ELSEVIER

Canadian Association of Radiologists Journal 64 (2013) 148–153

CANADIAN ASSOCIATION OF RADIOLOGISTS JOURNAL

www.carjonline.org

Abdominal Imaging / Imagerie abdominale

Cross-Sectional Imaging of Nontraumatic Peritoneal and Mesenteric Emergencies

Michael N. Patlas, MD, FRCPC[a,*], Abdullah Alabousi, MD[a], Mariano Scaglione, MD[b], Luigia Romano, MD[c], Jorge A. Soto, MD[d]

[a]*Division of Emergency/Trauma Radiology, Department of Radiology, McMaster University, Hamilton, Ontario, Canada*
[b]*Department of Radiology, Pineta Grande Medical Center, Castel Volturno, Italy*
[c]*Department of Radiology, Cardarelli Hospital, Naples, Italy*
[d]*Department of Radiology, Boston Medical Center, Boston University School of Medicine, Boston, Massachusetts*

Abstract

Multiple nontraumatic peritoneal and mesenteric emergencies are encountered at imaging of patients in the emergency department. Peritoneal and mesenteric emergencies are usually detected in patients in the emergency department during evaluation of nonspecific abdominal pain. A high index of suspicion is required for the establishment of early diagnosis and aversion of life-threatening complications in cases of peritoneal carcinomatosis, nontraumatic hemoperitoneum, and peritonitis. A correct diagnosis of omental infarction, mesenteric adenitis, and mesenteric panniculitis helps patients primarily by avoiding unnecessary surgery. In this review article, we illustrate the cross-sectional imaging appearance of various nontraumatic peritoneal and mesenteric emergencies by emphasizing the role of the emergency radiologist in detecting and managing these entities.

Résumé

De nombreux cas d'urgence péritonéale et mésentérique non traumatiques surviennent en imagerie au service d'urgence. Les urgences péritonéales et mésentériques sont habituellement détectées au cours de l'évaluation de patients présentant des douleurs abdominales non spécifiques. Un fort indice de suspicion est nécessaire pour établir un diagnostic précoce et éviter les complications potentiellement mortelles dans les cas de carcinomatose péritonéale, d'hémopéritoine non traumatique et de péritonite. Un diagnostic exact d'infarctus épiploïque, d'adénite mésentérique et de panniculite mésentérique aide les patients principalement en permettant d'éviter toute chirurgie superflue. Le présent article de synthèse illustre les aspects d'imagerie transversale de diverses urgences péritonéales et mésentériques non traumatiques en soulignant le rôle du radiologiste d'urgence en ce qui a trait à la détection et à la prise en charge de ces entités cliniques.

Key Words: Nontraumatic emergencies; Peritoneum; Mesentery; Multidetector computed tomography

The peritoneum is the most extensive serous membrane in the human body. It envelops the peritoneal cavity, forms the mesenteries and omenta, and completely or partially covers the abdominal and pelvic organs. The peritoneal cavity is the potential space between the layers of visceral and parietal peritoneum. The parietal peritoneum lines the abdominal wall, the undersurface of the diaphragm, retroperitoneum, and pelvis. The visceral peritoneum surrounds the intra-abdominal viscera and forms the mesenteries and omenta. The mesenteries are double folds of the peritoneum that divide the peritoneal cavity into multiple interconnected spaces [1].

Nontraumatic peritoneal and mesenteric emergencies are uncommon entities. Peritoneal and mesenteric conditions have a wide range of clinical presentations, from nonspecific abdominal pain to hypovolemic shock. The vague symptoms at presentation and the absence of specific laboratory tests limit the ability to make prompt clinical diagnoses. Delayed detection of spontaneous hemoperitoneum, peritonitis, or peritoneal carcinomatosis leads to devastating consequences. Other peritoneal and mesenteric entities encountered in the emergency department (omental infarction, mesenteric adenitis, and mesenteric panniculitis) are important mimics of surgical abdominal conditions. Traditionally, peritoneal

* Address for correspondence: Michael N. Patlas, MD, Department of Radiology, Hamilton General Hospital, 237 Barton St E, Hamilton, Ontario L8L 2X2, Canada.

E-mail address: patlas@hhsc.ca (M. N. Patlas).

0846-5371/$ - see front matter
http://dx.doi.org/10.1016/j.carj.2013.02.001

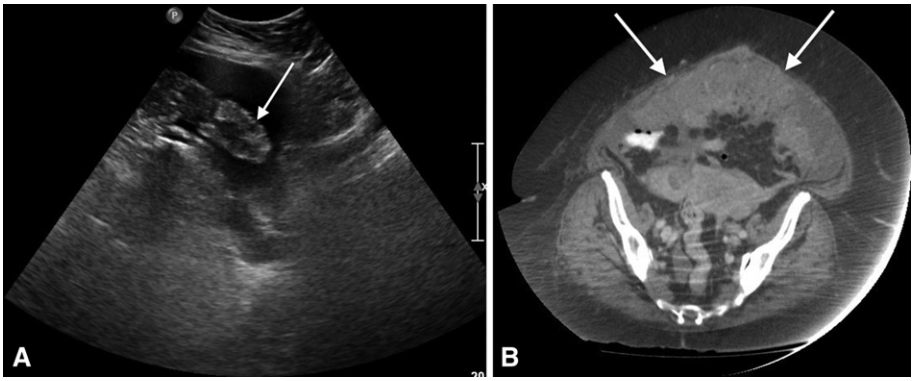

Figure 1. (A) Longitudinal sonogram, showing omental cake (arrow) in a patient with ascites; the finding was overlooked during the initial interpretation. (B) Axial contrast-enhanced computed tomography, demonstrating extensive omental involvement (arrows) in the same patient.

and mesenteric emergencies had been diagnosed on laparotomy. Judicious use of cross-sectional imaging of patients in the emergency department establishes accurate early diagnoses and helps avoid life-threatening complications and unnecessary surgery. The radiologist plays a pivotal role in the decision-making process and management of these conditions. This article provides an overview of the key cross-sectional imaging findings seen in patients with nontraumatic peritoneal and mesenteric emergencies.

Acute Presentations of Peritoneal Carcinomatosis

The evaluation of patients with unexplained abdominal distension or pain should raise the suspicion of peritoneal carcinomatosis. Patients may present with abdominal enlargement due to rapid accumulation of ascites and with acute pain and vomiting related to bowel obstruction. Peritoneal carcinomatosis is diagnosed synchronously with the primary tumour in 55% of nongynaecological malignancies [2]. Gastrointestinal carcinomas (stomach, colon, appendix, gallbladder, and pancreas), ovarian, uterine, breast, and lung cancer may metastasize to the peritoneum [1]. Often, the emergency department radiologist is the first physician to raise suspicion of carcinomatosis in a patient without a prior diagnosis of malignancy. Meticulous attention to detail is required when an abdominal sonogram (often the first imaging test requested) is obtained and interpreted. An inexperienced reader properly checks abdominal solid and hollow organs, and notes ascites but tends to overlook peritoneal deposits (including omental caking) when a sonogram is evaluated (Figure 1). Every case of unexplained ascites should motivate imagers to exclude carcinomatosis. The presence of particulate material within the ascitic fluid or loculations of the ascites are suspicious findings [1]. The normal omentum is generally difficult to visualize on sonography (US). However, the thickened nodular omentum can be more readily appreciated in the presence of ascites. Radiologists have to consider sites of stasis of peritoneal fluid and to assess the pouch of Douglas, diaphragmatic surfaces, and paracolic gutters. These same areas, as well as the ileocecal region, and the root of the small bowel mesentery should be scrutinized on multidetector computed tomography (MDCT). The advantage of MDCT is the ability to detect peritoneal deposits in patients without or with minimal ascites (Figure 2). Patients could present with flank pain and initially be imaged by nonenhanced MDCT to exclude ureteric stone. Any suspicious areas on unenhanced MDCT should be reassessed after administration of intravenous contrast. An additional clinical scenario often found in patients with peritoneal carcinomatosis is unexplained bowel obstruction, especially due to prior unknown colorectal cancer [1]. The role of the radiologist is not only to make the diagnosis and delineate the level of obstruction but also to detect peritoneal metastatic deposits.

Nontraumatic Hemoperitoneum

Nontraumatic hemoperitoneum could be spontaneous or caused by iatrogenic intervention. Spontaneous hemoperitoneum is uncommon. Patients may present with severe abdominal pain or distension, decreased hematocrit level, or hypovolemic shock [3]. Possible causes include bleeding from a vascular tumour (hepatocellular carcinoma, hepatic

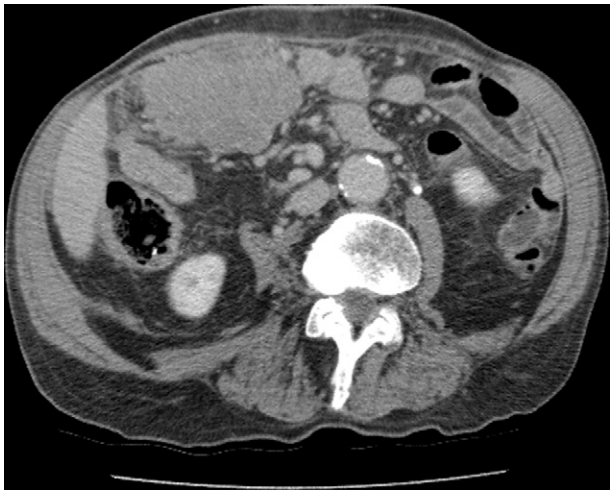

Figure 2. Axial contrast-enhanced computed tomography image in a patient who presented to the emergency department with abdominal pain, demonstrating a large omental mass at the right upper quadrant.

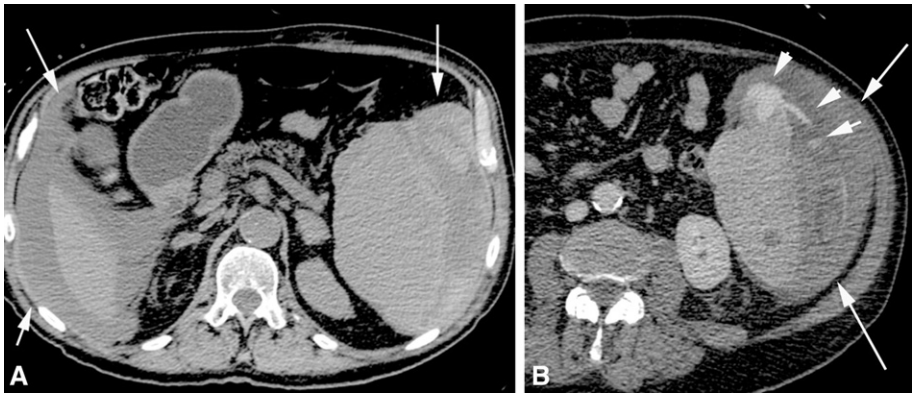

Figure 3. (A) Unenhanced axial computed tomography (CT), demonstrating spontaneous splenic rupture complicated by hemoperitoneum (arrows). (B) Axial contrast-enhanced CT obtained in the portal venous phase, showing active extravasation of intravascular contrast from the spleen (short arrows) and hemoperitoneum (long arrows).

adenoma), atraumatic splenic rupture, leaking arterial aneurysm, or ectopic pregnancy [4]. Surgery, invasive procedures, or anticoagulation therapy may also be the cause of significant hemoperitoneum. MDCT is the modality of choice for assessment of patients with suspicion of hemoperitoneum due to its speed and ability to assess all peritoneal spaces, regardless of body habitus. Similar to traumatic causes, it is critical to identify the source of active bleeding [3]. Evidence for active bleeding should lead to immediate clinical assessment with a prompt decision regarding endovascular or surgical intervention. If active bleeding is excluded, then a meticulous search should be initiated for a possible source of bleeding. Hepatic or splenic hemorrhage usually extends in a caudal direction and accumulates in the pouch of Douglas. The volume of blood that accumulates in the pelvis is a good indicator of the severity of the bleeding.

A meticulous examination of the viscera should include evaluation of the liver to exclude bleeding from a ruptured vascular hepatic tumour as well as of the spleen to rule out a spontaneous splenic rupture. Atraumatic splenic ruptures are rare and typically occur in patients with significant splenomegaly [5]. The most common etiologies are hematologic malignancies and infections, such as malaria and infectious mononucleosis. MDCT shows an abnormal spleen with perisplenic (''sentinel'') clot and free intraperitoneal fluid (Figure 3).

Rupture of a splenic artery aneurysm or pseudoaneurysm is an uncommon but life-threatening condition. The majority of the aneurysms are small (2-3 cm) and are detected incidentally on abdominal cross-sectional imaging. The risk of rupture is estimated at 2%–3% [6,7]. Pseudoaneurysms are usually larger than true aneurysms of the splenic artery and almost always present with symptoms. The mean size is 4.8 cm [8] and the risk of rupture is 37%. Catheter angiography and endovascular interventions are preferred means for treatment of a previously diagnosed aneurysm. However, the procedure requires an arterial puncture with its related complications and may be time consuming. Splenic artery aneurysms can also be detected on US. The limitations of US for the visualization of small aneurysms include obesity, a large amount of intra-abdominal gas, limited spatial resolution, and operator dependence [9]. Contrast-enhanced MDCT and computed tomography (CT) angiography are the optimal imaging tests for complete assessment of patients with spontaneous hemoperitoneum and suspected aneurysm or pseudoaneurysm. CT angiography is also optimal for the characterization of an aneurysm incidentally detected on imaging performed for unrelated reason. Vascular abnormalities are generally easier to identify on the arterial phase of a CT angiogram (Figure 4). Nevertheless, imagers have to consider splenic aneurysm in the differential diagnosis of a patient with spontaneous hemoperitoneum of unknown origin and meticulously scrutinize the left upper quadrant on scans obtained at the portal venous phase or without intravenous contrast. Patients who present with shock should be concurrently resuscitated and scanned while in the CT procedure room. Ideally, endovascular intervention would be performed in the same room or in an adjacent angiography suite.

Figure 4. Arterial phase of axial computed tomography, showing ruptured splenic pseudoaneurysm.

A large leaking abdominal aortic aneurysm can also cause intraperitoneal bleeding. Moreover, in the case of suspicion for bleeding related to the female reproductive organs, additional evaluation by US is advised. Gynaecological conditions (ruptured ovarian cyst or ruptured ectopic pregnancy) are the most common source of spontaneous hemoperitoneum in women of childbearing age.

Peritonitis and Peritoneal Abscess

Peritonitis can be caused by a variety of infectious and noninfectious processes. Infectious peritonitis usually occurs in patients with a history of recent abdominal surgery, bowel perforation, appendicitis, diverticulitis, Crohn disease, or perforation of a peptic ulcer. Furthermore, primary bacterial peritonitis can be encountered in patients with cirrhosis or nephrotic syndrome. Noninfectious peritonitis includes chemical peritonitis in patients with pancreatitis due to irritation of the peritoneal surface by pancreatic juices as well as sclerosing peritonitis in individuals undergoing continuous ambulatory peritoneal dialysis.

Peritonitis appears on MDCT (Figure 5) and magnetic resonance imaging as diffusely thickened and enhancing peritoneum and mesentery [10]. The peritoneal contour will remain smooth in the majority of cases, in contrast to the nodular appearance typical of peritoneal carcinomatosis. US will show loculated ascites and debris within the ascitic fluid [11]. Peritonitis can be complicated by intra-abdominal abscess formation. MDCT has the ability to detect abscesses and demonstrate their complications, which include small and large bowel obstruction as well as ureteric involvement with development of hydronephrosis. MDCT depicts the internal architecture of infected collections and the presence of septa, and guides appropriate triaging of patients with collections amenable for percutaneous drainage under CT guidance. MDCT also shows findings of perihepatitis, which is defined as inflammation of the peritoneal capsule of the liver. Perihepatitis was originally described in association with pelvic inflammatory disease (Fitz-Hugh–Curtis syndrome). Of note, changes of perihepatitis are better appreciated on the arterial phase of multiphase MDCT [12]. Detection of abscesses and their complications on the same examination improves the workflow in busy emergency departments and imaging departments, and expedites definitive treatment.

Figure 5. Coronal reformation of contrast-enhanced computed tomography image, demonstrating thickened and enhancing peritoneum (arrow) in a patient with peritonitis.

Limitations of US for the diagnosis of intra-abdominal infected fluid collections include difficult US differentiation between a gas-containing abscess and a gas-filled bowel loop [13]. In addition, US can be a challenging examination in patients who are obese or after surgery and who cannot tolerate compression. However, US has an important role in the bedside assessment of patients in the intensive care unit who are critically ill with suspected abscess, for guidance of drainage procedures, and for follow-up of patients with a previously diagnosed abscess.

Omental Infarction

Patients with acute right upper or lower quadrant pain are often referred to imaging for the exclusion of cholecystitis, appendicitis, or diverticulitis. One important mimicker of these conditions is omental infarction. This entity cannot be reliably diagnosed based on clinical evaluation alone. Imaging plays a crucial role in diagnosis and avoidance of unnecessary antimicrobial therapy and laparotomy. An omental infarction is a rare entity due to the rich blood supply of the omentum. However, the right lateral edge of the omentum has a tenuous blood supply; therefore, the right inferior omentum is more prone to ischemia and infarction (Figure 6) [14]. The left-sided omental infarctions are uncommon (Figure 7). Of note, secondary omental infarctions can occur after trauma, surgery, or inflammation of the omentum. These secondary infarctions are generally located adjacent to the surgical site. Omental infarctions can also occur as a complication of an incarcerated hernia.

Regardless of the etiology, MDCT will show a large encapsulated fatty mass located anterior to the ascending or transverse colon (Figure 6). The mass typically measures more than 5 cm and lacks the central dot typically seen in epiploic appendagitis [15]. Nondiscrete haziness of the omental fat can be an early sign or an incomplete or partial infarction (Figure 7A). Swirling of vessels is observed in cases of omental torsion. Colonic thickening is uncommon but can develop secondary to omental inflammation. Omental infarctions with secondary colonic thickening may be difficult to differentiate from diverticulitis. Follow-up imaging by MDCT or US is required in these cases to demonstrate the dominant extracolonic fatty mass. Moreover,

Figure 6. Sagittal reformation of contrast-enhanced axial computed tomography, showing a large mixed fatty and soft tissue attenuation mass (arrows, arrowheads) located anterior to ascending colon in keeping with omental infarction.

an omental infarction can occasionally become infected with development of an abscess.

US in patients with an omental infarction depicts an echogenic noncompressible mass. The location of the mass corresponds to the point of maximal tenderness on physical examination. Immobility of the lesion is a useful feature for US characterization. Normal intra-abdominal contents move with respiration. The inflammatory omental mass is adherent to the parietal peritoneum and remains fixed during dynamic scanning [13].

Mesenteric Adenitis

Mesenteric adenitis deserves serious consideration in the differential diagnosis of right lower quadrant (RLQ) pain in patients in the emergency department. Visualization of a normal appendix in patients with RLQ pain generally results in a conclusion of ''no explanation for the abdominal pain.'' However, mesenteric adenitis represents an important yet uncommon entity mimicking acute appendicitis in both pediatric and adult populations. A timely imaging diagnosis of mesenteric adenitis in cases of RLQ pain will allow patients to avoid unnecessary surgery. The exquisite spatial resolution of MDCT facilitates a confident diagnosis (Figure 8). Macari et al [16] defined mesenteric adenitis as the presence of 3 or more RLQ mesenteric lymph nodes, each measuring 5 mm or more. The diagnosis is made when mesenteric adenopathy is demonstrated in patients with RLQ pain, fever, and malaise. Mesenteric adenitis is divided into primary and secondary types. In cases of primary mesenteric adenitis, an underlying inflammatory process is not evident on imaging. Infectious terminal ileitis is considered to be the most common cause of primary adenitis. When cross-sectional imaging demonstrates mild thickening of the terminal ileum and mesenteric adenitis in a patient with acute RLQ pain, infection with *Yersinia enterocolitica* should be considered [17]. Secondary adenitis is associated with specific inflammatory abdominal conditions (Crohn disease, appendicitis, celiac disease).

Mesenteric Panniculitis

Mesenteric panniculitis is a nonspecific inflammation and fibrosis of the fatty tissue of the bowel mesentery. Panniculitis may be discovered incidentally during evaluation of abdominal MDCT performed for an unrelated indication. However, some patients present with abdominal pain, fever, and vomiting related to inflammation and/or mass effect. The diagnosis requires exclusion of inflammatory bowel disease, pancreatitis, and extra-abdominal fat necrosis [17]. The imaging spectrum varies from a well-defined fatty mass to ill-defined areas of high attenuation within the mesenteric fat. There is predominant involvement of the jejunal mesentery as confirmed by macroscopic studies. Therefore, left-sided orientation of the fatty mesenteric mass is the characteristic finding on imaging. The lesion envelops the superior mesenteric vessels and displaces adjacent bowel

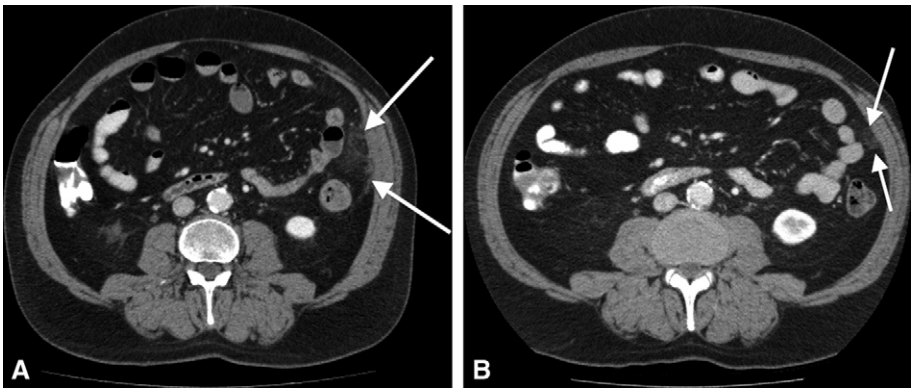

Figure 7. (A) Axial contrast-enhanced computed tomography (CT) image, depicting fatty mass (arrows) at the left mid abdomen, representing omental infarction. (B) Follow-up CT performed 1 month later, showing marked improvement of infarction (arrows).

Figure 8. Axial contrast-enhanced computed tomography image, demonstrating multiple enlarged mesenteric lymph nodes at the right lower quadrant (arrows) in a patient with mesenteric adenitis.

loops. The mass is surrounded by a high-attenuation thin pseudocapsule (Figure 9).

There are multiple small (usually less than 5 mm in diameter) mesenteric lymph nodes within the mass. The ''fat halo'' sign appears as low-density fat surrounding vessels and nodes, and represents preservation of normal fat-density contrasting with the high density of inflamed fat. Originally, it was reported that the ''fat halo'' sign helps differentiate mesenteric panniculitis from malignant conditions that involve the mesentery. However, more recent articles demonstrated the presence of this sign in patients with lymphoma [18]. Areas of fibrosis within the inflammatory mass manifest as linear bands of soft-tissue attenuation. Occasionally, fibrotic lesions have a spiculated appearance that mimics a neoplastic process [15]. Patients with mesenteric panniculitis diagnosed on MDCT obtained in an emergency setting require clinical and imaging follow-up due to uncommon progression to retractile mesenteritis that causes small bowel obstruction and vascular narrowing.

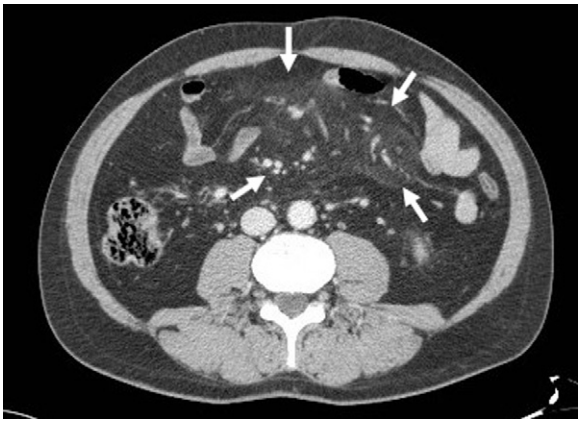

Figure 9. Axial contrast-enhanced computed tomography image obtained at the portal venous phase, depicting fatty mesenteric mass surrounded by a thin pseudocapsule (arrows).

Summary

There are numerous nontraumatic peritoneal and mesenteric emergencies. MDCT is the modality of choice for the evaluation of patients in the emergency department with these often life-threatening entities due to its speed and ability to assess all peritoneal compartments. The crucial initial steps for the radiologist are to consider these uncommon conditions in the differential diagnosis, use the various CT signs to detect intraperitoneal blood and/or pus, scrutinize the peritoneal surfaces and mesentery, and determine whether emergent intervention is indicated. After these steps are completed, nonsurgical emergencies should be confidently diagnosed and unnecessary surgery avoided.

References

[1] Levy AD, Shaw LC, Sobin LH. Secondary tumors and tumorlike lesions of the peritoneal cavity: imaging features with pathologic correlation. Radiographics 2009;29:347–73.
[2] Chu DZ, Lang NP, Thompson C, et al. Peritoneal carcinomatosis in nongynecologic malignancy: a prospective study of prognostic factors. Cancer 1989;63:364–7.
[3] Lubner M, Menias C, Rucker C, et al. Blood in the belly: CT findings of hemoperitoneum. Radiographics 2007;27:109–25.
[4] Casillas VJ, Amendola MA, Gascue A, et al. Imaging of nontraumatic hemorrhagic hepatic lesions. Radiographics 2000;20:367–78.
[5] Furlan A, Fakhran S, Federle MP. Spontaneous abdominal hemorrhage: causes, CT findings, and clinical implications. AJR Am J Roentgenol 2009;193:1077–87.
[6] Madoff DC, Denys A, Wallace MJ, et al. Splenic arterial interventions: anatomy, indications, technical considerations, and potential complications. Radiographics 2005;25(suppl 1):S191–211.
[7] Nosher JL, Chung J, Brevetti LS, et al. Visceral and renal artery aneurysms: a pictorial essay on endovascular therapy. Radiographics 2006;26:1687–704.
[8] Tessier DJ, Stone WM, Fowl RJ, et al. Clinical features and management of splenic artery pseudoaneurysm: case series and cumulative review of literature. J Vasc Surg 2003;38:969–74.
[9] Agrawal GA, Johnson PT, Fishman EK. Splenic artery aneurysms and pseudoaneurysms: clinical distinctions and CT appearances. AJR Am J Roentgenol 2007;188:992–9.
[10] Elsayes KM, Staveteig PT, Narra VR, et al. MRI of the peritoneum: spectrum of abnormalities. AJR Am J Roentgenol 2006;186:1368–79.
[11] Edell SL, Gefter WB. Ultrasonic differentiation of types of ascitic fluid. AJR Am J Roentgenol 1979;133:111–4.
[12] Kim S, Kim TU, Lee JW, et al. The perihepatic space: comprehensive anatomy and CT features of pathologic conditions. Radiographics 2007;27:129–43.
[13] Hanbidge AE, Lynch D, Wilson SR. US of the peritoneum. Radiographics 2003;23:663–84.
[14] Kamaya A, Federle MP, Desser TS. Imaging manifestations of abdominal fat necrosis and its mimics. Radiographics 2011;31:2021–34.
[15] Singh AK, Gervais DA, Hahn PF, et al. Acute epiploic appendagitis and its mimics. Radiographics 2005;25:1521–34.
[16] Macari M, Hines J, Balthazar E, et al. Mesenteric adenitis: CT diagnosis of primary versus secondary causes, incidence, and clinical significance in pediatric and adult patients. AJR Am J Roentgenol 2002;178:853–8.
[17] Lucey BC, Stuhlfaut JW, Soto JA. Mesenteric lymph nodes seen at imaging: causes and significance. Radiographics 2005;25:351–65.
[18] Pereira JM, Sirlin CB, Pinto PS, et al. CT and MR imaging of extrahepatic fatty masses of the abdomen and pelvis: techniques, diagnosis, differential diagnosis, and pitfalls. Radiographics 2005;25:69–85.