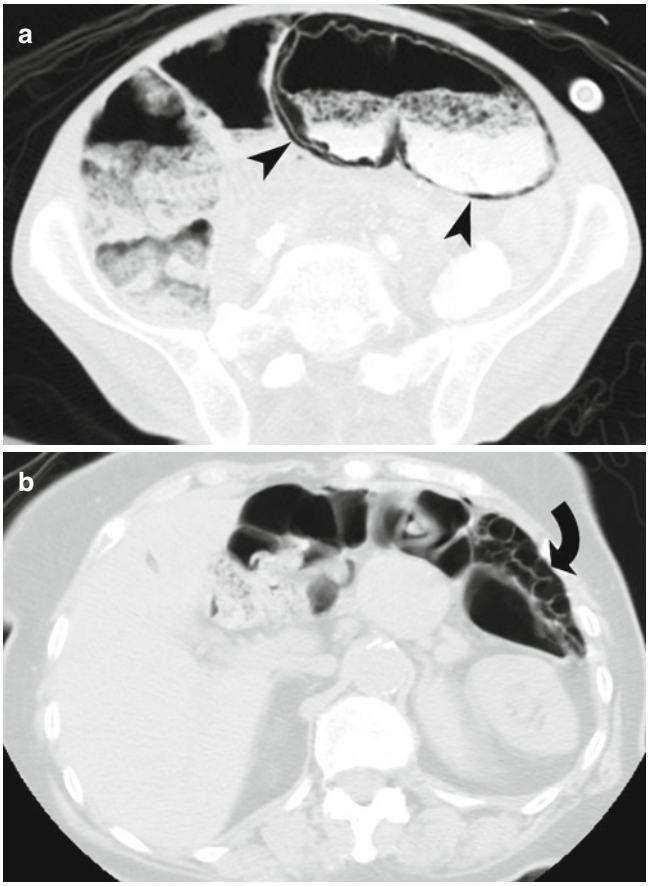

Fig. 6.18 Colonic ischemia. (**a**, **b**) CT of the abdomen (lung windows) demonstrates linear (**a**) and cystic (**b**) pneumatosis involving the transverse colon. Linear pneumatosis is believed to be associated with worse prognosis

GI Bleeding

Although most common site of gastrointestinal tract bleeding is from the esophagus, stomach, or duodenum, 30 % of bleeding originates from the lower gastrointestinal tract, distal to the ligament of Treitz [18]. Upper gastrointestinal bleeding accounts for two-thirds of gastrointestinal bleedings and is most commonly due to peptic ulcers and gastritis. Lower gastrointestinal bleeding is most commonly seen in older patients than upper gastrointestinal bleeding. The main causes of bleeding in the lower intestinal tract are diverticular disease (20–55 %), angiodysplasia (3–40 %), tumors (8–26 %), inflammatory diseases (6–22 %), and benign lesions of the anorectal tract (9–10 %) [18].

Clinically, lower gastrointestinal bleeding presents as hematochezia, which refers to passage of bright red blood. Small bleedings (<100 mL/day) may remain asymptomatic, but when blood loss is higher or acute (>500 mL or >15 % blood volume), the patient may suffer hypotensive shock.

In patients with lower gastrointestinal bleeding, Tc 99m-labeled RBC scan is the investigation of choice because of its ability to detect intermittent bleeding (Fig. 6.19). Unlike Tc 99m sulfur colloid, Tc 99m-labeled RBC scan allows detection of bleeding over several hours. It is less sensitive than Tc 99m sulfur colloid in detection of bleeding. Tc 99m sulfur colloid scan has extremely high sensitivity in detecting bleeding as low as 0.05–0.1 mL/min, but has the disadvantage of being sensitive only if the bleeding occurs within 20 min of radiopharmaceutical injection.

If scintigraphy demonstrates bleeding, then conventional angiography is performed for diagnostic and therapeutic reasons. If bleeding is identified on angiography, vasopressin infusion or transcatheter embolization could be performed.

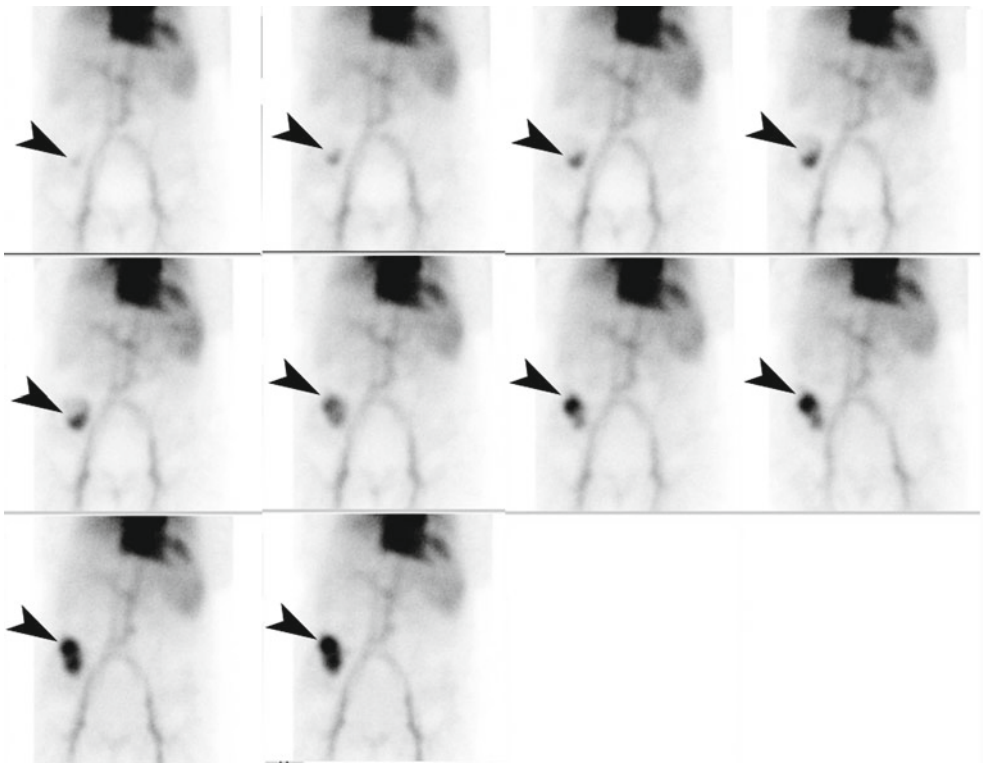

Fig. 6.19 Lower gastrointestinal bleeding on Tc 99m-labeled RBC scan. Tc 99m-labeled RBC scan demonstrates progressively increasing radiotracer activity (*arrowheads*) in the cecum

To identify bleeding on angiography, the rate of bleeding must be more than 0.5 mL/min. Colonoscopy should be performed if the hematochezia has subsided and when the diagnostic yield of angiography is low.

Acute Epiploic Appendagitis

Acute epiploic appendagitis is characterized by torsion or venous occlusion of epiploic appendages. Since epiploic appendages are more in number in the sigmoid colon, this condition most commonly affects the sigmoid colon (62 %) (Table 6.5) [7]. Unlike omental infarction, this condition is more common in older age group of fourth to fifth decades. It is clinically most often misdiagnosed as acute sigmoid diverticulitis.

On imaging, epiploic appendagitis is most often seen as a 1.5- to 3.5-cm-diameter focal fat density lesion with central high-density (54 %) and surrounding inflammation [7] (Fig. 6.20).

Acute epiploic appendagitis is medically managed with Motrin. In majority of the patients, the symptoms resolve within 10 days of symptom onset.

Acute Segmental Omental Infarction

Acute segmental infarction is a rare cause of right lower quadrant pain, often clinically misdiagnosed as acute appendicitis. The conditions predisposing to this condition include obesity, trauma, overeating, laxative use, overexertion, and congestive heart failure.

Table 6.5 Location of acute epiploic appendagitis [7]

Location	Frequency (%)
Sigmoid colon	62
Descending colon	18
Cecum	12
Ascending colon	8
Transverse colon	0
Anterior	82
Lateral	8

The CT findings include heterogeneous fat density lesion which is usually larger than the lesion seen with acute epiploic appendagitis (Fig. 6.21). It is located in the greater omentum, most often in the right lower quadrant [6]. The importance of making the CT diagnosis of this condition is because of the medical management of this condition and its tendency to mimic a surgical abdomen.

Teaching Points

1. Contrast-enhanced CT is the imaging modality of choice in the evaluation of acute left lower quadrant pain.
2. For the initial presentation of suspected Crohn's disease in patients with abdominal pain, fever, and diarrhea, CT enterography is considered the most appropriate imaging modality.

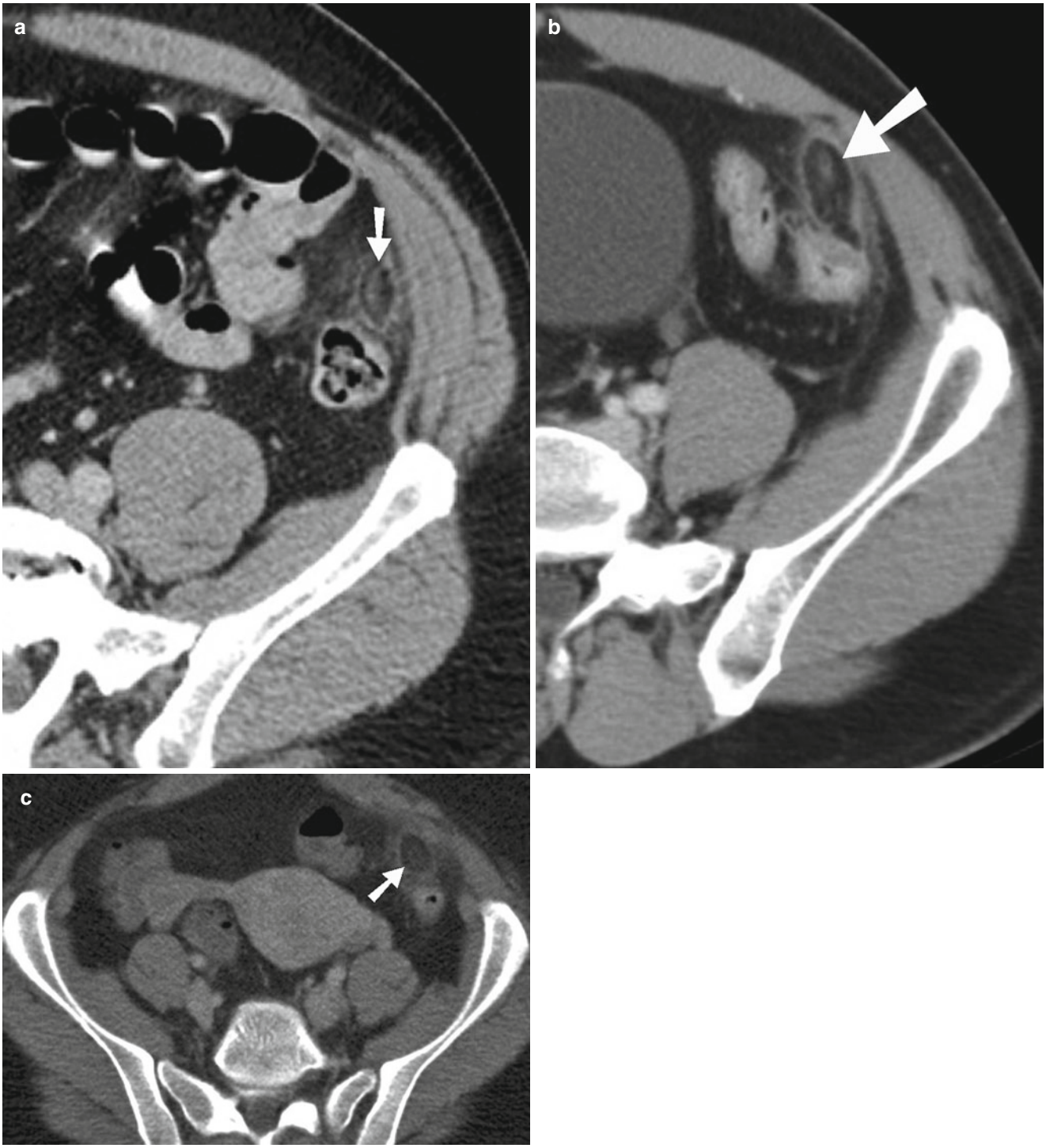

Fig. 6.20 Acute epiploic appendagitis. (**a**–**c**) CT study demonstrates inflamed epiploic appendage (*arrows*) in the left lower quadrant. The central high density with the fatty lesion represents thrombosed or congested vessel

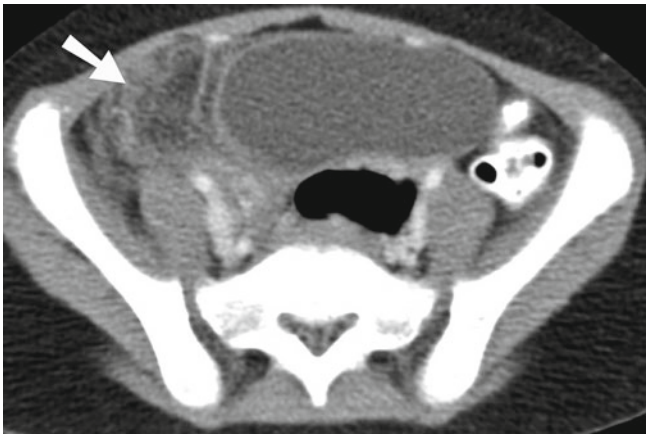

Fig. 6.21 Acute segmental omental infarction. Contrast-enhanced CT in a child shows inflammatory omental lesion (*arrow*) in the right lower quadrant. The appendix was normal and seen at a higher level

3. For adult and pediatric patients with known Crohn's disease, presenting with fever, abdominal pain, and leukocytosis, routine contrast-enhanced CT is considered the imaging modality of choice.
4. Sigmoid volvulus accounts for 75 % and cecal volvulus accounts for 20 % of large bowel obstructions.

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