ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.clinicalimagingscience.org

Journal of Clinical Imaging Science

Diagnostic Radiology *Pictorial Essay*

Intraperitoneal anatomy with the aid of pathologic fluid and gas: An imaging pictorial review

Matthew Montanarella[1], Kimberly Boldig[2], Mayur Virarkar[1], Sindhu Kumar[1], Sherif Elsherif[1], Chandana Lall[1], Dheeraj Reddy Gopireddy[1]

Departments of [1]Radiology and [2]Internal Medicine, UF College of Medicine-Jacksonville, Jacksonville, United States.

***Corresponding author:**
Matthew Montanarella, Department of Radiology, UF College of Medicine-Jacksonville, Jacksonville, United States.

matthew.montanarella@jax.ufl.edu

Received : 15 March 2023
Accepted : 12 April 2023
Published : 19 May 2023

DOI
10.25259/JCIS_29_2023

Quick Response Code:

ABSTRACT

The peritoneum is a large serosal membrane enveloping the abdomen and pelvic organs and forming the peritoneal cavity. This complex relationship forms many named abdominopelvic spaces, which are frequently involved in infectious, inflammatory, neoplastic, and traumatic pathologies. The knowledge of this anatomy is essential to the radiologist to localize and describe the extent of the disease accurately. This manuscript provides a comprehensive pictorial review of the peritoneal anatomy to describe pathologic fluid and gas.

Keywords: Peritoneum, Peritoneal anatomy, Peritoneal spaces, Pathologic fluid, Pathologic gas

INTRODUCTION

The peritoneum is the largest serosal membrane in the body which lines the abdominal cavity and intra-abdominal organs. The peritoneum forms a closed cavity in the male and is pierced by the fallopian tubes in females. The potential space between the parietal (lines the abdominal wall) peritoneum and the visceral (surrounds the internal organs) peritoneum is termed the peritoneal cavity. The peritoneum creates a complex relationship with the abdominal viscera by forming the omentum, mesentery, ligaments, and potential spaces [Figure 1].

These are important when describing intra-abdominal infectious, neoplastic, inflammatory, and traumatic pathologies. The peritoneal membranes create a lubricated surface by secretion of a sterile peritoneal fluid which ensures frictionless visceral movement within the abdomen and aids in the microbial defense.[1-3] While the retroperitoneal spaces are divided into specific compartments, the spread of intraperitoneal disease is guided by subdiaphragmatic pressures, bowel peristalsis, and gravitational forces termed cephalic circulation.[1,4] The continuous intra-abdominal pressure and the lymphatic drainage through the subphrenic and submesothelial lymphatics dictate predictable routes of disease spread.[3,5]

It is imperative for radiologists to thoroughly understand the complex anatomy of the peritoneal cavity to localize and assess the extent of the disease precisely. This manuscript provides a comprehensive pictorial review of peritoneal anatomy. The complexities of peritoneal anatomy can be demonstrated using three-dimensional imaging modalities such as computed tomography (CT) and magnetic resonance imaging to describe pathologic fluid and gas.

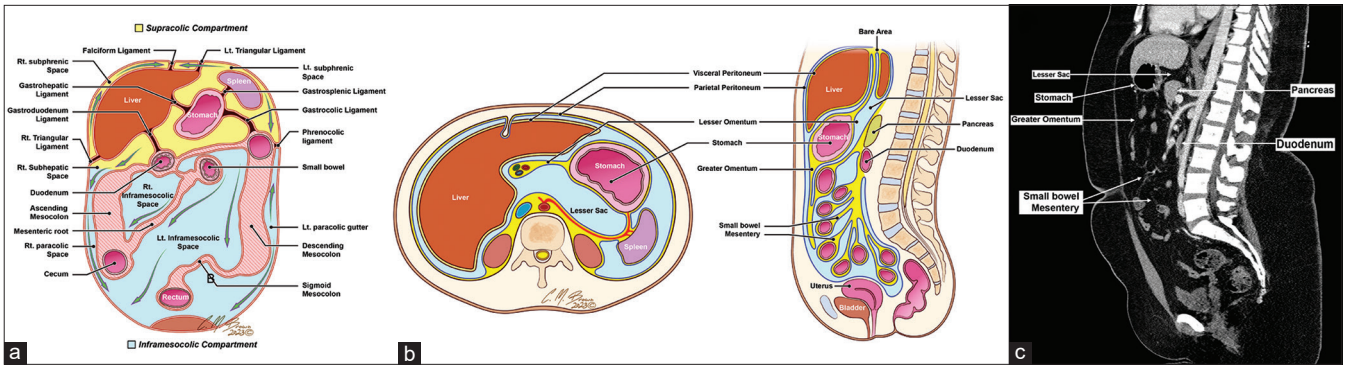

Figure 1: Illustrations (a and b) and a normal computed tomography abdomen and pelvis coronal reformatted image (c) reviewing the anatomy of the peritoneum.

BASIC PERITONEAL EMBRYOLOGY

To thoroughly discuss the embryological anatomy of the peritoneum, it is best to start with a discussion of the following terms; ligament, omentum, and mesentery. A peritoneal ligament comprises two folds of the peritoneum, suspending an organ within the peritoneal cavity, and they are usually named after the organs to which they connect.[6] An omentum is a specialized ligament that connects the stomach to another structure within the abdominal cavity.[6,7] A mesentery is two folds of the peritoneum that suspend abdominal organs to the retroperitoneum.[6]

Embryological development of the peritoneum begins during the gastrulation stage at week 5, during which a disk of endoderm, ectoderm, and mesoderm layers form.[8-11] The mesoderm layer differentiates into a lateral plate mesoderm, paraxial mesoderm, and intermediate mesoderm. Following this, the two lateral plate mesoderm forms the parietal and visceral plates, which envelop the amnion and yolk sac. This parietal plate and the ectodermal layer form the parietal peritoneum, whereas the visceral plate and the endoderm develop into the visceral peritoneum.[8] A coelomic cavity forms following the visceral and parietal plate mesoderm joining. The primitive gut protrudes into the peritoneal cavity and its lining mesodermal cells to form the future visceral peritoneum.[11] The peritoneal ligaments are formed from the primitive dorsal and ventral mesentery, layers of peritoneum that suspend the primitive gut tube/gastrointestinal organs and separate the right and left coelomic cavities.[6]

PERITONEAL SPACES

There are two main compartments to the peritoneal cavity, separated by the transverse colon and its mesentery connecting the bowel to the posterior abdominal wall; they are termed the supramesocolic and inframesocolic compartments [Figure 1a].[12] The supramesocolic compartment is divided into left and right. Multiple subspaces are subsequently described in.[13]

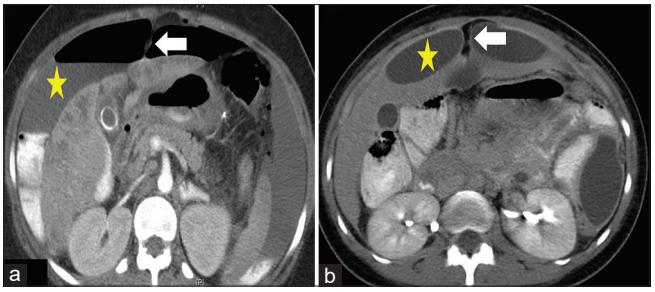

Figure 2: A 32-year-old woman with bowel perforation. Contiguous computed tomography axial images of the abdomen with IV contrast (a and b) demonstrating an abscess within the right subphrenic space (star). The white arrow indicates the falciform ligament, which separates the right subphrenic space into the right and left sides.

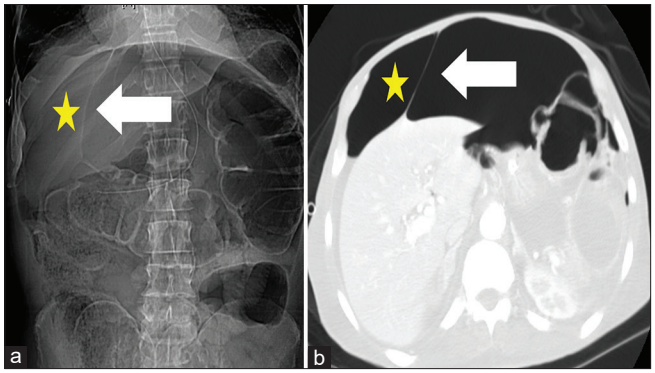

Figure 3: A 45-year-old man with bowel perforation. (a) Abdominal computed tomography (CT) scout image and (b) CT abdomen axial image on lung window demonstrating large volume pneumoperitoneum within the right subphrenic space (star). The falciform ligament (arrow) is noted, which separates the right subphrenic space into the right and left subphrenic spaces.

SUPRAMESOCOLIC COMPARTMENT

The supramesocolic ligaments aid in suspending the gut tube from the abdominal wall and help delineate peritoneal compartments.[14] The ventral mesentery forms three

ligaments: Falciform, gastrohepatic, and hepatoduodenal [Figure 1a]. The dorsal mesentery forms five ligaments named for the organs/structures that they connect: Gastrophrenic, gastropancreatic, gastrosplenic, splenorenal, and phrenocolic [Figure 1a].[15] The gastrosplenic ligament is frequently a route of the spread of inflammatory fluid from pancreatitis. Although not connected to the lesser sac (described below), fluid is often mistaken for a fluid collection in this space.[16]

THE RIGHT SUBPHRENIC SPACE

The subphrenic space is a large compartment separated into the right and left by the falciform ligament [Figure 1]. The right subphrenic space is bounded by the diaphragmatic surface of the right hepatic lobe, the coronary ligament posteriorly, and the falciform ligament medially.[1,17] The falciform ligament attaches the anterior surface of the liver to the anterior abdominal wall, which contains the obliterated umbilical vein and is continuous with the ligamentous venosum. The right subhepatic space is commonly involved in abdominopelvic infections and seeding from pelvic malignancy, where the paracolic gutter (described below) acts as a conduit for disease spread [Figure 2].[18,19]

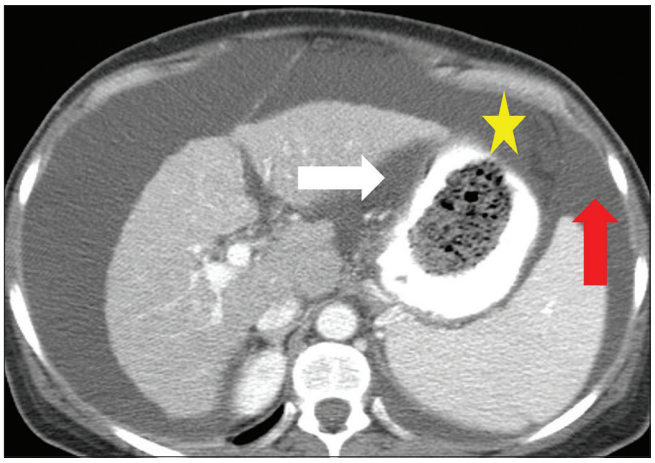

Figure 4: A 53-year-old man with liver cirrhosis. Computed tomography abdomen axial image with IV contrast in a patient with ascites demonstrating the subdivisions of the left subphrenic space. The star indicates the immediate subphrenic space. The white and red arrows indicate the left subhepatic and perisplenic spaces.

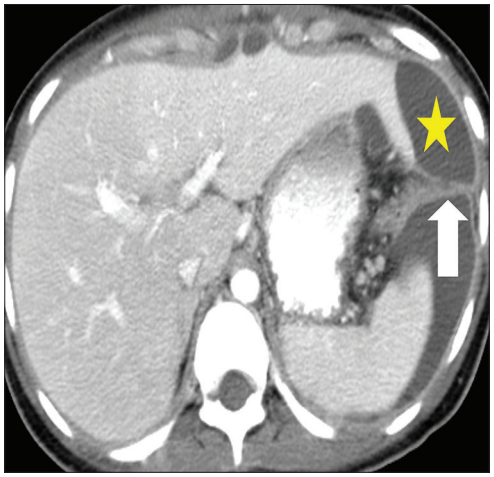

Figure 5: A 29-year-old woman with tubo-ovarian abscess. Computed tomography abdomen axial image with IV contrast demonstrating an abscess within the immediate left subphrenic space (star). The white arrow indicates the gastrophrenic ligament.

Subphrenic abscesses also occur as a complication of intra-abdominal surgery.[20] Absorption of inflammatory material of the peritoneal cavity through the subphrenic and submesothelial lymphatics is more prominent on the right; hence, why right subphrenic abscesses are a more common occurrence than on the left.[21] It is common to have small amounts of pathologic fluid accumulate in this space in an isolation.[22] Gas may also accumulate in this space following hollow visceral rupture [Figure 3]. An important distinction must be made with intraperitoneal and extraperitoneal free air related to hollow visceral rupture. Rarely, in these cases, air may be retroperitoneal and may diffuse between intra-

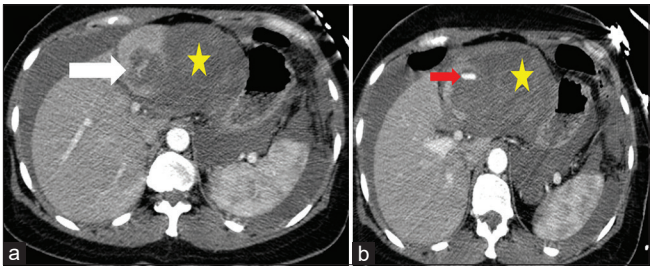

Figure 6: A 66-year-old male with hepatocellular carcinoma. (a and b) contiguous computed tomography axial images of the abdomen with IV contrast demonstrating a ruptured left hepatic lobe hepatocellular carcinoma (white arrow) and hematoma within the left subhepatic space (star). The red arrow indicates active contrast extravasation.

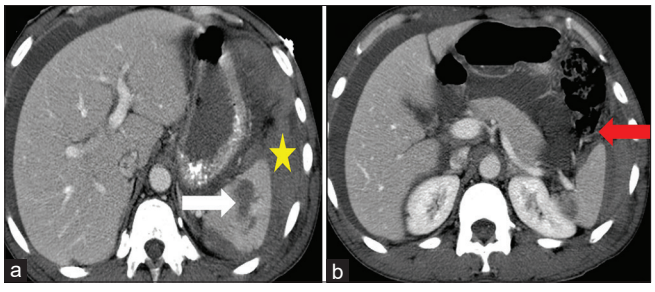

Figure 7: A 30-year-old man with blunt abdominal trauma. (a and b) Contiguous computed tomography axial images of the abdomen with IV contrast demonstrating a splenic laceration (white arrow) and a hematoma in the perisplenic space (star) in a patient with blunt abdominal trauma. The red arrow indicates the phrenicocolic ligament.

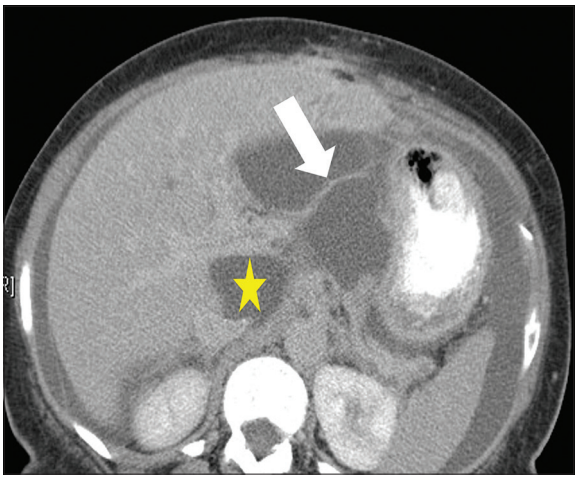

Figure 8: A 34-year-old man with bowel perforation. Computed tomography abdomen axial image with IV contrast demonstrating an abscess within the anterior right subhepatic space (star). The white arrow indicates the gastrohepatic ligament.

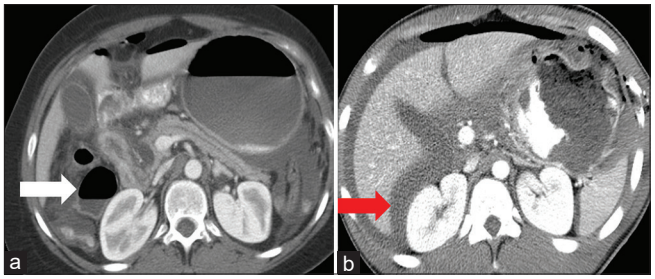

Figure 9: A 37-year-old woman with sepsis and intraperitoneal infection. (a) Computed tomography (CT) abdomen axial image demonstrating abscess (white arrow) within Morrison's pouch. A 40-year-old man status post gunshot wound to the abdomen. (b) CT abdomen axial image demonstrating blood products (red arrow) within Morrison's pouch.

abdominal fascial planes. When air is introduced to these compartments subcutaneous emphysema, pneumothorax, and pneumopericardium may ensue, leading to atypical patient presentations.[23]

THE LEFT SUBPHRENIC SPACE

The coronary ligament of the left hepatic lobe attaches superiorly in the midline of the abdomen and is located more anteriorly than the right coronary ligament. Thus, pathologic fluid in the left subphrenic space can communicate throughout the space.[24-27] The left subphrenic space [Figure 4] is further arbitrarily subdivided into the immediate subphrenic space, the left subhepatic space, and the perisplenic space. The phrenicocolic ligament extends from the splenic flexure to the lateral diaphragm separating this space from the left paracolic gutter serving as a potential barrier of pathologic fluid from the left paracolic gutter.[28]

The immediate subphrenic space is located between the diaphragm and gastric fundus, including the area anterior to the lateral segment of the left hepatic lobe [Figure 5]. This space is a common location for fluid, abscess, hemoperitoneum, and collections from gastric processes.[1,29-31] The left subhepatic space, also known as the gastrohepatic space, is located between the lateral segment of the left hepatic lobe and the stomach [Figure 6]. This space commonly involves collections from peptic ulcers (gastric and duodenal) and gallbladder inflammation.[32] Pathologies of the left lobe of the liver may also involve this space. The perisplenic space surrounds the spleen and is bounded inferiorly by the phrenicocolic ligament. This space is a common location for pathologic fluid abscesses or blood from injury to the spleen in blunt and penetrating abdominal trauma [Figure 7].[33-36] The tail of the pancreas

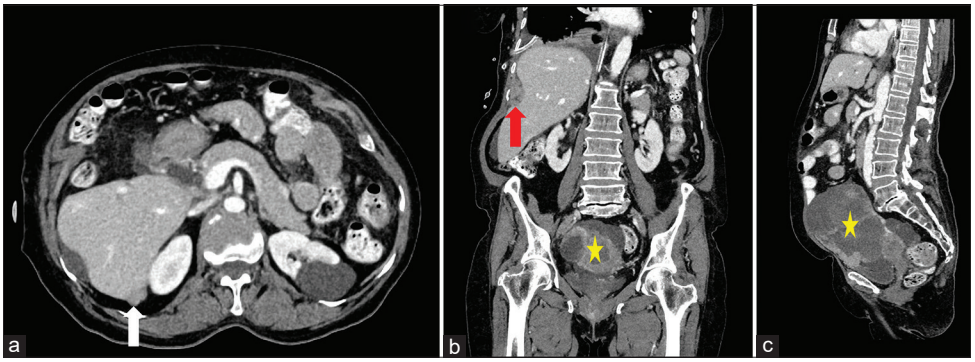

Figure 10: A 62-year-old woman with stage four cholangiocarcinoma. Computed tomography abdomen and pelvis axial image (a), coronal (b), and sagittal (c) reformatted images demonstrating a metastatic peritoneal deposit in the posterior right subhepatic space (white arrow). A peritoneal mass is seen between the liver parenchyma and the right abdominal wall (red arrow). A large metastatic mass is seen centered within the pelvis (star).

extends along the splenic vasculature and terminates within the splenic hilum in close relationship with the perisplenic space. Pancreatitis can rarely (1–5%) affect this space by causing splenic abscess, hemorrhage, infarction, vascular injury, or intrasplenic pseudocyst.[37]

THE RIGHT SUBHEPATIC SPACE

The right subhepatic space [Figure 1] is inferiorly limited by the transverse colon, mesentery, and the peritoneum of the right kidney.[28,38] The right hepatic lobe is anterior to this space.[15,38] This space is subdivided into anterior and posterior compartments. The anterior right subhepatic space is posterior to the porta-hepatis and communicates with the lesser sac (described below) through the foramen of Winslow [Figure 8].[15]

The posterior right subhepatic space is the hepatorenal fossa or Morrison pouch, the most dependent space in the supine patient [Figure 9]. An abscess may develop in this area following surgery or non-surgical etiologies.[39,40] This space has implications in evaluating patients with blunt abdominal trauma as it is the typical site of fluid accumulation in cases of liver injury.[41,42] The posterior right subhepatic space may be site for peritoneal involvement in metastatic carcinoma [Figure 10].

THE LESSER SAC

The lesser peritoneal sac, or the omental bursa, is the space between the stomach and the pancreas and comprises the lesser and greater omentum [Figure 1b and c].[43,44] The lesser sac communicates with the remainder of the peritoneal cavity through the epiploic foramen of Winslow.[45] The foramen of Winslow is bordered anteriorly by the portal triad (hepatic artery, portal vein, and common bile duct) and posteriorly by the inferior vena cava. The anterior border of the lesser sac includes the gastrohepatic and hepatoduodenal ligaments along with the stomach, greater omentum, and lesser omentum. The transverse colon/transeverse mesentery, pancreas, superior aspect of the left kidney, and diaphragm form the posterior border of this space.[45] Isolated fluid within the lesser sac raises concern for the pathology of organs located within the space, such as perforated peptic ulcer disease, pancreatitis, or cholecystitis. Still, it may represent post-operative fluid from a gastric or hepatobiliary surgery.[6,46-49] Three recesses are present within the lesser sac, termed the superior, inferior, and splenic recesses.[43,50] The

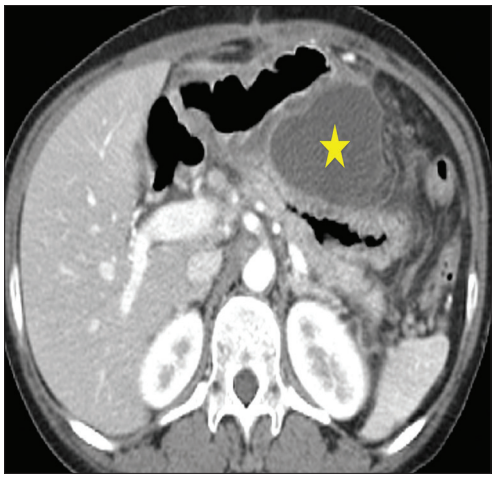

Figure 12: A 49-year-old man with a history of pancreatitis. Computed tomography abdomen axial image with IV contrast demonstrating a pancreatic pseudocyst (star) in the inferior recess of the lesser sac.

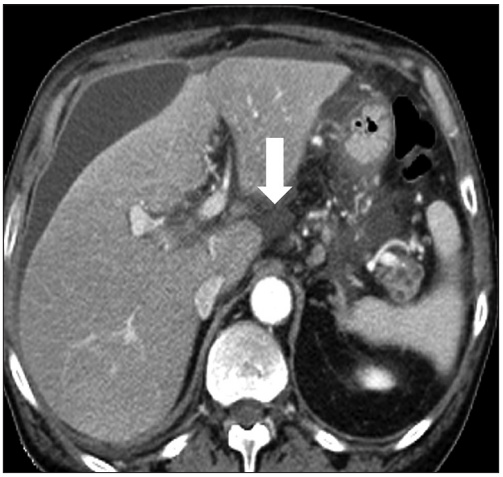

Figure 11: A 52-year-old-man with pancreatitis. Computed tomography abdomen axial image with IV contrast demonstrating a small fluid collection in the superior recess of the lesser sac (white arrow).

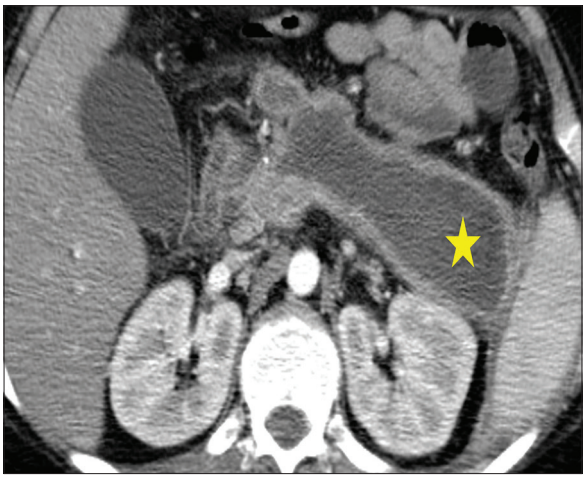

Figure 13: A 63-year-old man with hemorrhagic pancreatitis. Computed tomography abdomen axial image with IV contrast demonstrating a pseudocyst in the splenic recess of the lesser sac (star).

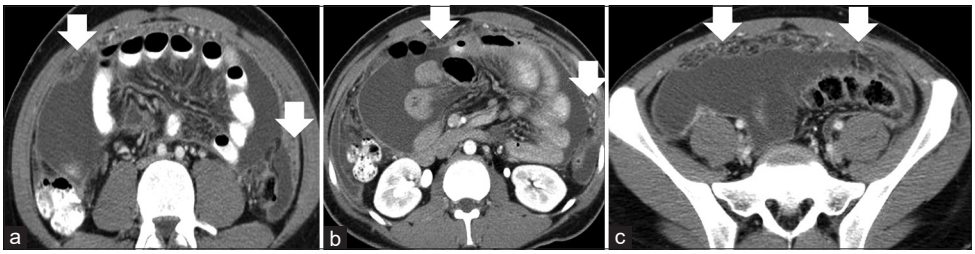

Figure 14: A 53-year-old woman with disseminated TB and peritoneal ascites. (a through c) Contiguous computed tomography axial images of the abdomen with IV contrast demonstrating omental thickening (white arrows).

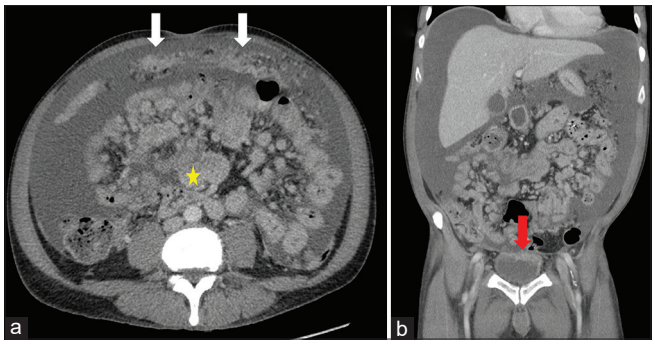

Figure 15: A 60-year-old male with stage four bladder carcinoma. Axial (a) and coronal reformatted image (b) demonstrating nodular thickening at the bladder dome (red arrow), omental metastasis (white arrows). Of note is a large metastatic deposit within the small bowel mesentery (star) and innumerable enlarged mesenteric lymph nodes.

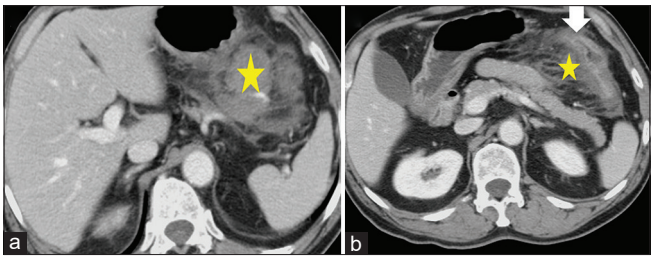

Figure 16: A 41-year-old man with blunt abdominal trauma. (a and b) Contiguous computed tomography axial images of the abdomen with IV contrast (a and b) demonstrating hematoma in the transverse mesocolon (stars).

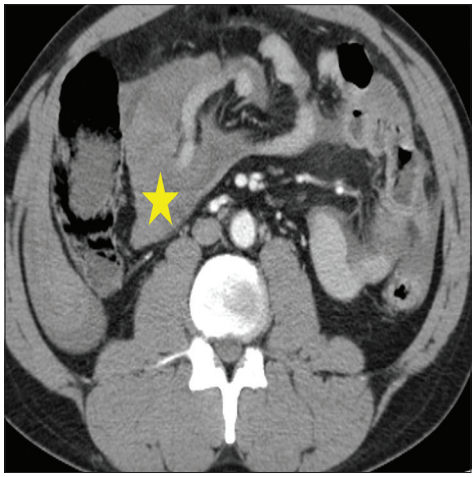

Figure 17: A 44-year-old man with blunt abdominal trauma. Computed tomography abdomen axial image with IV contrast demonstrating a hematoma within the small bowel mesentery (star).

superior recess surrounds the medial aspect of the caudate lobe of the liver and is separated from the splenic recess by the gastropancreatic fold [Figure 11]. The inferior recess separates the stomach from the pancreas and transverse mesocolon [Figure 12]. The splenic recess extends across the midline of the abdomen into the splenic hilum [Figure 13].

MESENTERIES AND INFRAMESOCOLIC COMPARTMENTS

The dorsal mesentery forms the greater omentum, transverse mesocolon, small bowel mesentery, and sigmoid mesocolon. The greater omentum is a large apron-like fold containing four layers connecting the greater curvature of the stomach to the transverse colon, anterior to the small bowel [Figure 1b and c]. The greater omentum contains mainly fat in addition to blood vessels and lymphatics.[51,52] On CT, the greater omentum appears as a band of fatty tissue posterior to the anterior abdominal wall. Various pathologic processes, such as malignant peritoneal deposits, may alter the appearance of the greater omentum giving it a nodular or mass-like appearance [Figures 14 and 15].[53]

The transverse mesocolon arises from the anteroinferior border of the pancreas, suspending the transverse colon from the posterior abdominal wall, and it contains the middle colic vessels. Due to its proximity, this structure is commonly involved in pancreatic and colonic diseases such as pancreatitis and colonic trauma [Figure 16].[54,55]

The small bowel mesentery suspends the bowel from the retroperitoneum and extends from the ligament of treitz to the ileocecal valve. This mesentery contains the superior

mesenteric vessels and lymph nodes.[56] The small bowel mesentery is frequently involved in traumatic, benign, and malignant pathologic processes. Blunt abdominal trauma may lead to mesenteric infiltration/stranding early or frank hematoma [Figure 17].[55,57,58]

The paracolic gutters reside laterally along the ascending and descending colon [Figure 18]. The paracolic gutters freely communicate with the pelvis and are commonly a conduit for the metastatic spread in the abdominopelvic malignancy.[32,59] An additional intraperitoneal recess termed the intersigmoid recess is in the undersurface of the sigmoid mesocolon and is a common space for pathologic fluid to collect [Figure 19].

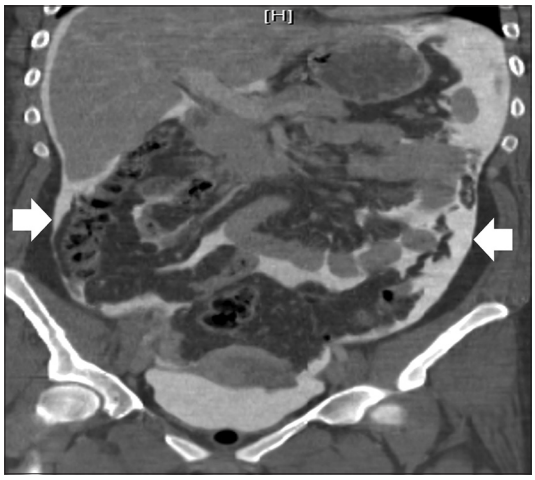

Figure 18: A 47-year-old man with bowel perforation. Computed tomography abdomen axial image with IV contrast demonstrating contrast extravasation into the right and left pericolic gutters (white arrows).

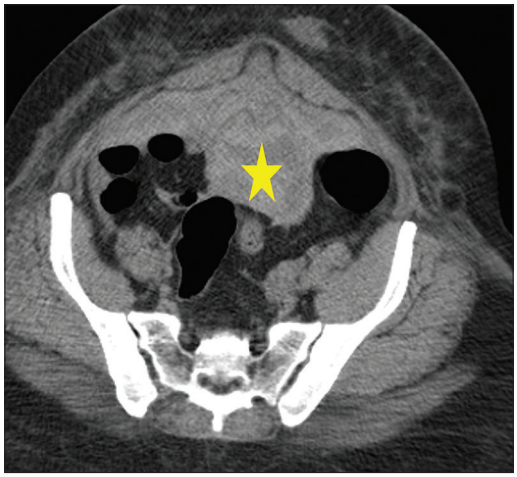

Figure 19: A 43-year-old man with blunt abdominal trauma. computed tomography abdomen axial image with IV contrast demonstrating a hematoma within the intersigmoid recess (star).

PELVIC LIGAMENTS AND SPACES

Like the ligaments within the abdomen, the pelvis contains ligaments that anchor the organs to the abdominal wall, termed the broad, round, and umbilical ligaments [Figure 20]. The broad ligament is a large drape that extends from the uterus to the pelvic side wall and may be involved in pathologic processes of the pelvis.[60,61] The round ligament attaches the uterine cornua, travels to the pelvic sidewall and inguinal

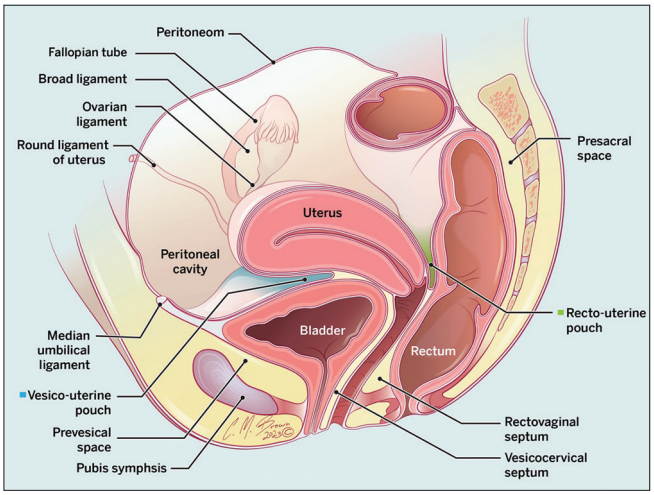

Figure 20: Illustration demonstrating the ligaments and peritoneal spaces of the pelvis.

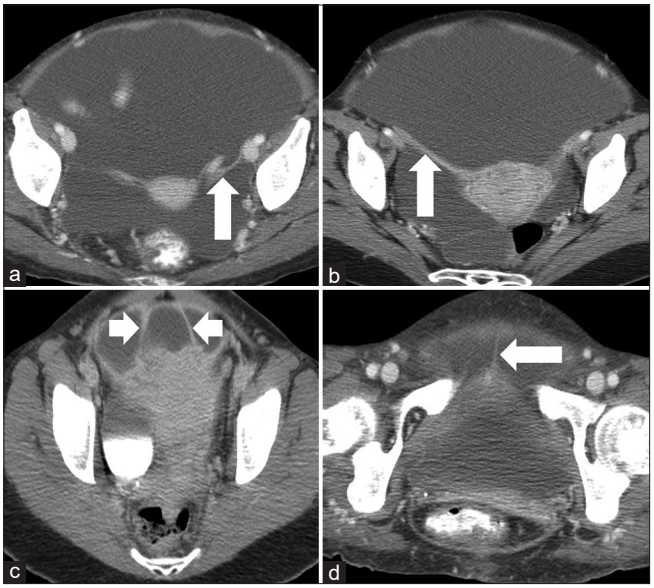

Figure 21: A 57-year-old woman with large volume peritoneal ascites. (a-d) Contiguous computed tomography axial images of the abdomen with IV contrast in a patient with large volume ascites, which well delineates the pelvic ligaments. Arrow in image (a) indicates the broad ligament. Arrow in image (b) indicates the round ligament. Arrows in image (c) indicate the paired medial umbilical ligaments. Arrow in image (d) indicates the median umbilical fold.

canal, and ultimately terminates in fibers ending in the mons pubis.[62] The lateral, medial, and median umbilical folds are peritoneal reflections over the deep inferior epigastric vessels, obliterated umbilical arteries, and urachus, respectively. These ligaments are well delineated in a patient with abdominopelvic ascites [Figure 21]. The rectouterine pouch (pouch of Douglas) is bounded anteriorly by the broad ligament and uterus and is the women's most dependent portion of the pelvis [Figure 20]. This space is commonly filled with pathologic fluid in the setting of pelvic infection and malignancy.[63,64] This space is synonymous with the rectovesical space in males anteriorly bounded by the bladder. As such, this space can accumulate fluid dependently within the pelvis.[65]

CONCLUSION

When describing the extent of abdominopelvic disease, a thorough understanding of the complexities of peritoneal anatomy is essential to the radiologist. Knowledge of the peritoneal spaces may help localize the pathologic organ of interest in subtle isolated fluid collections within the abdomen or pelvis. This profound anatomical knowledge can also be imperative when predicting the metastatic spread of abdominopelvic malignancy.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Wasnik AP, Maturen KE, Kaza RK, Al-Hawary MM, Francis IR. Primary and secondary disease of the peritoneum and mesentery: Review of anatomy and imaging features. Abdom Imaging 2015;40:626-42.
2. Levy AD, Arnáiz J, Shaw JC, Sobin LH. From the archives of the AFIP: Primary peritoneal tumors: Imaging features with pathologic correlation. Radiographics 2008;28:583-607.
3. Levy AD, Shaw JC, Sobin LH. Secondary tumors and tumorlike lesions of the peritoneal cavity: Imaging features with pathologic correlation. Radiographics 2009;29:347-73.
4. Meyers MA, Oliphant M, Berne AS, Feldberg MA. The peritoneal ligaments and mesenteries: Pathways of intraabdominal spread of disease. Radiology 1987;163:593-604.
5. Feldman GB, Knapp RC. Lymphatic drainage of the peritoneal cavity and its significance in ovarian cancer. Am J Obstet Gynecol 1974;119:991-4.
6. DeMeo JH, Fulcher AS, Austin RF Jr. Anatomic CT demonstration of the peritoneal spaces, ligaments, and mesenteries: Normal and pathologic processes. Radiographics 1995;15:755-70.
7. Yoo E, Kim JH, Kim MJ, Yu JS, Chung JJ, Yoo HS, *et al*. Greater and lesser omenta: Normal anatomy and pathologic processes. Radiographics 2007;27:707-20.
8. van Baal JO, Van de Vijver KK, Nieuwland R, van Noorden CJ, van Driel WJ, Sturk A, *et al*. The histophysiology and pathophysiology of the peritoneum. Tissue Cell 2017;49:95-105.
9. Hesseldahl H, Larsen JF. Ultrastructure of human yolk sac: Endoderm, mesenchyme, tubules and mesothelium. Am J Anat 1969;126:315-35.
10. van Baal JO, van Noorden CJ, Nieuwland R, Van de Vijver KK, Sturk A, van Driel WJ, *et al*. Development of peritoneal carcinomatosis in epithelial ovarian cancer: A review. J Histochem Cytochem 2018;66:67-83.
11. Kastelein AW, Vos LM, de Jong KH, van Baal JO, Nieuwland R, van Noorden CJ, *et al*. Embryology, anatomy, physiology and pathophysiology of the peritoneum and the peritoneal vasculature. Semin Cell Dev Biol 2019;92:27-36.
12. Elsayes KM, Staveteig PT, Narra VR, Leyendecker JR, Lewis JS Jr., Brown JJ. MRI of the peritoneum: Spectrum of abnormalities. AJR Am J Roentgenol 2006;186:1368-79.
13. Rubenstein WA, Auh YH, Whalen JP, Kazam E. The perihepatic spaces: Computed tomographic and ultrasound imaging. Radiology 1983;149:231-9.
14. Solass W, Struller F, Horvath P, Königsrainer A, Sipos B, Weinreich FJ. Morphology of the peritoneal cavity and pathophysiological consequences. Pleura Peritoneum 2016;1:193-201.
15. Tirkes T, Sandrasegaran K, Patel AA, Hollar MA, Tejada JG, Tann M, *et al*. Peritoneal and retroperitoneal anatomy and its relevance for cross-sectional imaging. Radiographics 2012;32:437-51.
16. Oliphant M, Berne AS, Meyers MA. The subperitoneal space of the abdomen and pelvis: Planes of continuity. AJR Am J Roentgenol 1996;167:1433-9.
17. Davis CE Jr., VanHorn CN, Frazier AB, Dizon A. Subphrenic space infection--reassessment. Ann Surg 1968;168:1004-10.
18. Healy JC. Detection of peritoneal metastases. Cancer Imaging 2001;1:4-12.
19. Wooler GH. Subphrenic abscess. Thorax 1956;11:211-22.
20. Sherman NJ, Davis JR, Jesseph JE. Subphrenic abscess. A continuing hazard. Am J Surg 1969;117:117-23.
21. DeCrosse JJ, Poulin TL, Fox PS, Condon RE. Subphrenic abscess. Surg Gynecol Obstet 1974;138:841-6.
22. Srinualnad N, Dixon AK. Right anterior subphrenic space: An important site for the early detection of intraperitoneal fluid on abdominal CT. Abdom Imaging 1999;24:614-7.
23. Tiwari A, Sharma H, Qamar K, Sodeman T, Nawras A. Recognition of extraperitoneal colonic perforation following colonoscopy: A review of the literature. Case Rep Gastroenterol 2017;11:256-64.
24. Boyd DP. The anatomy and pathology of the subphrenic spaces. Surg Clin North Am 1958;38:619-26.
25. Boyd DP. The subphrenic spaces and the emperor's new robes. N Engl J Med 1966;275:911-7.
26. Meyers MA. The spread and localization of acute

intraperitoneal effusions. Radiology 1970;95:547-54.
27. Liu S, Liu H, Luan M. Cross-section anatomy of the subphrenic spaces. Zhonghua Wai Ke Za Zhi 1996;34:120-2.
28. Healy JC, Reznek RH. The peritoneum, mesenteries and omenta: Normal anatomy and pathological processes. Eur Radiol 1998;8:886-900.
29. Halvorsen RA, Jones MA, Rice RP, Thompson WM. Anterior left subphrenic abscess: Characteristic plain film and CT appearance. AJR Am J Roentgenol 1982;139:283-9.
30. Magilligan DJ Jr. Suprahepatic abscess. Arch Surg 1968;96:14-9.
31. Mottram ME. Subphrenic abscess: Roentgen considerations. Calif Med 1967;107:20-5.
32. Silverman PM. The subperitoneal space: Mechanisms of tumour spread in the peritoneal cavity, mesentery, and omentum. Cancer Imaging 2003;4:25-9.
33. Levine CD, Patel UJ, Wachsberg RH, Simmons MZ, Baker SR, Cho KC. CT in patients with blunt abdominal trauma: Clinical significance of intraperitoneal fluid detected on a scan with otherwise normal findings. AJR Am J Roentgenol 1995;164:1381-5.
34. Moore EE, Cogbill TH, Jurkovich GJ, Shackford SR, Malangoni MA, Champion HR. Organ injury scaling: Spleen and liver (1994 revision). J Trauma 1995;38:323-4.
35. Kozar RA, Crandall M, Shanmuganathan K, Zarzaur BL, Coburn M, Cribari C, *et al.* Organ injury scaling 2018 update: Spleen, liver, and kidney. J Trauma Acute Care Surg 2018;85:1119-22.
36. Balthazar EJ, Hilton S, Naidich D, Megibow A, Levine R. CT of splenic and perisplenic abnormalities in septic patients. AJR Am J Roentgenol 1985;144:53-6.
37. Fishman EK, Soyer P, Bliss DF, Bluemke DA, Devine N. Splenic involvement in pancreatitis: Spectrum of CT findings. AJR Am J Roentgenol 1995;164:631-5.
38. Kim S, Kim TU, Lee JW, Lee TH, Lee SH, Jeon TY, *et al*. The perihepatic space: Comprehensive anatomy and CT features of pathologic conditions. Radiographics 2007;27:129-43.
39. Berger HJ, De Graaff C, Baggish DA, Taylor KJ, Hoffer PB. Subhepatic intraperitoneal abscess. JAMA 1979;242:657-9.
40. Moga D, Perișanu Ș, Popențiu A, Sora D, Magdu H. Right retroperitoneal and subhepatic abscess; late complications due to spilled stones during laparoscopic cholecystectomy-case report. Chirurgia (Bucur) 2016;111:67-70.
41. Körner M, Krötz MM, Degenhart C, Pfeifer KJ, Reiser MF, Linsenmaier U. Current role of emergency US in patients with major trauma. Radiographics 2008;28:225-42.
42. Dolich MO, McKenney MG, Varela JE, Compton RP, McKenney KL, Cohn SM. 2,576 ultrasounds for blunt abdominal trauma. J Trauma 2001;50:108-12.
43. Elmohr MM, Blair KJ, Menias CO, Nada A, Shaaban AM, Sandrasegaran K, *et al*. The lesser sac and foramen of winslow: Anatomy, embryology, and CT appearance of pathologic processes. AJR Am J Roentgenol 2020;215:843-51.
44. Nichols DM. Lesser sac anatomy. AJR Am J Roentgenol 1985;145:651-2.
45. Shrestha BM, Brown PW, Wilkie ME, Raftery AT. The anatomy and pathology of the lesser sac: Implications for peritoneal dialysis. Perit Dial Int 2010;30:496-501.
46. Gore RM, Callen PW, Filly RA. Lesser sac fluid in predicting the etiology of ascites: CT findings. AJR Am J Roentgenol 1982;139:71-4.
47. Jeffrey RB, Federle MP, Goodman PC. Computed tomography of the lesser peritoneal sac. Radiology 1981;141:117-22.
48. Bendahan J, Cozacov C, Freund U. Posterior duodenal ulcer: Acute free perforation into the lesser sac. Isr J Med Sci 1987;23:205-8.
49. Balani A, Dey AK, Sarjare S, Chatur C. Emphysematous pancreatitis: Classic findings. BMJ Case Rep 2016;2016:bcr-2016-217445.
50. Dodds WJ, Foley WD, Lawson TL, Stewart ET, Taylor A. Anatomy and imaging of the lesser peritoneal sac. AJR Am J Roentgenol 1985;144:567-75.
51. Liebermann-Meffert D. The greater omentum. Anatomy, embryology, and surgical applications. Surg Clin North Am 2000;80:275-93, xii.
52. Sompayrac SW, Mindelzun RE, Silverman PM, Sze R. The greater omentum. AJR Am J Roentgenol 1997;168:683-7.
53. Raptopoulos V, Gourtsoyiannis N. Peritoneal carcinomatosis. Eur Radiol 2001;11:2195-206.
54. Hanks PW, Brody JM. Blunt injury to mesentery and small bowel: CT evaluation. Radiol Clin North Am 2003;41:1171-82.
55. Chi XX, Zhang XM, Chen TW, Huang XH, Yang L, Tang W, *et al*. The normal transverse mesocolon and involvement of the mesocolon in acute pancreatitis: An MRI study. PLoS One 2014;9:e93687.
56. Okino Y, Kiyosue H, Mori H, Komatsu E, Matsumoto S, Yamada Y, *et al*. Root of the small-bowel mesentery: Correlative anatomy and CT features of pathologic conditions. Radiographics 2001;21:1475-90.
57. Hagiwara A, Yukioka T, Satou M, Yoshii H, Yamamoto S, Matsuda H, *et al*. Early diagnosis of small intestine rupture from blunt abdominal trauma using computed tomography: Significance of the streaky density within the mesentery. J Trauma 1995;38:630-3.
58. Wang RF, Chong CF, Hsu HT, Wang TL, Chen CC. Mesenteric injury caused by minor blunt abdominal trauma. Emerg Med J 2006;23:e27.
59. Krishnamurthy S, Balasubramaniam R. Role of imaging in peritoneal surface malignancies. Indian J Surg Oncol 2016;7:441-52.
60. Heller DS. Lesions of the broad ligament: A review. J Minim Invasive Gynecol 2015;22:1163-8.
61. Gardner GH, Greene RR, Peckham BM. Normal and cystic structures of the broad ligament. Am J Obstet Gynecol 1948;55:917-39.
62. Chaudhry SR, Imonugo O, Jozsa F, Chaudhry K. Anatomy, abdomen and pelvis: Ligaments. In: StatPearls. Treasure Island, FL: StatPearls; 2022.
63. Sorensen T. The pouch of Douglas. Med J Aust 2015;202:598-9.
64. Heller DS. Lesions of the pouch of Douglas: A review. J Minim Invasive Gynecol 2016;23:28-33.
65. Pannu HK, Oliphant M. The subperitoneal space and peritoneal cavity: Basic concepts. Abdom Imaging 2015;40:2710-22.

How to cite this article: Montanarella M, Boldig K, Virarkar M, Kumar S, Elsherif S, Lall C, *et al*. Intraperitoneal anatomy with the aid of pathologic fluid and gas: An imaging pictorial review. J Clin Imaging Sci 2023;13:13.