Acute Disease of the Abdominal Wall

Catherine Cyteval

Contents

Abstract

Various acute diseases, including hernia, hematoma, and abscess, can occur within the abdominal wall. Different imaging modalities have been used to confirm suspected abdominal wall lesions or postsurgical complications; adequate visualization of intra-abdominal organs and the abdominal wall, fast imaging acquisition, three-dimensional data sets, multiplanar reformation capabilities, and contrast material injection allowing visualization of vascularization in the abdominal wall are important advantages of multidetector row computed tomography compared with other modalities.

1 Normal Anatomy of the Abdominal Wall

The abdominal wall represents the boundaries of the abdominal cavity (Salmons 1995). It consists of skin, subcutaneous tissues, and a muscular layer that is divided into anterior, anterolateral, and posterior groups (Fig. 1). The abdominal wall is separated from the peritoneum by a layer of fascia that has different names depending on where it covers (e.g., fascia transversalis, psoas fascia) (Fisch and Brodey 1981).

The anterior muscle group consists of rectus abdominis muscles lying within the rectus sheath. The rectus abdominis muscle is a paired muscle running vertically on each side of the anterior wall of the human abdomen. There are two parallel muscles, separated by a midline band of connective tissue

C. Cyteval (✉)
Service d'imagerie médicale, Hôpital Lapeyronie,
371 Avenue du Doyen Gaston Giraud,
34295 Montpellier Cedex 5, France
e-mail: c-cyteval@chu-montpellier.fr

P. Taourel (ed.), *CT of the Acute Abdomen,* Medical Radiology. Diagnostic Imaging,
DOI: 10.1007/174_2010_91, © Springer-Verlag Berlin Heidelberg 2011

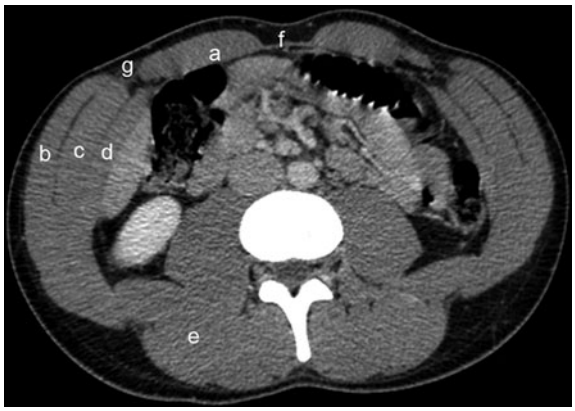

Fig. 1 Axial computed tomography (CT) scan of the lower abdomen shows the abdominal muscles, which are as follows: *a* rectus abdominis muscle, *b* external oblique muscle, *c* internal oblique muscle, *d* transverse abdominal muscle, *e* posterior muscle group, *f* linea alba, and *g* Spiegel line

Fig. 2 The axial contrast-enhanced reformatted CT image of the abdomen shows herniation of omental fat through the umbilical orifice (*arrow*) with stranding of herniated fat (*arrowhead*)

Fig. 3 Incarceration of an inguinal hernia in an 80-year-old man. **a**, **b** Axial contrast-enhanced reformatted CT images of the abdomen show a strangulated left direct inguinal hernia located entirely anterior to the orthogonal lines drawn at the pubic tubercle (**a**) with wall thickening and reduction of the mural enhancement of herniated bowel, severe fat stranding (*arrow*), mesenteric engorgement (*arrowhead*), and extraluminal fluid confined to the hernial sac (*thin arrow*), findings that suggest strangulation (**b**). **c**, **d** Sagittal and coronal contrast-enhanced reformatted CT images of the abdomen more clearly show mural thickening and reduction of the mural enhancement of herniated bowel (compare with that of intra-abdominal bowel loops)

called the linea alba (white line). It extends from the pubic symphysis inferiorly to the xiphoid process and lower costal cartilages superiorly. The rectus abdominis muscle is usually crossed by three fibrous bands linked by the tendinous inscriptions.

The anterolateral muscle group is formed by external and internal oblique and transversus abdominis muscles:

– The external oblique muscle is the largest and the most superficial (outermost) of the three flat

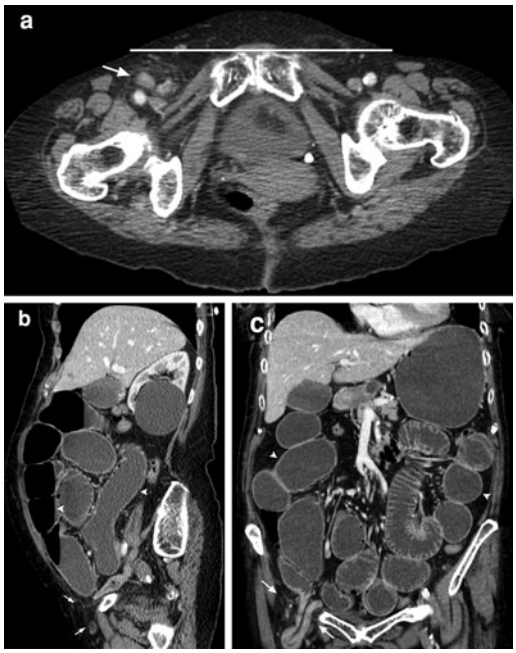

Fig. 4 Strangulated femoral hernia in a 75-year-old woman. **a** The axial contrast-enhanced reformatted CT image of the abdomen shows a strangulated right hernia entirely located posterior to the orthogonal lines drawn at the pubic tubercle. Mural enhancement of herniated bowel is normal (similar to that of intra-abdominal bowel loops). **b**, **c** Sagittal and coronal contrast-enhanced reformatted CT images of the abdomen more clearly show the amplitude of the wall defect (*arrows*), air–fluid levels, and dilatation of intra-abdominal bowel loops secondary to small bowel obstruction (*arrowhead*)

muscles of the lateral anterior abdomen. It arises from the external surfaces and inferior borders of the fifth through 12th ribs. It ends at the linea alba, pubic crest, tubercle, anterior superior iliac spine, and anterior half of the iliac crest. The aponeurosis of the external oblique muscle forms the inguinal ligament. The muscle also contributes to the inguinal canal.

– Just deep to the external oblique is the internal oblique muscle. Its fibers run perpendicular to the external oblique muscle, beginning in the thoracolumbar fascia of the lower back, the anterior two thirds of the iliac crest, and the lateral half of the inguinal ligament. The muscle fibers run from these points superiomedially (up and toward the midline) to the muscle's insertions on the inferior borders of the tenth through 12th ribs and the linea alba.
– The transverse abdominal muscle is the deepest muscle layer of the lateral abdominal wall. It lies

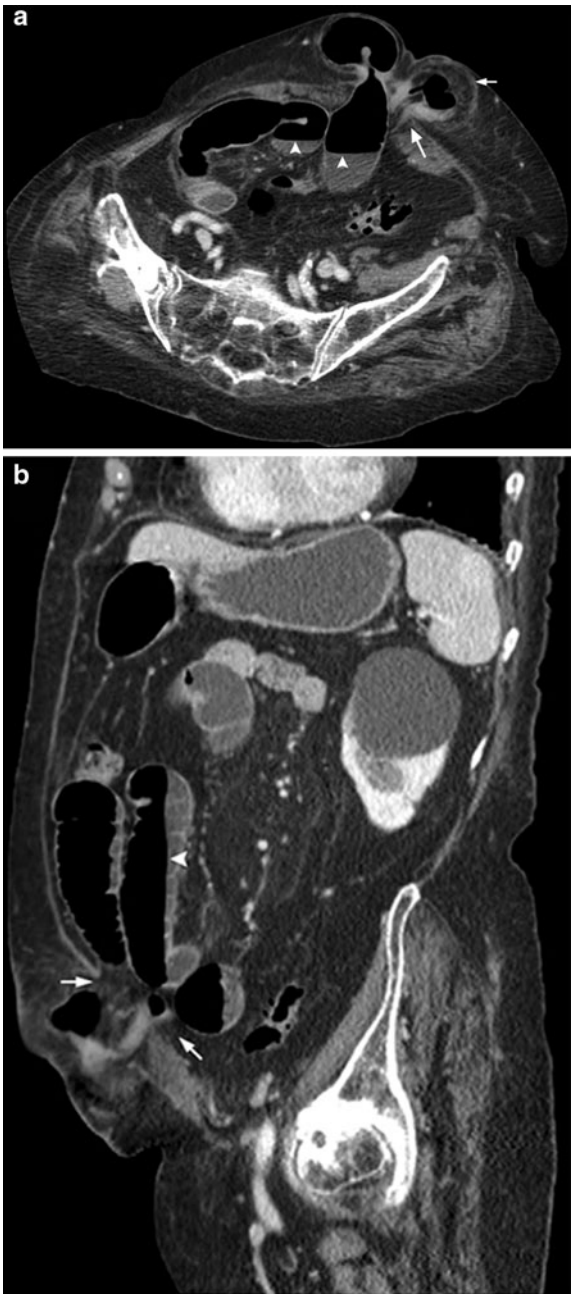

Fig. 5 Hypogastric paramedial hernia in an 85-year-old woman who presented with abdominal distension. **a**, **b** Axial and sagittal contrast-enhanced reformatted CT images of the abdomen show a strangulated hernia (*arrows*) causing small bowel obstruction (*arrowheads*). A herniated bowel loop with a C-shaped configuration and fat stranding around the herniation are also seen. The sagittal contrast-enhanced reformatted CT image (**b**) of the abdomen more clearly demonstrates the amplitude of the wall defect (*thin arrows*), air–fluid levels, and dilatation of intra-abdominal bowel loops secondary to small bowel obstruction (*arrowhead*)

Fig. 6 The axial unenhanced CT scan of the abdomen shows a hematoma of the right internal oblique muscle (*arrow*) in a 33-year-old hemophilic patient. The muscle appears thickened and hypoattenuating relative to surrounding tissues

just below the internal oblique muscle. The muscle runs laterally from the front of the inside part of the hip bone (anterior iliac crest and inguinal ligament) to the last rib of the rib cage and ends by joining with the rectus abdominis muscle.

The inguinal canal is a short, narrow, diagonal passage in the lower anterior abdominal wall that is lined by the aponeuroses of these three muscles. It has openings at either end: the deep and superficial inguinal rings. The deep inguinal ring is an oval gap in the fascia transversalis and lies 1 cm superior to the inguinal ligament and lateral to the inferior epigastric vessels. The superficial inguinal ring is a triangular opening in the aponeurosis of the external oblique muscle. In males, the inguinal canal transmits the spermatic cord, spermatic artery, and the genital branch of the genitofemoral nerve from the pelvic cavity to the scrotum that includes the vas deferens and the testicular artery. In females, it transmits the round ligament of the uterus and the ilioinguinal nerve to the labia majora (Bhosale et al. 2008).

Latissimus dorsi, quadratus lumborum, and paraspinal muscles make up the posterior muscle group.

2 Hernia

Abdominal wall hernias are frequent, and although most of them are asymptomatic, they may develop acute complications that necessitate emergent surgery. In the USA, complications related to external hernias represent one of the most common reasons for

Fig. 7 Rectus sheath hematoma in a 78-year-old woman receiving anticoagulation therapy. **a** The axial enhanced CT scan of the abdomen shows a hematoma contained in the left rectus sheath with a roughly oval form (*arrow*) hypoattenuating relative to surrounding tissues. **b** The sagittal unenhanced reformatted CT image of the abdomen more clearly shows the hematoma developed above the level of the arcuate line

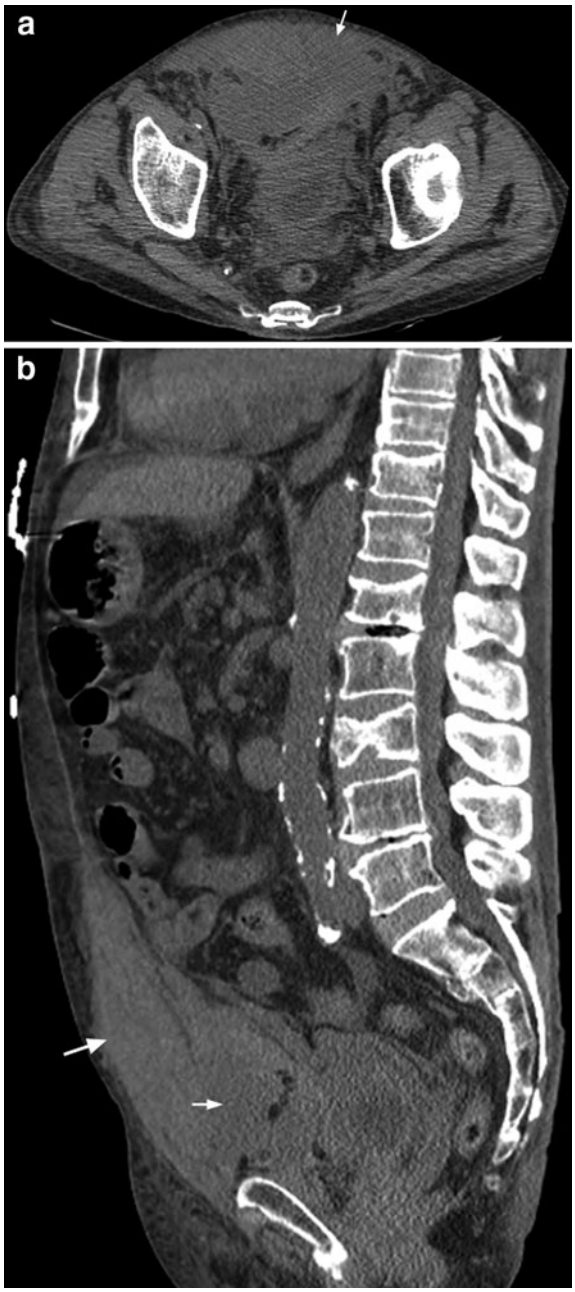

Fig. 8 Rectus sheath hematoma in a hemodialysis patient. **a** The axial unenhanced CT scan of the abdomen shows a hematoma of the rectus (*arrow*). **b** The sagittal reformatted CT image of the abdomen more clearly shows the hematoma developed below the level of the arcuate line and breaks back through the fascia transversalis into the Retzius space (*thin arrow*)

emergent surgery performed in patients over 50 years old (Rutkow 2003). Prompt diagnosis is desirable because delay is associated with greater morbidity. Because of its superior anatomic detailing, multidetector row computed tomography (CT) may detect subtle signs of complication within the hernial sac, including bowel obstruction, incarceration, and strangulation, as well as traumatic wall hernias and postsurgical complications (e.g., hernia recurrence, fluid collections, infection, mesh-related complications). Axial CT imaging performed with the patient in the supine position is typical. If hernias are seen, a thin reconstruction (sections of 2.5-mm or less) may improve multiplanar reformation. Postural maneuvers (e.g., prone or lateral decubitus patient positioning) and maneuvers that increase intra-abdominal pressure (e.g., straining, Valsalva maneuver) can help depict subtle hernias that would otherwise be missed (Emby and Aoun 2003). Intravenous administration of contrast material is necessary for characterization of the vascular supply. Positive oral contrast material or water may be used to better visualize bowel loops.

2.1 Types of Abdominal Wall Hernias

2.1.1 Groin Hernias

Groin hernias include inguinal hernias (direct or indirect) and femoral hernias.

Inguinal hernias are the most common type of abdominal wall hernia. They occur in children (most commonly indirect-type hernias) and adults (both direct and indirect types), manifesting themselves medial (direct type) or lateral (indirect type) to the inferior epigastric vessels (Ghahremani et al. 1987). Regardless of the patient's age, inguinal hernias are more common in males than in females. In boys, most inguinal hernias develop because the peritoneal extension accompanying the testis fails to obliterate. In adults, inguinal hernias are caused by acquired weakness and dilatation of the internal inguinal ring.

Femoral hernias are less common than inguinal hernias. They occur medial to the femoral vein and posterior to the inguinal ligament, usually on the right side. Unlike inguinal hernias, they are more common in females.

Both types of hernias are defined by their relationships relative to the inguinal ligament. Inguinal hernias are superior to the ligament, whereas femoral hernias lie below the ligament. Indirect inguinal hernias and femoral hernias are more prone to obstruction than direct inguinal hernias (Wechsler et al.

Fig. 9 Acute arterial hemorrhage in a 34-year-old woman after fibrinolysis for pulmonary embolism. **a** The axial unenhanced CT scan shows an intra-abdominal hematoma (*arrows*). **b**, **c** Two-phase contrast-enhanced reformatted CT images show extravasation of contrast material (*arrowhead*) into the hematoma. On the arterial phase image (**b**) only a small amount of contrast material is evident underneath the abdominal wall, whereas the venous phase images (**c**) show active bleeding (*arrows*) into the hematoma

1989), and are frequently responsible for incarceration of a short segment of bowel herniating through a narrow hernia neck.

Although the inguinal ligament may not be visible on CT, the pubic tubercle, corresponding to the anteroinferior insertion site of this ligament, is easily detected on CT (Wechsler et al. 1989). Inguinal hernias, anatomically situated above the ligament, are located entirely anterior to (direct inguinal hernia) or partially anterior to (indirect inguinal hernia) orthogonal lines drawn at the pubic tubercle from an axial image. Femoral hernias that are situated below the ligament are located posterior to orthogonal lines drawn at the pubic tubercle on an axial image.

2.1.2 Ventral Hernias

Ventral hernias include all hernias within the anterior and lateral abdominal walls. Midline defects affect umbilical, paraumbilical, epigastric, and hypogastric hernias (Fig. 2). Umbilical hernias are by far the most common type of ventral hernias; they are usually small and are particularly common in women. Paraumbilical hernias are large abdominal defects through the linea alba in the umbilicus region and are usually related to diastasis of the rectus abdominis muscles. Epigastric hernias and hypogastric hernias occur in the linea alba above and below the umbilicus, respectively.

Paramedian or lateral defects may also occur, although they are less common. Spiegel hernia is located between the rectus abdominis muscle and the aponeurosis of the oblique muscles below the umbilicus. Typically, omentum and short segments of bowel protrude through the defect. These entities have a high prevalence of incarceration.

2.1.3 Lumbar Hernias

Lumbar hernias occur through defects in the lumbar muscles or the posterior fascia, below the 12th rib and above the iliac crest. They usually occur after surgery or trauma. Herniation may occur through the superior (Grynflett–Lesshaft) or, less commonly, the inferior (petit) lumbar triangle. The superior lumbar triangle is bordered by the internal oblique muscle anteriorly, the 12th rib superiorly, and the erector spinal muscle posteriorly. The inferior lumbar triangle is bordered by the external oblique muscle anteriorly, the iliac crest inferiorly, and the latissimus dorsi muscle posteriorly. Diffuse lumbar hernias may also occur, usually after flank incisions in kidney surgery, and may contain bowel loops, retroperitoneal fat, kidneys, or other viscera.

2.1.4 Hernias Due to an Incision or a Traumatism

Incisional hernias are delayed complications of abdominal surgery. They may manifest themselves anywhere in the abdominal wall and are more commonly encountered in association with vertical than with transverse incisions. Incisional hernias usually manifest themselves during the first few months after surgery. Their reported prevalence ranges from 0.5 to 13.9% for most abdominal surgical operations (Ghahremani et al. 1987).

Abdominal trauma can result in a wide variety of abdominal wall hernias, ranging from small defects caused by direct injury to more extensive defects resulting from compression injury to the abdomen. The most common locations are areas of relative anatomic weakness: the lumbar region and the lower abdomen.

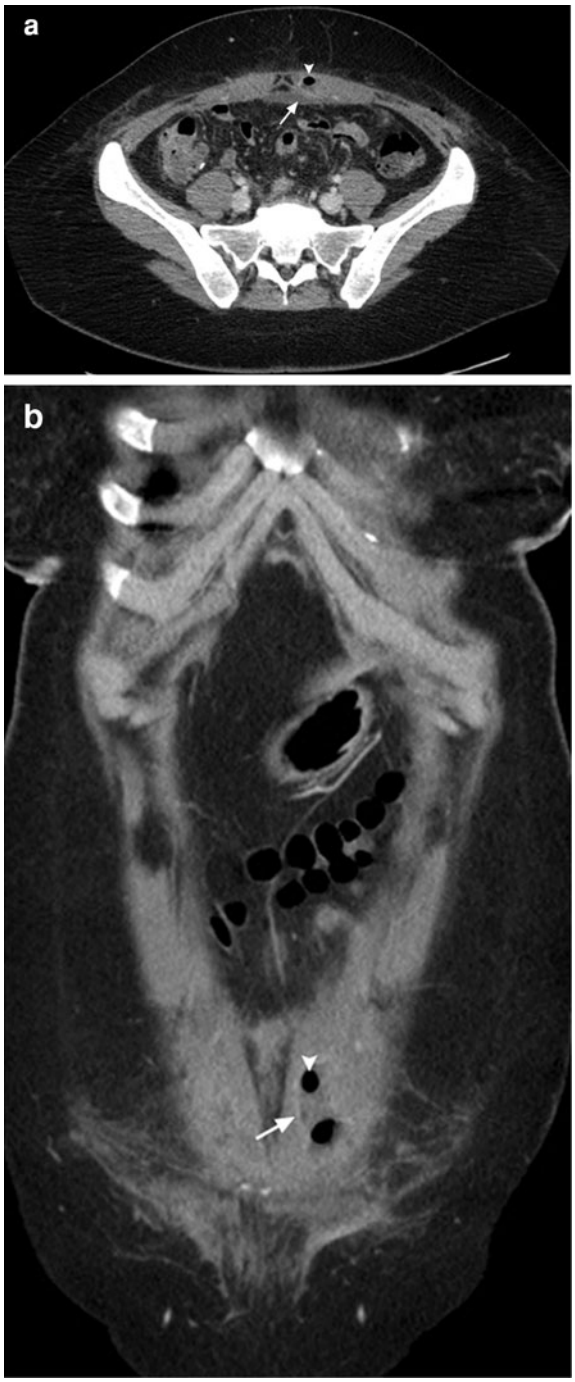

Fig. 10 Infected fluid collection within the abdominal wall in a 30-year-old woman 3 weeks after conservative surgery for endometriosis. **a**, **b** Axial and coronal contrast-enhanced reformatted CT scans of the lower abdomen show gas within the rectus sheath fluid collection (*arrowhead*), enhancement of the collection wall, and fat stranding around the collection that was suspicious of an infection (*arrow*)

2.1.5 Other Hernias

Less common hernias include interparietal, Richter, and Littre hernias of the abdominal wall, and sciatic, obturator, and perineal hernias in the pelvis.

"Interparietal (interstitial) hernia" refers to a hernial sac located in the fascial planes between the abdominal wall muscles that does not exit into the subcutaneous tissue. This type of hernia occurs most frequently in the inguinal region. "Richter hernia" refers to herniation of the antimesenteric wall of the bowel that does not compromise the entire wall circumference. It most frequently occurs in association with femoral hernias. "Littre hernia" refers to an inguinal hernia that contains a Meckel diverticulum. All of these uncommon abdominal hernias are particularly prone to incarceration and strangulation (Harrison et al. 1995).

Pelvic hernias most frequently occur in elderly women and are secondary to acquired weakness of the pelvic floor. Sciatic and obturator hernias are rare and usually manifest themselves as herniation of small bowel loops or a ureter through the sciatic or obturator foramen, respectively. Perineal hernias are more common than sciatic or obturator hernias and occur adjacent to the anus or labia majora or in the gluteal region.

2.2 Causes of Acute Symptoms in Abdominal Wall Hernias

The most common complications of abdominal wall hernias lead to acute abdominal pain. Early diagnosis of hernia complications is feasible with multidetector row CT, potentially improving the patient's outcome by preserving bowel viability (Yu et al. 2004).

2.2.1 Incarceration

"Incarceration" refers to an irreducible hernia and is diagnosed clinically when a hernia cannot be reduced or pushed back manually. The diagnosis of incarceration cannot be made with imaging alone, but can be suggested when herniation occurs through a small defect and the hernial sac has a narrow neck. Detection is important because incarceration predisposes a patient to complications such as obstruction, inflammation, and ischemia. Axial and multiplanar reformation images improve visualization of the hernia defect and permit assessment of the size and content (Aguirre et al. 2004). Impending strangulation of

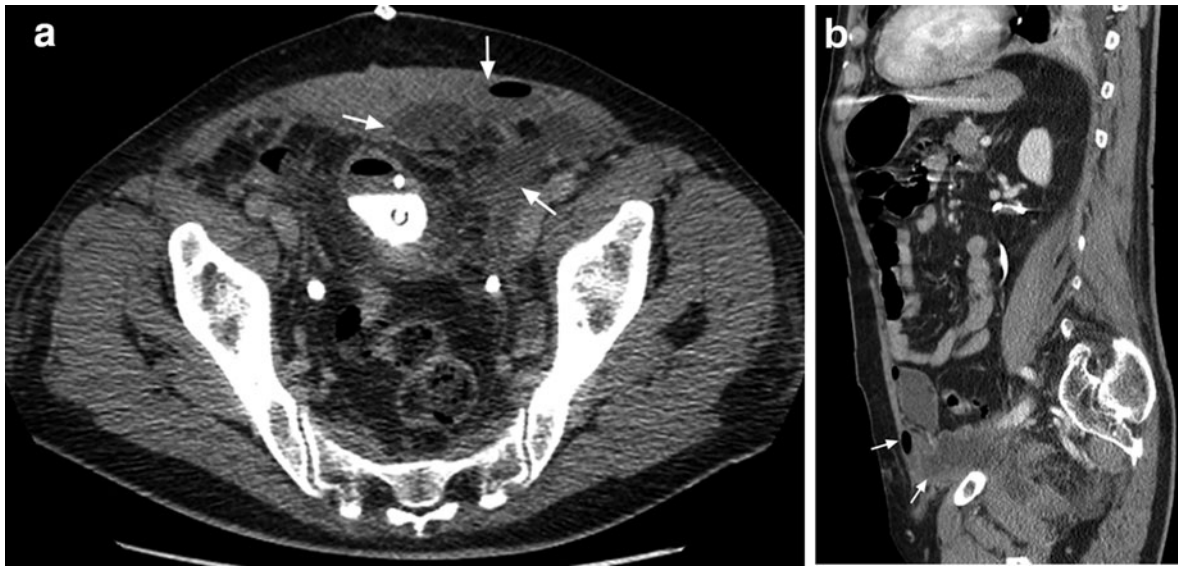

Fig. 11 Abscess within the abdominal wall after prostatic surgery in a 74-year-old man. **a**, **b** Axial and sagittal contrast-enhanced reformatted CT scans of the lower abdomen show large fluid collections into the Retzius space spreading through the fascia transversalis into the abdominal wall containing gas

Fig. 12 Infected fluid collection (*arrow*) in a 62-year-old man who had undergone colonic surgery for cancer 2 weeks before. The CT scan shows a second collection just before the spine (*arrowhead*). Infection was confirmed by microbiologic analysis of the wall fluid collection obtained using imaging-guided aspiration

Fig. 13 Myositis in a 34-year-old man with HIV infection for 5 years. The axial unenhanced reformatted CT image of the abdomen shows diffuse hypoattenuation of the posterior muscle group with increased volume

these hernias should be suspected when there is free fluid within the hernial sac, bowel wall thickening, or luminal dilatation (Fig. 3). If fatty tissue or fluid but no bowel is present in an incarcerated hernia, time is not a limiting factor in preparing the patient for surgery. In contrast, incarcerated bowel requires immediate surgery to prevent bowel necrosis and subsequent resection of the affected bowel loop (Rettenbacher et al. 2001).

2.2.2 Strangulation

"Strangulation" refers to ischemia caused by a compromised blood supply. It usually occurs when the hernia defect obstructs the afferent and efferent bowel loops, creating a closed loop within the herniated bowel. Multidetector row CT findings include closed loop obstruction and ischemia (Yu et al. 2004). Findings in closed loop obstruction include dilated, fluid-filled U-shaped or C-shaped loops of bowel entrapped

within the hernial sac and proximal obstruction. Ischemia findings include wall thickening, abnormal mural hypoattenuation or hyperattenuation and enhancement, mesenteric vessel engorgement, fat obliteration, mesenteric haziness, and ascites (Fig. 4). The afferent and efferent limbs may have a "serrated beak" appearance at the transition point. Strangulated abdominal wall hernias are associated with a high surgical fatality rate (6–23%) secondary to the strangulated viscus (Bendavid 1998). Normal mural enhancement does not exclude strangulation, whereas abnormal enhancement strongly suggests it.

2.2.3 Bowel Obstruction

After adhesions, abdominal wall hernias are the second leading cause of small bowel obstruction (10–15% of cases) (Macari and Megibow 2001). Colonic obstruction caused by abdominal wall hernia is uncommon. Most cases of bowel obstruction secondary to abdominal wall hernia occur after incarceration and strangulation. In these cases, bowel obstruction occurs with the transition point at the level of the hernia. Key CT findings include dilated bowel proximal to the hernia associated with normal-caliber, reduced-caliber, or collapsed bowel distal to the obstruction (Fig. 5). The degree of change in caliber helps predict the grade of obstruction. Other findings may include tapering of the afferent and efferent limbs at the hernia defect, dilatation of the herniated bowel loops, and fecalization of small bowel contents proximal to the obstruction (Furukawa et al. 2001).

2.3 Complications of Surgical Repair Procedures in Abdominal Wall Hernias

Several different surgical procedures are used to repair abdominal wall hernias, ranging from open or laparoscopic suture repair to the use of mesh. Two main types of mesh with different principal components are used: polypropylene mesh, which is not visible on CT because it is isoattenuating relative to surrounding tissues and expanded polytetrafluoroethylene mesh which is hyperattenuating relative to surrounding tissues.

Complications after surgical hernia repair may occur in up to 50% of cases. Half of them may require surgical reintervention and immediate accurate diagnosis with multidetector row CT. In addition to complications due to hernia recurrence or infection, some complications are mesh-specific. Inflammatory reactions may create fibrosis of surrounding tissues or intraperitoneal adhesions and can lead to small bowel obstruction (Bendavid 1998). Less frequently, meshes may detach from supporting tissues and migrate within the abdominal wall or within the peritoneum (Parra et al. 2004).

3 Hematoma

Abdominal wall hematomas may be associated with trauma, anticoagulation therapy (especially subcutaneous injection of heparin), and blood dyscrasia, or may occur spontaneously because of muscular strain. These commonly involve the anterior or anterolateral muscle groups and may dissect along fascial planes or involve the muscle itself. Acute hematomas are hyperdense because of clot formation, and attenuation values decrease with time as breakdown of blood products occurs (Fig. 6).

Hematomas of the rectus sheath developed above the level of the arcuate line are mostly contained within the rectus sheath and take a roughly oval form (Fig. 7). Hematomas below the level of the arcuate line in the lower third of the abdominal wall tend to break back through the fascia transversalis into the Retzius space (Fig. 8). This failure often results in large collection of blood, with fluid–fluid level, occupying much of the pelvis (Blum et al. 1995).

Although hematomas are typically treated nonsurgically, a residual mass may persist for several weeks. Malignant tumors of the abdominal wall are uncommon and are usually metastases (especially lung tumors and pancreatic tumors). Primary sarcomas may also develop and are sometimes found when bleeding occurs.They should be discussed when the patient is not receiving anticoagulation therapy, or when blood dyscrasia is found. High attenuation on unenhanced images, lack of enhancement, and resolution on follow-up studies help to confirm the diagnosis of simple hematoma (Moreno Gallego 1997).

In patients with blood pressure instability, a CT scan with injection of contrast material (without injection, arterial time, portal time, and late time) has to be carried out to identify the artery responsible for bleeding and allow the planning of a possible embolization (Fig. 9).

4 Abscess

Inflammatory disease of the abdominal wall commonly results from postsurgical wound infection or extension of an intra-abdominal abscess. Infected fluid collections may involve subcutaneous (superficial) or mesh-surrounding (deep) tissues. Differentiation is important because superficial infections are managed conservatively, whereas deep infections require intervention such as percutaneous drainage or prosthesis removal. When the usefulness of physical examination is limited, particularly in obese patients, CT is the method of choice to evaluate suspected abdominal wall infection. Imaging is used to confirm the presence and define the location and volume of collections, to guide aspiration, and to monitor treatment. At the beginning of the infection, CT can visualize diffuse edema with cellulitis. When a fluid collection is found, an abscess can be suspected in front of the following: fat stranding in surrounding tissues, an enhanced rim, thick septa, gas or gas–fluid level (the latter reported to be present in approximately 30% of abscesses), and the development of a new collection 1 week or more after surgical repair (Pandolfo et al. 1986). When imaging findings alone do not adequately help one to predict the nature of a fluid collection, imaging-guided aspiration is often necessary to establish the diagnosis (Figs. 10, 11, 12).

5 Unspecific Muscular Disease

Seldom unspecific muscular disease can cause acute pain (e.g., myositis or muscular tears when coughing) and has to be sought when no abdominal or retroperitoneal lesion explains the symptoms (Fig. 13).

6 Conclusions

A CT scan is especially crucial in acute abdominal wall diseases because it allows excellent anatomic delineation and vascular approach of the findings. In addition to visualizing the abdominal wall, it allows intra-abdominal exploration, which is essential for planning the optimal treatment.

References

Aguirre DA, Casola G, Sirlin C (2004) Abdominal wall hernias: MDCT findings. AJR Am J Roentgenol 183(3):681–690

Bendavid R (1998) Complications of groin hernia surgery. Surg Clin North Am 78(6):1089–1103

Bhosale PR et al (2008) The inguinal canal: anatomy and imaging features of common and uncommon masses. Radiographics 28(3):819–835; quiz 913

Blum A et al (1995) Imaging of severe forms of hematoma in the rectus abdominis under anticoagulants. J Radiol 76(5):267–273

Emby DJ, Aoun G (2003) CT technique for suspected anterior abdominal wall hernia. AJR Am J Roentgenol 181(2):431–433

Fisch AE, Brodey PA (1981) Computed tomography of the anterior abdominal wall: normal anatomy and pathology. J Comput Assist Tomogr 5(5):728–733

Furukawa A et al (2001) Helical CT in the diagnosis of small bowel obstruction. Radiographics 21(2):341–355

Ghahremani GG et al (1987) CT diagnosis of occult incisional hernias. AJR Am J Roentgenol 148(1):139–142

Harrison LA et al (1995) Abdominal wall hernias: review of herniography and correlation with cross-sectional imaging. Radiographics 15(2):315–332

Ianora AA et al (2000) Abdominal wall hernias: imaging with spiral CT. Eur Radiol 10(6):914–919

Macari M, Megibow A (2001) Imaging of suspected acute small bowel obstruction. Semin Roentgenol 36(2):108–117

Moreno Gallego A et al (1997) Ultrasonography and computed tomography reduces unnecessary surgery in abdominal rectus sheath haematoma. Br J Sep 84(9):1295–1297

Pandolfo I et al (1986) CT findings in palpable lesions of the anterior abdominal wall. J Comput Assist Tomogr 10(4):629–633

Parra JA et al (2004) Prosthetic mesh used for inguinal and ventral hernia repair: normal appearance and complications in ultrasound and CT. Br J Radiol 77(915):261–265

Rettenbacher T et al (2001) Abdominal wall hernias: cross-sectional imaging signs of incarceration determined with sonography. AJR Am J Roentgenol 177(5):1061–1066

Rutkow IM (2003) Demographic and socioeconomic aspects of hernia repair in the United States in 2003. Surg Clin North Am 83(5):1045–1051 v–vi

Salmons S (1995) Muscles of the abdomen. In: Gray's anatomy. Churchill Livingstone, New York, pp 819–829

Wechsler RJ et al (1989) Cross-sectional imaging of abdominal wall hernias. AJR Am J Roentgenol 153(3):517–521

Yu CY et al (2004) Strangulated transmesosigmoid hernia: CT diagnosis. Abdom Imaging 29(2):158–160