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REVIEW

A review of anatomy, pathology, and disease spread in the perisplenic region

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Abstract

The perisplenic region is a complex anatomical area involving multiple peritoneal and subperitoneal structures, which influence the presentation and behavior of various pathologic processes. This review is a comprehensive resource for perisplenic anatomy and pathology with associated clinical presentations and imaging findings. Understanding the pathophysiologic intricacies of the perisplenic region assists the radiologist in building a helpful differential diagnosis and recognizing predictable disease patterns.

Keywords Anatomy · Radiology–pathology correlation · Perisplenic region · Peritoneal disease

Introduction

This review of perisplenic anatomy and pathology provides the radiologist a roadmap for navigating this intricately complex and oft-overlooked anatomical region. Knowledge of the peritoneal spaces, recesses, and ligaments is helpful in recognizing various perisplenic pathologies and routes of disease spread. Both primary and secondary perisplenic disease processes demonstrate distinct, and often predictable, characteristics related to neighboring peritoneal structures.

Relevant anatomy

This section highlights key anatomical components in the perisplenic region, including the spleen, peritoneal spaces, and subperitoneal ligaments. An understanding of these

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structural relationships provides a foundation for locating various perisplenic pathologies.

The spleen

The spleen is a predominantly subperitoneal organ located in the left hypochondrium. Its anatomic borders include the phrenicocolic ligament inferiorly, the diaphragm superiorly and posterolaterally, the stomach medially and anterolaterally, and the left kidney posteromedially [1]. A layer of visceral peritoneum covers the spleen's fibrous capsule with the exception of the splenic hilum, thus making the hilum a retroperitoneal structure. This anatomic distinction explains the possibility of both intra- and retroperitoneal splenic hematomas [2]. The hilum serves as an insertion point for the splenic artery and vein, lymphatics and nerves. It is also an attachment site for the gastrosplenic and splenorenal ligaments and often directly contacts the pancreatic tail. This anatomic relationship facilitates disease spread between the spleen and pancreas.

Peritoneal spaces of the perisplenic region

The perisplenic region primarily involves the left supramesocolic space and the left paracolic space (gutter), both located in the greater peritoneal sac. The left supramesocolic space is divided into the left subphrenic space, which is further separated into recesses. The left subphrenic space includes the gastrosplenic (between the spleen and stomach), splenorenal (between the left kidney and the spleen), and perisplenic (between the spleen and the diaphragm) recesses (Fig. 1). The inferior aspect of the perisplenic recess is sometimes called the splenocolic recess. A fourth recess, the splenic recess, is located in the lesser sac and is separated from the greater sac by the splenorenal and gastrosplenic ligaments.

Ligaments of the perisplenic region

Abdominopelvic ligaments are double-layered peritoneal folds located in the subperitoneal space (the space deep to the peritoneal cavity) [3, 4]. Ligaments provide structural support for subperitoneal organs by anchoring them to the abdominal wall. Ligaments also act as boundaries for

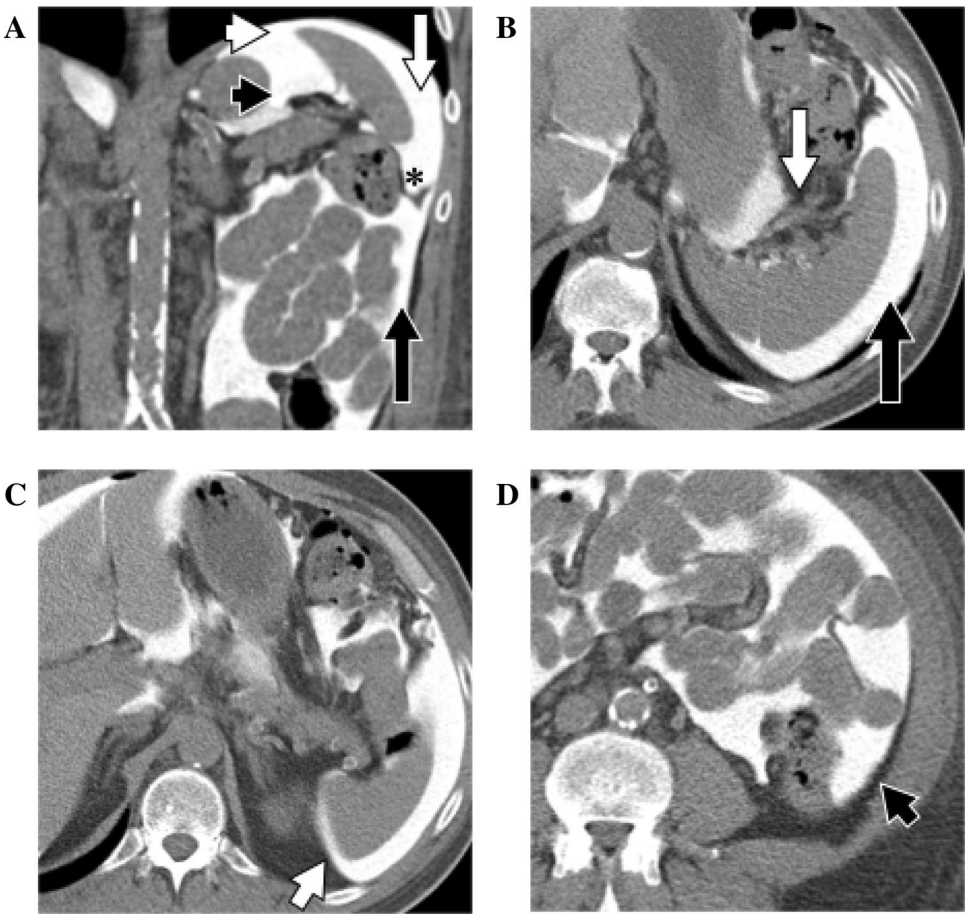

Fig. 1 Anatomy of the perisplenic region in a CT peritoneography case example. **a–d** Coronal (**a**) and axial (**b**–**d**) CT peritoneography images detail perisplenic peritoneal anatomy and the splenic hilum. **a** Left subphrenic space (short white arrow), gastrosplenic recess (short black arrow), perisplenic recess (long white arrow), left paracolic space (long black arrow). Asterisk denotes the phrenicocolic ligament. **b** Perisplenic recess (black arrow). Splenic hilum with branching vessels (white arrow). **c** Splenorenal recess (white arrow). **d** Left paracolic space (black arrow)

Table 1 Principle perisplenic ligaments

Ligament name	Contents	Attachments	Anatomic relevance	Clinical significance
Gastrosplenic	Short gastric and gastroepiploic vessels	Greater curvature of the stomach to the splenic hilum	Partition between gastrosplenic recess of the greater sac and the splenic recess of the lesser sac	Laxity can result in splenic torsion
Splenorenal	Splenic artery and vein; pancreatic tail	Splenic hilum to anterior left kidney	Contiguous with gastrosplenic ligament at splenic hilum; forms left boundary of the lesser sac	Facilitates disease spread between pancreatic tail, stomach, and spleen; laxity can result in splenic torsion
Phrenicocolic	Does not contain vasculature	Splenic flexure of the colon to the diaphragm	Continuous with transverse mesocolon and splenorenal ligament	Deters disease spread between left subphrenic and left paracolic spaces

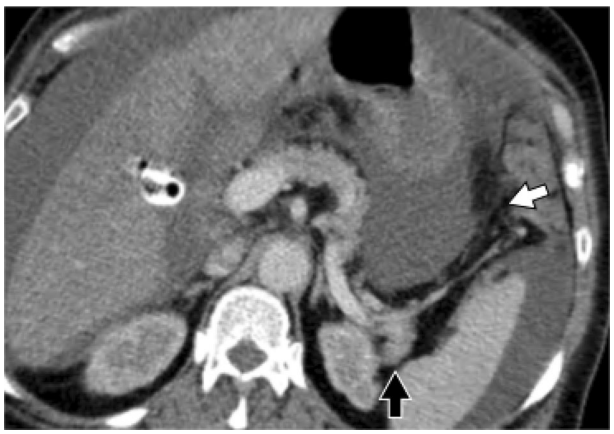

Fig. 2 A patient with portal hypertension. Axial contrast-enhanced CT image of the abdomen at the level of the kidneys showing the expected location of the gastrosplenic (white arrow) and splenorenal (black arrow) ligaments. Diffuse ascites throughout the left subphrenic space, left paracolic gutter, right subphrenic space, lesser sac is present. There is also a partially visualized transjugular intrahepatic portosystemic shunt

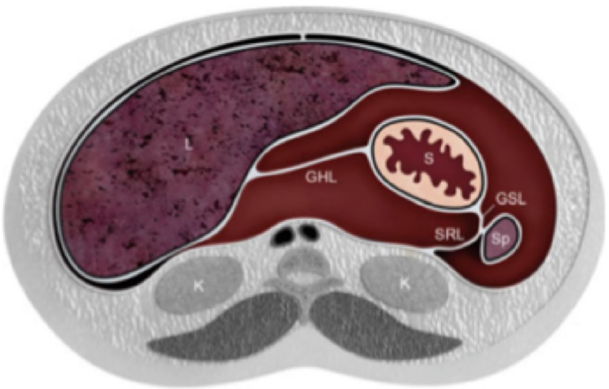

Fig. 3 Graphic illustration of some perisplenic ligaments, in addition to the gastrohepatic ligament (GHL). The gastrosplenic ligament (GSL) connects the greater curvature of the stomach to the spleen (Sp). The splenorenal ligament (SRL) joins the GSL at the splenic hilum and attaches the spleen to the left kidney (K)

peritoneal spaces and recesses. In addition, some ligaments contain vessels and lymphatics, which serve as intra-abdominal passageways for disease spread.

The perisplenic region contains up to eight ligaments: gastrosplenic, splenorenal, phrenicocolic, splenophrenic, splenocolic, pancreaticosplenic, pancreaticocolic, and the presplenic fold. Of these structures, the gastrosplenic, splenorenal, and phrenicocolic ligaments are considered the principal splenic ligaments (Table 1) [5–7]. The triangular-shaped gastrosplenic ligament extends from the greater curvature of the stomach to the splenic hilum and contains the short gastric and gastroepiploic vessels (Fig. 2). The gastrosplenic ligament serves as a partition between the gastrosplenic recess of the greater sac and the splenic recess of the lesser sac.

The splenorenal (or lienorenal) ligament extends from the splenic hilum to the anterior left kidney (Fig. 2). It contains the splenic artery and vein, as well as the pancreatic tail. The splenorenal ligament and the splenic hilum are retroperitoneal structures, as they are not covered in visceral peritoneum. At the level of the splenic hilum, the gastrosplenic and splenorenal ligaments are contiguous and form the left boundary of the lesser peritoneal sac (Fig. 3). Due to the close proximity of these ligaments, disease spread is possible between the pancreatic tail, stomach, and spleen [1].

The phrenicocolic ligament courses from the splenic flexure of the colon to the diaphragm. It provides structural support for the spleen and does not contain any vasculature. Although this ligament acts as a partial barricade between the left subphrenic and left paracolic spaces, disease spread between these areas is still possible due to incomplete blockade. The phrenicocolic ligament is continuous with the transverse mesocolon and splenorenal ligament, which facilitates disease spread from the pancreatic tail to the splenic flexure [1].

The remaining splenic ligaments are less constant and may be anatomically absent. The pancreatocolic ligament is a thin fibrous band that occasionally forms when the spleen does not directly contact the pancreatic tail. When present, the presplenic fold is anterior to the gastrosplenic ligament and may contain the left gastroepiploic vessels [5].

Pathology in the perisplenic region

Abnormalities in the perisplenic region may be secondary to congenital, inflammatory, infectious or neoplastic conditions. Infectious and malignant pathologies from adjacent organs, like the pancreas and kidney, may also involve the perisplenic region. It is worth mentioning that many splenic and perisplenic findings are discovered incidentally during everyday radiology practice. In the absence of an extra-splenic malignancy, these incidental findings are often benign and do not require additional diagnostic imaging. In order to effectively decipher and report on clinically significant perisplenic findings, the radiologist must be aware of common and uncommon pathologies in this anatomic region.

Perisplenic congenital abnormalities

Congenital abnormalities in the perisplenic region predominantly involve the spleen. Accessory spleens, or splenules, are ectopic foci of splenic tissue that fail to fuse with the spleen during embryological development. In a study of 1,000 consecutive CT examinations by Mortelé et al. [8], single splenules were seen in 15.6% of patients. Splenules are most often located in the splenic hilum, followed by the greater omentum and the pancreatic tail [9]. While accessory spleens are typically incidental lesions, they do need to be reported in certain conditions, such as in immune thrombocytopenic purpura, as failure to remove the accessory splenules at the time of splenectomy may result in recurrence of the condition. Rarely, accessory splenules may undergo complications such as torsion or infarction [10, 11]. On contrast-enhanced CT, a torsed accessory spleen appears as a non-enhancing, well-circumscribed soft tissue mass with surrounding hemorrhage or edema from venous congestion due to torsion at the vascular pedicle. A focus of swirling vessels leading to the accessory spleen identifies the torsed pedicle. A torsed accessory spleen may demonstrate increased capsular enhancement, as the splenic capsular arteries are often patent during torsion [12].

Occasionally, splenules are misdiagnosed as adenopathy or peritoneal implants. However, splenules tend to be well defined and demonstrate similar attenuation and enhancement characteristics of a normal spleen. On non-contrast CT imaging, splenules are slightly hypoattenuating compared to the liver. On contrast-enhanced CT, splenules demonstrate striated enhancement on arterial phase and homogenous enhancement on venous and delayed phases. On MRI, splenules follow the same appearance of a normal spleen on all phases, including diffusion-weighted (DW) imaging. Jang et al. verified that intrapancreatic accessory spleens (IPAS) have similar signal intensity to the spleen on DW images and ADC maps, which distinguishes IPAS from solid pancreatic tumors less than 3 cm (Fig. 4) [13].

When a splenule is not confidently characterized with CT or MR imaging, nuclear medicine studies are utilized. After the administration of Technetium-99m sulfur colloid or Technetium-99m heat-damaged red blood cells, splenules demonstrate focal radiotracer uptake.

A wandering spleen occurs when the spleen is not securely anchored to the left upper quadrant and freely travels within abdomen. This phenomenon is typically due to increased splenic ligament laxity, particularly involving the gastrosplenic and splenorenal ligaments. The most concerning sequela of a wandering spleen is splenic torsion (Fig. 5), which requires treatment with an emergent splenectomy [14]. On contrast-enhanced CT, a torsed wandering spleen is enlarged and poorly enhancing, often abnormally located in the lower abdomen or pelvis. Swirling non-enhancing splenic vessels, known as the "whirl sign," are often identified near the splenic hilum and are a very specific sign of splenic torsion.

Other congenital pathologies encountered in the perisplenic region include polysplenia and splenosis. Polysplenia will typically present with additional congenital abnormalities in the lungs, liver, or stomach. Splenosis is an acquired condition in which ectopic splenic tissue autotransplants within the abdomen, pelvis, or thorax. Patients with splenosis have a history of traumatic splenic injury or splenectomy. After splenic rupture or splenectomy, residual foci of splenic tissue seed other body compartments. Unlike accessory spleens, which are fed by splenic artery branches, ectopic splenic foci recruit local blood supply from nearby tissues. Soft tissue nodular densities seen in splenosis are sometimes mistaken for a primary malignancy or metastatic disease. If a patient's clinical history is equivocal or unavailable, nuclear scintigraphy with technetium-99m tagged to heat-damaged red blood cells shows increased tracer uptake in ectopic splenic tissue [15].

Perisplenic vascular lesions

Acquired or congenital vascular lesions in the perisplenic region predominantly involve the splenic artery and vein.

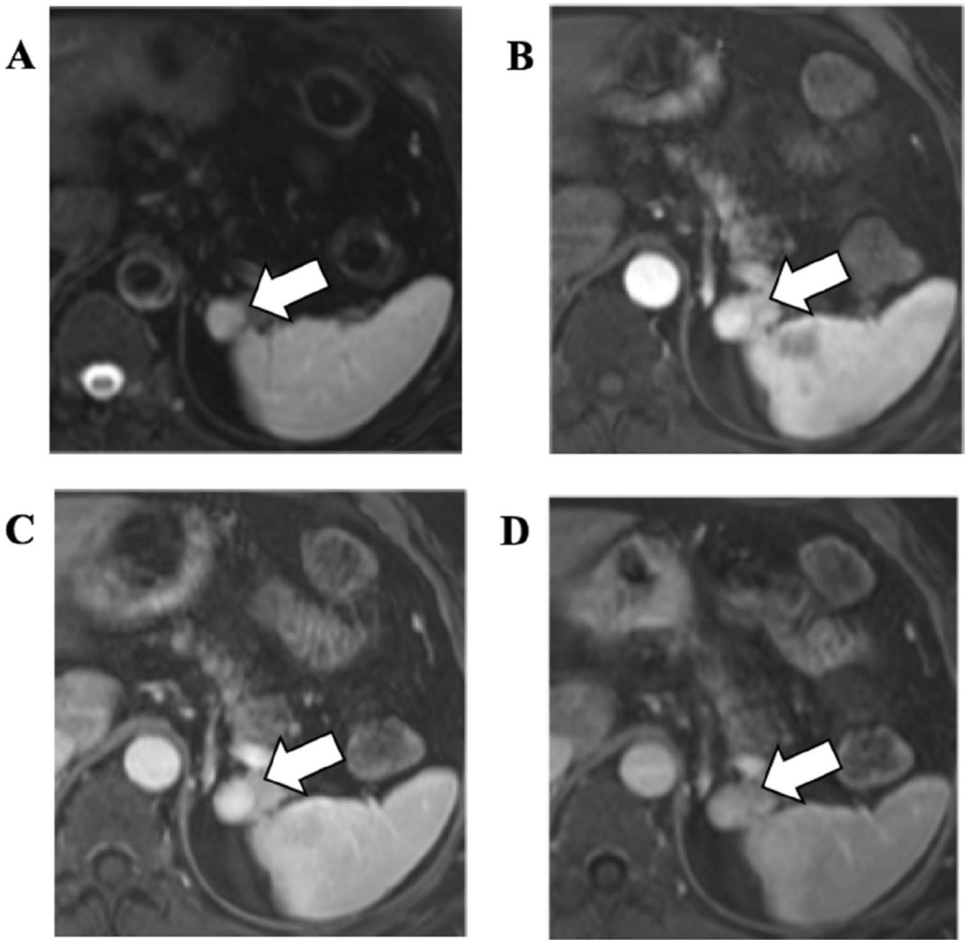

Fig. 4 A case of an accessory spleen within the pancreatic tail. **a** Axial T2-weighted fat sat MR image shows a hyperintense structure (arrow) in the pancreatic tail similar to splenic signal. **b–d** Axial post-contrast MR images in arterial (**b**), venous (**c**) and delayed (**d**) phases show the lesion (arrows) following splenic enhancing patterns, suggestive of an accessory spleen

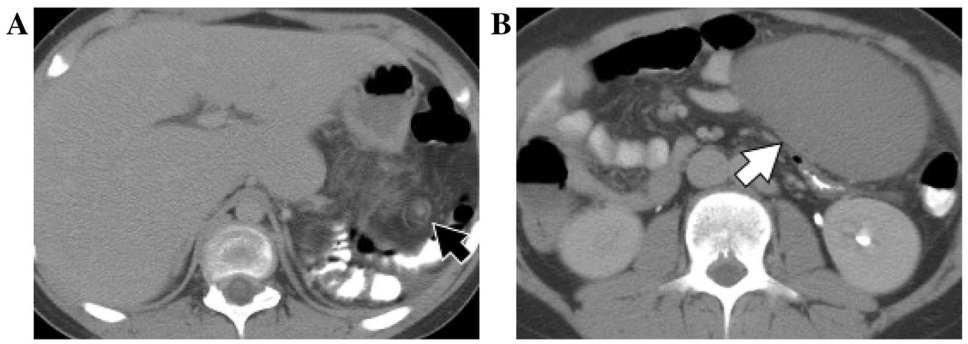

Fig. 5 A case of a torsed wandering spleen. **a, b** Sequential axial contrast-enhanced CT images show a "whirl" or "swirl sign" (**a**, black arrow) representing tortuous splenic vessels at the expected location of the spleen. Inferiorly, an abnormally located spleen poorly enhances (**b**, white arrow) due to ischemic changes from torsion

Splenic artery aneurysms result from abnormal dilation of the splenic artery (usually greater than 1 cm) and are related to various etiologies, including portal hypertension, collagen vascular disease, liver transplantation, and pregnancy [16]. The splenic artery is the most common location for splanchnic arterial aneurysms with an estimated prevalence between 0.1 and 10% [17–20]. The vast majority of splenic artery aneurysms are asymptomatic until ruptured, which occurs spontaneously in 2–10% of cases [21–23]. A patient with a ruptured aneurysm often presents with abdominal pain and gastrointestinal bleeding [24]. Typical pre-contrast and arterial-phase CT findings include ring-like calcifications and a homogenously enhancing mass near the splenic artery, respectively. Treatment of splenic artery aneurysms measuring less than 2 cm is often deferred due to the low likelihood of spontaneous rupture [25]. For aneurysms greater than 2 cm or symptomatic lesions, endovascular therapy is considered. Digital subtraction angiography aids in precise aneurysm characterization prior to treatment.

Splenic artery pseudoaneurysms (Fig. 6) are significantly rarer than true aneurysms with less than 200 cases reported in the literature [24]. Common etiologies include infection,

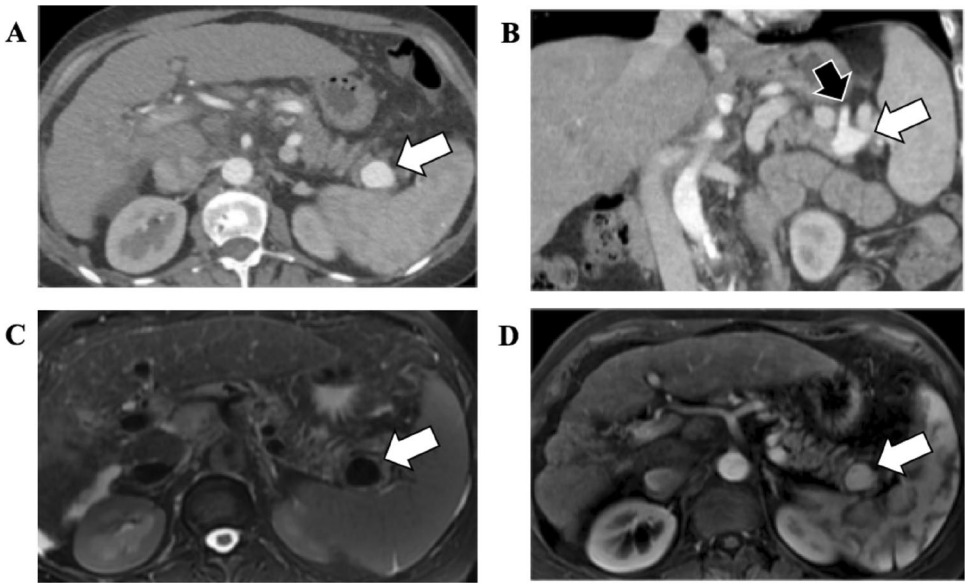

Fig. 6 Perisplenic vascular lesions. **a, b** Axial (**a**) and coronal (**b**) contrast-enhanced CT images during arterial phase show a splenic artery pseudoaneurysm (white arrow) as an enhancing saccular structure within the pancreatic tail that communicates with the splenic artery (black arrow). **c, d** Axial T2-weighted and arterial-phase post-contrast MR images show an ovoid flow void in the pancreatic tail (white arrow) on T2-weighted image, which avidly enhances in arterial phase (white arrow) consistent with splenic artery pseudoaneurysm

trauma, and inflammation, specifically pancreatitis. Unlike true splenic artery aneurysms, pseudoaneurysms involve focal dilation of the media and intima only. Because pseudoaneurysmal walls are thinner, they are more prone to rupture. If untreated, the mortality rate for a ruptured pseudoaneurysm can be greater than 90% [26]. A key distinguishing feature between splenic artery aneurysms and pseudoaneurysms is symptomatology, as the latter almost always present with abdominal pain, hematochezia, melena, or hematemesis. On CT, pseudoaneurysms are enhancing foci adjacent to the splenic artery or within the splenic parenchyma. They can resemble active hemorrhage, specifically if intraparenchymal, but do not increase in size on delayed images. A saccular pseudoaneurysm may mimic the morphology of a true aneurysm, but pseudoaneurysms are not peripherally calcified. If the clinical history includes trauma or pancreatitis, a pseudoaneurysm may be associated with a perisplenic hematoma or regional inflammatory changes, respectively. Unlike true aneurysms, all splenic artery pseudoaneurysms are treated regardless of size due to a higher risk of rupture [24].

Perisplenic venous pathologies are frequently seen in portal hypertension with the formation of portosystemic collaterals. In a study by Cho et al. [27], perisplenic varices were identified on CT in 30% of patients with portal hypertension. Perisplenic varices often course through the splenocolic ligament and appear as dilated, serpentine veins either anterior or posterior to the spleen. They may communicate with inferior phrenic veins or retrogastric varices posteriorly. Sometimes, they present in the splenic hilum, as well. Approximately, 10% of patients with portal hypertension demonstrate splenorenal shunting, which appears as a dilated, tortuous retroperitoneal venous channel between the spleen and left kidney [27]. With shunting, blood bypasses the portal venous system and flows from the splenic vein to the inferior vena cava via the left renal vein.

Perisplenic air and fluid collections

Pneumoperitoneum frequently results from ruptured hollow viscus due to infectious, ischemic, or iatrogenic etiologies. Air is typically seen in non-dependent portions of the left upper quadrant, particularly in the left subphrenic space, in perisplenic pneumoperitoneum (Fig. 7a). Although rare, focal perisplenic air collections may result from a ruptured splenic abscess [28, 29].

Perisplenic fluid collections contain ascitic fluid, infectious debris, or blood (Fig. 7a–c). The formation and spread of fluid collections directly relate to the configurations of peritoneal spaces and subperitoneal ligaments. The location of the fluid collection, in addition to the clinical history and associated imaging findings, guides the radiologist in making the correct diagnosis. For example, perisplenic abscesses preferentially form in the left subphrenic space due to negative intra-abdominal pressure during respiration and subsequent upward flow of peritoneal fluid. In the setting of a suspected perisplenic abscess, the clinical history often includes left upper quadrant pain, fever, chills, and leukocytosis. On CT, a perisplenic abscess is a well-circumscribed hypoattenuating lesion with peripheral enhancement and surrounding inflammatory changes, such as fat stranding or ascites (Fig. 7b). In the setting of recent intra-abdominal surgery or trauma, a hyperattenuating perisplenic fluid collection suggests a hematoma (Fig. 7c).

Left subphrenic fluid collections commonly originate from splenic, gastric, or colonic splenic flexure pathology [3]. These fluid collections are often contained in the left

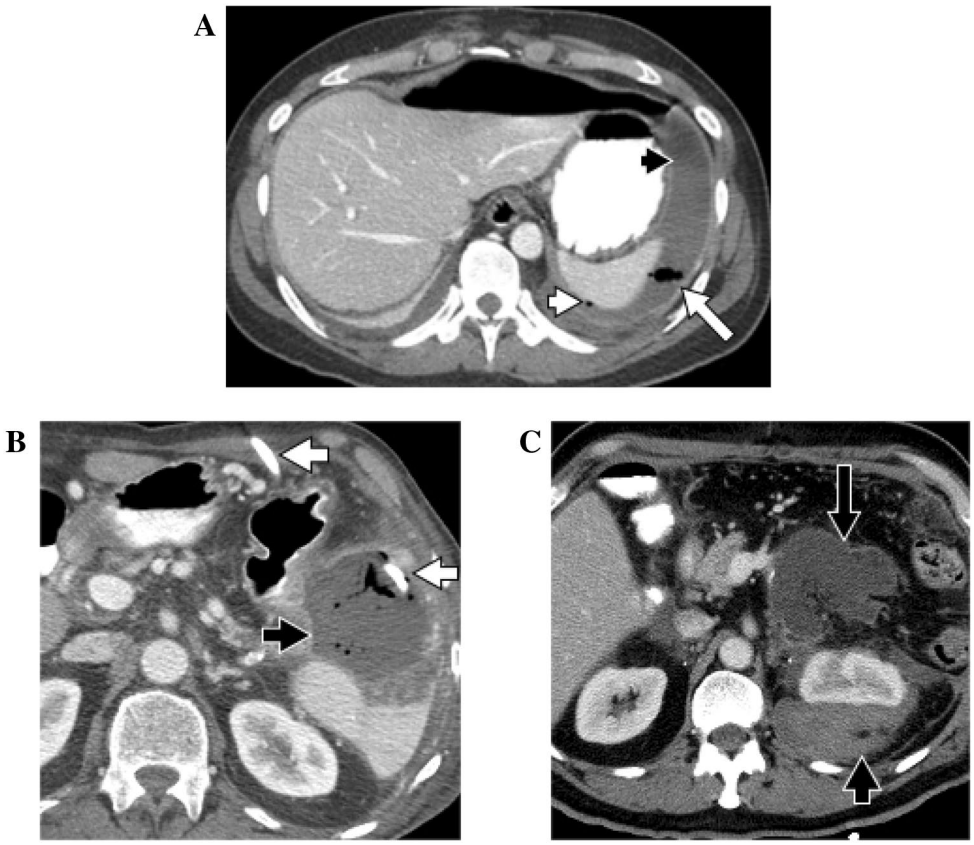

Fig. 7 Perisplenic air and fluid collections. **a** Axial contrast-enhanced CT image shows pneumoperitoneum with air in the left subphrenic space (short white arrow), air in the perisplenic recess (long white arrow), and perisplenic ascites (short black arrow), presumed due to rupture of a hollow viscus. **b** Axial contrast-enhanced CT image shows a perisplenic fluid collection with a mildly enhancing wall and internal foci of air consistent with pyogenic abscess (short black arrow). A percutaneous drain is partially visualized (white arrows). **c** This patient presented status post partial pancreatectomy of the pancreatic body and tail. Axial contrast-enhanced CT image shows a low-density fluid collection in the post-operative bed (long black arrow) and an additional large perisplenic and retroperitoneal high-density fluid collection consistent with hematoma formation (short black arrow) via the splenorenal ligament

subphrenic space until the volume grows too large. Fluid then spills over the phrenicocolic ligament and spreads to the left paracolic space, eventually reaching the pelvis. Large volumes of left subphrenic fluid can also cross midline to right-sided peritoneal spaces. The reverse pathway of disease spread from the pelvis to the left subphrenic space is less common, as the phrenicocolic ligament provides better blockade of fluid in this direction. This concept is reinforced by the infrequent formation of left upper quadrant abscesses in the setting of diffuse peritonitis [30].

Perisplenic fluid collections also form in the splenic recess of the lesser peritoneal sac. Splenic recess abscesses typically result from pathology affecting the lesser sac wall, like pancreatitis or gastric ulcer perforation. Lesser sac fluid collections are usually contained in this space due to epiploic foramen adhesions, which block fluid from entering the greater sac [30].

Perisplenic neoplasms

Although rare, a number of malignant and benign primary splenic neoplasms are described in the literature. More commonly, the spleen is host to secondary neoplastic involvement, particularly in lymphoma. While primary and secondary splenic neoplasms often present as intraparenchymal lesions, perisplenic extension occurs in the setting of large, aggressive, or infiltrating tumors. A comprehensive description of splenic tumors is beyond the scope of this article; a concise review of select tumors that may demonstrate perisplenic extension is provided in this section.

Splenic neoplasms are generally divided into lymphoid and vascular tumors. As the largest lymphoid organ in the body, the spleen is involved in approximately one-third of Hodgkin's and non-Hodgkin's lymphoma [31]. Primary splenic lymphoma occurs in only 1–2% of cases and is significantly rarer than secondary splenic involvement. The most common subtype of primary splenic lymphoma is diffuse large B-cell, which most commonly presents in the sixth and seventh decades of life [31]. Clinically, patients present with left upper quadrant pain attributed to splenomegaly or classic "B symptoms," such as night sweats, fever, weight loss, and malaise. Widespread metastatic disease with hepatic involvement is often present at the time of initial diagnosis. On imaging, splenic lymphoma presents with variable findings including diffusely infiltrative splenomegaly, micro- or macronodules, or a bulky mass [32]. Large, infiltrating splenic lymphoma undergoes extracapsular extension into the perisplenic region and adjacent organs (Fig. 8a). On post-contrast imaging, lymphomatous lesions poorly enhance. They appear hypodense on CT and hypointense on T1- and T2-weighted MR images.

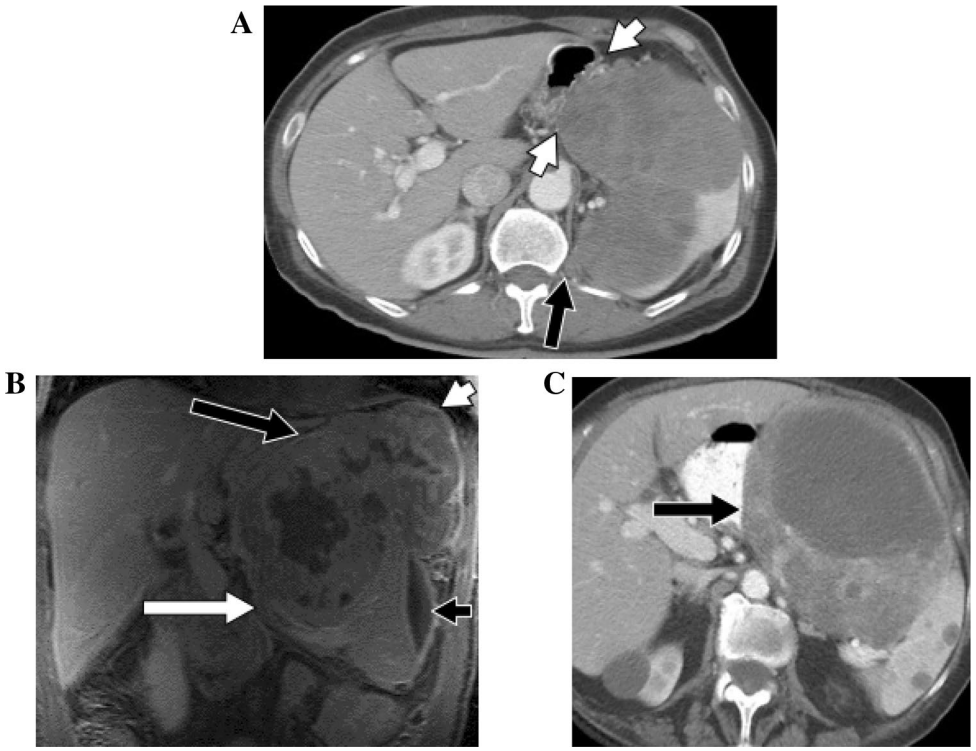

Fig. 8 Perisplenic neoplasms. **a** 51-year-old man with a known history of non-Hodgkin's lymphoma. Axial contrast-enhanced CT image shows a large low-density exophytic splenic mass protruding against the left renal surface (black arrow). It also has mass effect on the stomach, and the gastrosplenic recess is obliterated by the mass (white arrows). **b** 47-year-old male presented with left upper quadrant pain. Coronal contrast-enhanced T1-weighted MR image shows a large heterogeneously enhancing mass involving the superior pole of the spleen (long black arrow), which was later diagnosed as pathology-proven angiosarcoma. The mass extends into the left supramesocolic (long white arrow) and left subphrenic spaces (short white arrow). A subcapsular hematoma is noted along the lateral aspect of the spleen (short black arrow). **c** 70-year-old female who presented with abdominal discomfort. Axial contrast-enhanced CT image shows a large heterogeneously enhancing predominantly hypodense exophytic mass arising from the gastric surface of the spleen (black arrow). The patient underwent splenectomy and was found to have a benign thrombosed hemangioma with several smaller hemangiomas not seen on this image. Incidental renal cysts are noted

Angiosarcoma is a rare vascular tumor originating from blood vessel-lining endothelial cells (Fig. 8b). Its aggressive nature permits extracapsular invasion into the perisplenic region. Patients typically present with left upper quadrant pain or a palpable upper abdominal mass. Recognition of a splenic angiosarcoma is imperative as splenic rupture is a common complication, and splenectomy can improve mean survival time [33]. CT findings include a hypodense, heterogeneously enhancing mass with possible areas of necrosis and calcifications. Heterogeneous MR patterns are not consistent given the variable appearance of acute and chronic blood products on T1- and T2-weighted images. Splenic angiosarcoma should be suspected in a heterogeneously enhancing mass with hyperintense foci on T1- and T2-weighted spin echo images, which likely correspond to areas of subacute hemorrhage [34].

The most common benign primary splenic neoplasm is a hemangioma (Fig. 8c), which is usually asymptomatic and incidentally discovered. Splenic hemangiomas typically present as single lesions measuring less than 2 cm, but larger masses can involve the perisplenic region. Large hemangiomas are more prone to rupture and can mimic malignant splenic lesions, like angiosarcoma. On non-contrast CT, splenic hemangiomas are well-circumscribed hypo- to isoattenuating masses. On contrast-enhanced CT, splenic hemangiomas do not demonstrate peripheral nodular early arterial enhancement seen in hepatic hemangiomas. Instead, splenic hemangiomas have variable enhancement patterns, which range from solid continuous peripheral arterial enhancement to intermediate homogenous enhancement that persists on delayed images.[35, 36]. On MRI, splenic hemangiomas are hypo- to isointense on T1-weighted images and hyperintense on T2-weighted images.

Perisplenic metastatic disease

Perisplenic metastases arise from a variety of pathways. Although rare, hematogenous dissemination in colorectal,

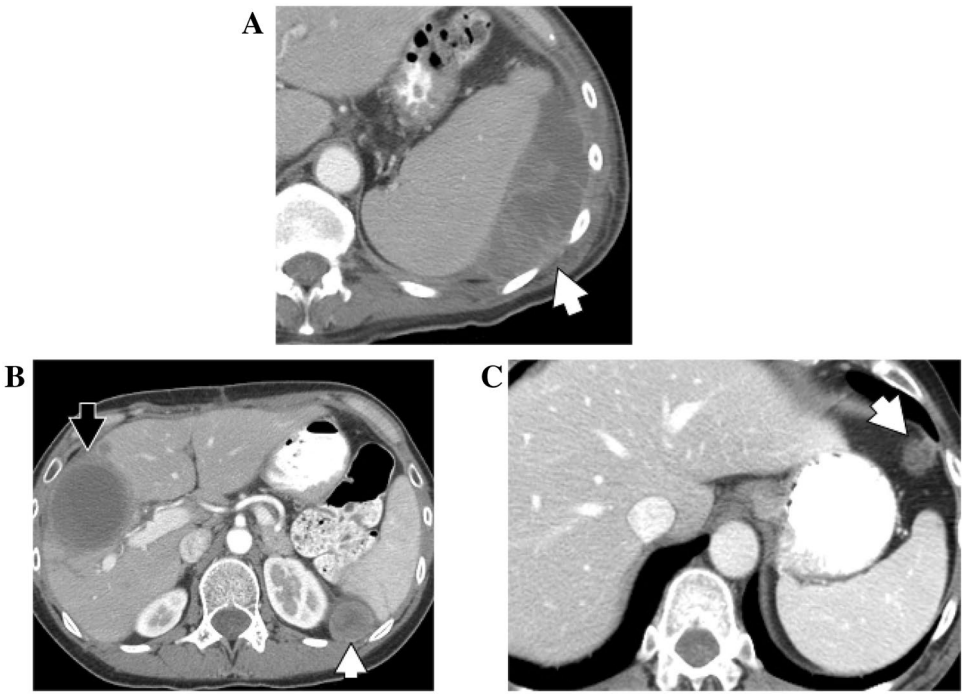

Fig. 9 Focal perisplenic metastatic disease. **a** 52-year-old male with history of acute myeloid leukemia. Axial contrast-enhanced CT image shows a large heterogeneously enhancing mass in the left subphrenic space abutting the left hemi-diaphragm and indenting the posterolateral splenic surface (white arrow). Biopsy confirmed extramedullary leukemic tumoral implants, also known as myeloid sarcoma. **b** 57-year-old male with history of gastrointestinal stromal tumor (GIST). Axial contrast-enhanced CT image shows a heterogeneously enhancing soft tissue mass in the splenorenal recess indenting the posterior splenic surface (white arrow). A hypodense right hepatic lobe lesion is compatible with metastasis (black arrow). **c** 48-year-old female with history of ovarian carcinoma. Axial contrast-enhanced CT image shows a focal soft tissue mass representing a peritoneal metastatic implant in the left subphrenic space adjacent to the left hemi-diaphragm (white arrow)

breast, and ovarian carcinomas, as well as melanoma, results in parenchymal splenic metastases [37]. Even more rare is hematogenous spread of hematopoietic malignancies resulting in perisplenic metastases (Fig. 9a).

More commonly, perisplenic metastases stem from transcoelomic spread between the peritoneal cavity and the subperitoneal space. This route of disease spread occurs more often in gastrointestinal cancers in men (Fig. 9b) and ovarian cancer in women [30].

Transcoelomic spread is affected by the physiologic movement of peritoneal fluid, which generally flows from the pelvis to the paracolic gutters to the subphrenic spaces. In addition, gravitational forces pool peritoneal fluid in dependent recesses, thus making some locations more susceptible to metastatic peritoneal implantation [30]. Since the phrenicocolic ligament partially blocks ascitic flow between the left paracolic gutter and left subphrenic space, peritoneal spread is more common in the right subphrenic space and Morison's pouch. Nevertheless, transcoelomic spread does contribute to perisplenic metastatic disease, particularly in the left subphrenic space due to upward ascitic flow and abundant diaphragmatic lymphatics (Fig. 9c).

Peritoneal metastases appear as diffuse peritoneal thickening with ascites, micro- or macronodular serosal implants, or invasive masses that encroach upon subperitoneal viscera and ligaments (Fig. 10a). Pseudomyxoma peritonei is a unique subtype of peritoneal metastatic disease associated with low-grade mucus-secreting tumors, such as mucinous appendiceal carcinoma (Fig. 10b and c). Deposition of gelatinous material on peritoneal and visceral surfaces results in characteristic scalloping of abdominal organ surfaces. On CT, low-attenuating mucin infiltrates the peritoneal cavity and involves subperitoneal spaces, omentum, and mesentery. In contrast to mucinous carcinomatosis, pseudomyxoma peritonei does not invade visceral organs but rather envelops them. This feature creates the classic scalloped appearance of mucin deposition, particularly on the hepatic and splenic surfaces. Occasionally, scattered curvilinear or amorphous calcifications are present within the low-attenuating mucin [38]. On MR, mucin deposits are T2 hyperintense and T1 hypointense.

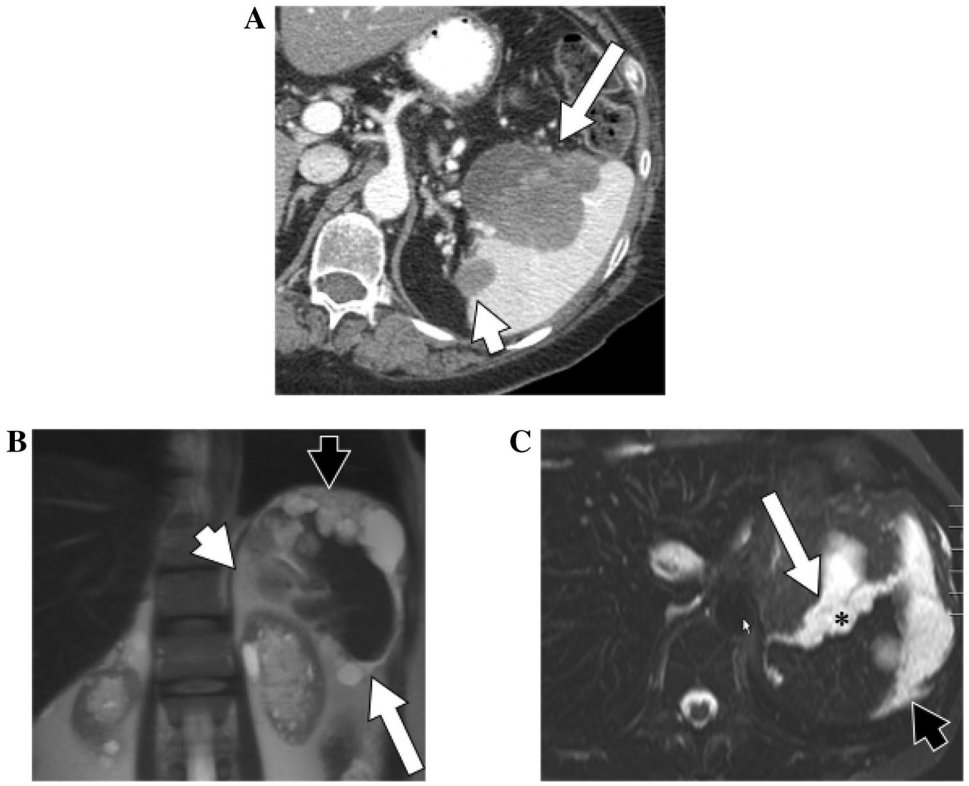

Fig. 10 Diffuse perisplenic peritoneal metastases. **a** 55-year-old female with a known history of ovarian carcinoma. Axial contrast-enhanced CT image shows heterogeneously enhancing soft tissue masses invading the spleen consistent with peritoneal carcinomatosis. The larger mass (long white arrow) abuts the posterior gastric wall along the gastrosplenic ligament. The small mass at the posteromedial aspect of the spleen (short white arrow) is centered at the presumed location of the splenorenal ligament. **b, c** 38-year-old female with history of mucinous appendiceal carcinoma. T2-weighted coronal (**b**) and fat-suppressed T2-weighted axial (**c**) images show multiple T1-intermediate intensity and T2-hyperintense globular masses in the left subphrenic space (short black arrow), gastrosplenic recess (long white arrow) and splenorenal recess (short white arrow). The splenic surface has a classic scalloped appearance created by deposited gelatinous material (asterisk)

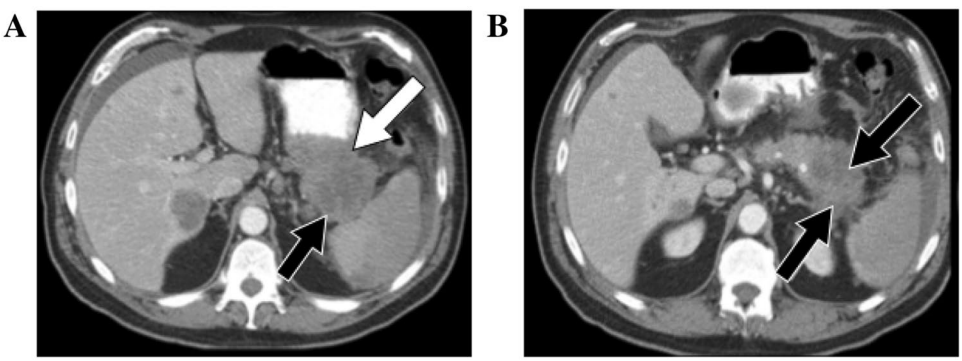

Fig. 11 68-year-old man with invasive adenocarcinoma of the pancreatic tail. **a, b**, Sequential axial contrast-enhanced CT images show a low-density mass in the pancreatic tail (black arrows) invading the posterior gastric wall (white arrow) and obliterating the gastrosplenic space. Heterogeneous appearance of the spleen is secondary to splenic vein occlusion by the mass

Perisplenic lesions from adjacent organs

The splenorenal ligament is a direct connection between the spleen and the pancreatic tail and facilitates disease spread between the pancreas and the perisplenic region. For example, pancreatic adenocarcinoma can directly invade the spleen and neighboring perisplenic ligaments with eventual spread to the stomach (Fig. 11). Pancreatitis can present with perisplenic fluid collections and pseudocysts, splenic infarction, or splenic subcapsular hemorrhage (Fig. 12). Splenic vein thrombosis and splenic artery pseudoaneurysm also occur in the setting of pancreatitis [39].

Some renal pathologies involve the perisplenic region given the close proximity between the spleen and left

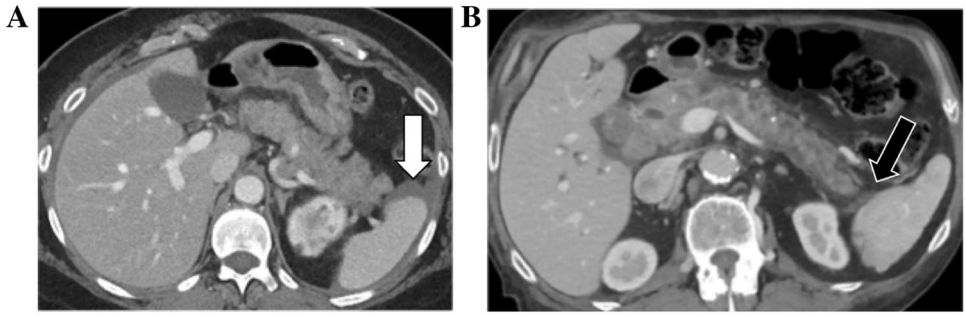

Fig. 12 Pancreatitis. **a** Axial contrast-enhanced CT images of a 63-year-old woman demonstrates an edematous pancreas with mild peripancreatic fat stranding and fluid extending to perisplenic recess (white arrow). **b** Axial contrast-enhanced CT images of an 88-year-old man with pancreatic cancer demonstrates an edematous and heterogeneous pancreas with fat stranding extending to splenic hilum (black arrow)

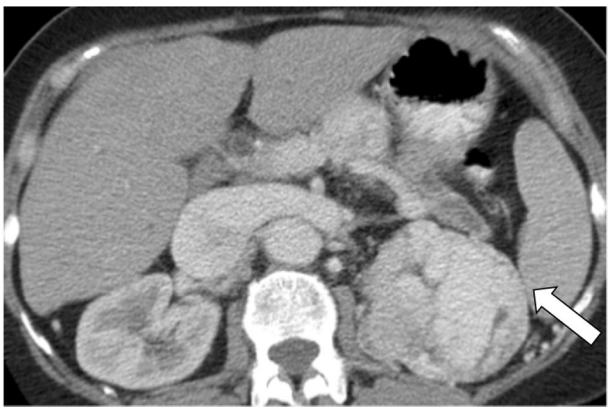

Fig. 13 Left renal cell carcinoma. Axial CT image of a 64-year-old woman demonstrates a large left renal mass that extends to the splenorenal recess and abuts the spleen (arrow)

kidney (Fig. 13). Although rare, splenic abscesses can form in the setting of acute pyelonephritis, likely due to infectious spread via the splenorenal ligament [40–42]. Of note, all patients in these case reports exhibited poorly controlled diabetes, which is a known predisposing factor for atypical infections. Perisplenic metastases from renal cell carcinoma (RCC) are described in the literature, although this entity is exceedingly rare [43–46]. RCC metastasis to the perisplenic region occurs via direct invasion in the setting of a large left-sided renal mass or hematogenously, as described in a case of right-sided RCC [45]. Both synchronous and metachronous splenic metastases are described in the literature, with the latter discovered up to fourteen years post-nephrectomy [43].

Conclusion

The perisplenic region is a complex area that includes the spleen and a network of peritoneal spaces and subperitoneal ligaments. These anatomic components influence the various pathologies and routes of disease spread in the perisplenic region. Awareness of common and rare pathologies, including characteristic clinical and imaging features, assists the radiologist in correctly identifying perisplenic abnormalities and diagnosing clinically relevant entities.

Author contributions A.E. designed the concept, performed literature search, drafted/edited/revised the manuscript, and compiled the image examples. C.O.M. provided close mentorship in the design of the concept, provided imaging examples, and reviewed/edited the manuscript. D.G. provided close mentorship in the design of the concept, provided imaging examples, and reviewed/edited the manuscript. N.C. performed literature search, added references, compiled image examples, and denoted imaging findings in case examples. A.M. performed literature search, added references, drafted portions of the manuscript, and provided patient case examples. A.S. and S.J. provided imaging examples and reviewed/edited the manuscript. K.M.E. provided close mentorship in the design of the concept, provided imaging examples, and reviewed/edited/approved the manuscript.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to disclose.

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