INTRODUCTION

The peritoneum, omentum and mesentery are common sites for secondary disease extension from adjacent visceral organs and distant metastatic deposits .In addition they are also important sites of primary neoplastic disease. Detection of peritoneal dissemination is essential in staging and subsequent management of the primary tumors.(1)

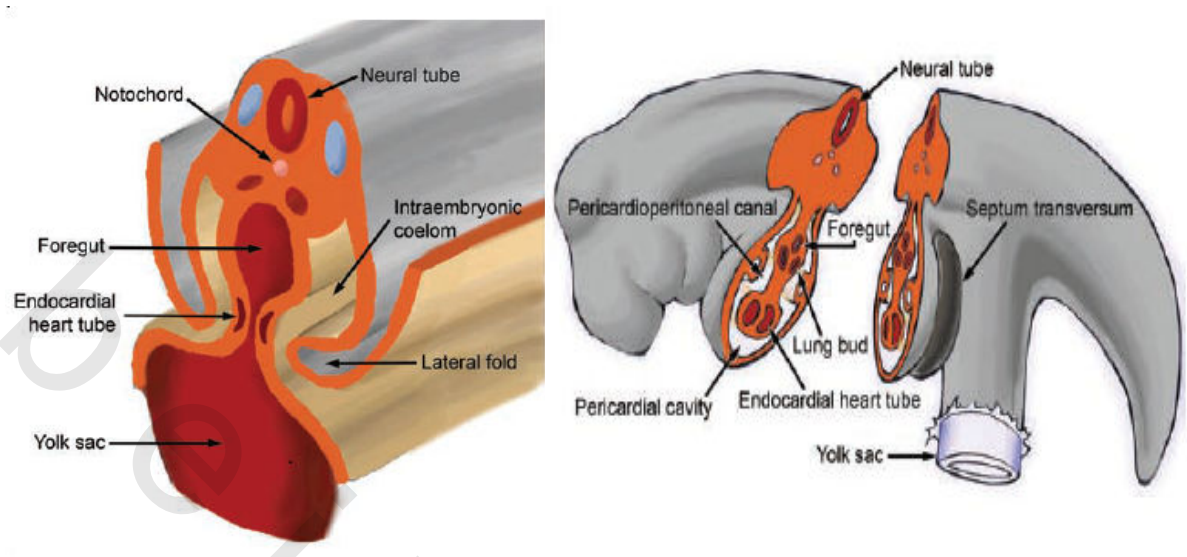
Although advances in imaging technology have allowed a significant increase in spatial resolution, detection of peritoneal disease remains a challenge, in part due to its complex anatomical configuration, and in part due to the extensive surface area that may host typically small, nodular tumor deposits.(1)

It has become essential that radiologists should understand the peritoneal spaces, ligaments and mesenteries in order to localize disease to a particular peritoneal space and formulate a differential diagnosis.(2)

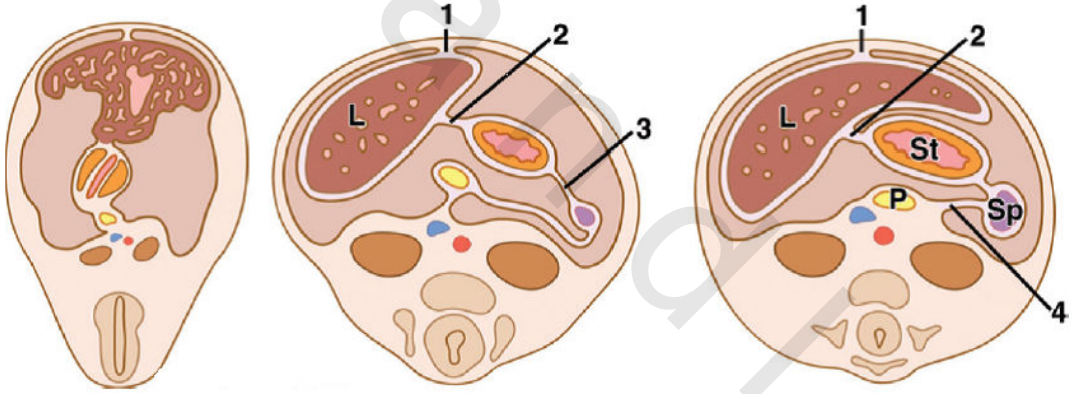
Embryologic Development of peritoneum and mesentery:

During the second week of development, the lateral margins of the mesoderm move ventrally and medially to enclose the yolk sac and form the single intra-embryonic coelomic cavity. This process divides the lateral mesoderm into a parietal layer and a visceral layer, which form the lining of the primitive coelomic cavity (Fig 1). The single coelomic space is later partitioned into thoracic and abdominal portions by the formation of the septum transversum, forming the future central tendon, as well as by two pleuroperitoneal membranes. The cephalic and middle parts of this cavity are the future pericardial cavity, while the thin lateral parts are the future peritoneal and pleural cavities. The separation of the pleuroperitoneal cavity is completed first on the right side.(3,4)

The position of the gut within the primitive mesentery plane divides the primitive mesentery into ventral and dorsal portions, which undergo specialization throughout fetal life (Fig 2). Vessels , lymphatics and nerves that supply the abdominal viscera are enfolded within the plane of the primitive mesentery. The liver grows within the ventral plane. The spleen and pancreas and a major portion of the gut grow within the dorsal plane. The rotations, descent, and resorption of the mesenteric plane take place throughout fetal life.(2)



Figure(1): Diagrams showing peritoneal development during the third week of emberyo. The lateral fold of the mesoderm moves ventrally and medially to enclose the yolk sac to form single intraemberyonic coelomic cavity. [5]



(a) (b) (c)

Figure(2): Illustrations showing the emberyological development of the dorsal and ventral mesentery at 4th (a),5th (b),and 6th (c) weeks of gestation.(1)The ventral part of the ventral mesentery becomes the falciform ligament,(2)The dorsal part of the ventral mesentery becomes the lesser omentum,(3)The ventral part of the dorsal mesentery becomes the gastrosplenic ligament,(4)The dorsal part of the dorsal mesentery becomes the splenorenal ligament.(L)The liver develops in the ventral mesentery, whereas the stomach(St),spleen(Sp) and pancreatic tail (P) develop in the dorsal mesentery. As the liver expands in the 5th and 6th weeks of gestation, the stomach and spleen are pushed to the left and the pancreatic tail becomes retroperitoneal.[2]

Anatomy of peritoneum and mesentery:

The peritoneum is a thin, translucent, serous membrane and is the largest and most complexly arranged serous membrane in the body. The peritoneum that lines the abdominal wall is called the parietal peritoneum, whereas the peritoneum that covers a viscus or an organ is called a visceral peritoneum. Both types of peritoneum consist of a single layer of simple low-cuboidal epithelium called a mesothelium. A capillary film of serous fluid (approximately 50–100 mL) separates the parietal and visceral layers of peritoneum and lubricates the peritoneal surfaces. (6)

The peritoneal cavity is a potential space between the two layers of the peritoneum. In men, the peritoneal cavity is closed, but in women, it communicates with the extraperitoneal pelvis through the fallopian tubes.(7)

Peritoneal ligaments are double layers of peritoneum that support a structure within the peritoneal cavity; omentum and mesentery are specifically named peritoneal ligaments. Omentum is a double layer of peritoneum that extends from the stomach and duodenal bulb to adjacent organs. The lesser omentum, which is made of two contiguous components called the gastrohepatic and hepatoduodenal ligaments, attaches the stomach and duodenal bulb to the liver. The greater omentum is attached to the stomach and hangs from the transverse colon. Mesentery is a double layer of peritoneum, the mesenteric contents include blood vessels, lymph nodes, nerves, and fat. The most mobile parts of the intestine have a mesentery ; the small bowel mesentery is attached to the retroperitoneum, and the retroperitoneal portions of the colon may contain remnant mesocolon.(2)

Peritoneal Ligaments:

I) Suspensory Ligaments of the Liver:

A) ***Triangular Ligaments:*** The triangular ligament is formed by the fusion of the superior and inferior reflections of the coronary ligaments. Unlike the left triangular ligament, the right triangular ligament is long and separates the right subphrenic space from the right subhepatic space. The triangular ligaments outline the bare area of the liver .(6)

B) ***Falciform Ligament****:* The falciform ligament is the remnant of the most ventral part of the ventral mesentery and contains the obliterated umbilical vein. It is a relative barrier to the transfer of fluid from the right subphrenic space to the left subphrenic space (Fig 3). It is important to realize that peritoneal tumor spread in the falciform ligament may mimic liver metastasis.(6)

II) Peritoneal Ligaments of the Stomach :

A) ***Lesser Omentum:*** The gastrohepatic and hepatoduodenal ligaments are contiguous peritoneal ligaments that form the lesser omentum and they are remnants of the dorsal portion of the ventral mesentery. The gastrohepatic ligament attaches the lesser curve of the stomach to the liver and contains the coronary vein and left gastric artery (Fig4). The hepatoduodenal ligament attaches the duodenum to the liver and contains the portal vein, hepatic artery, common hepatic ducts, and part of the cystic duct. Until the 8th embryonic week, this part of the ventral mesentery also contains the ventral part of

the pancreas, so the hepatoduodenal ligament is a route of spread of pancreatic disease to the porta hepatis and liver.[2]

B) Gastrosplenic Ligament: The dorsal mesentery extends between the greater curve of the stomach and the spleen (Fig 3a). The superior part of the dorsal mesentery becomes the gastrosplenic ligament, which contains the short gastric vessels and a collateral route of venous flow after splenic vein thrombosis. Fluid within the gastrosplenic ligament is often mistaken for a lesser sac collection.[8]

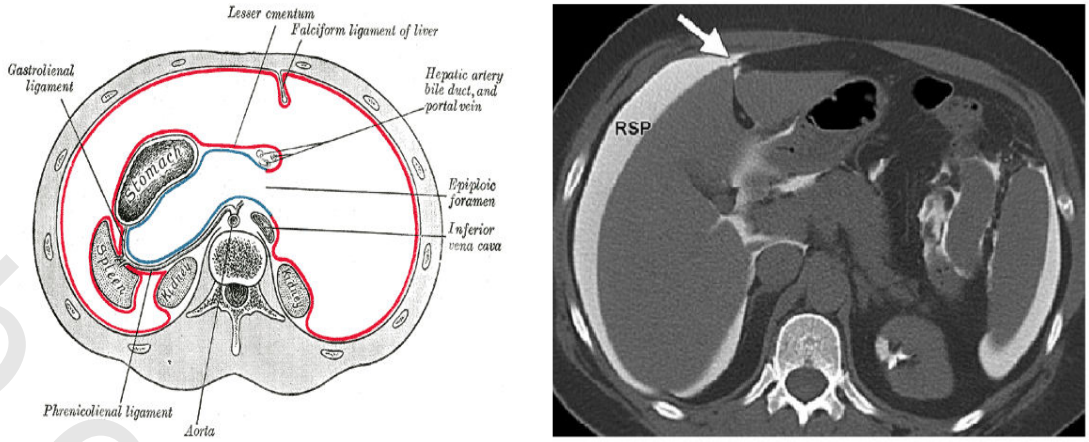
C) Greater Omentum: Because of the growth and rotation of the stomach in utero, the inferior aspect of the ventral part of the dorsal mesentery becomes redundant, and its two layers fuse with one another to form the gastrocolic ligament, or the greater omentum. The greater omentum may become visible if it is diseased or if ascites is present (Fig 5). [9]

(III) Splenorenal Ligament: The splenorenal ligament is the most dorsal aspect of the dorsal mesentery. It contains the pancreatic tail and splenorenal collateral vessels in patients with portal hypertension (Fig 3a). [2]

(IV) Transverse Mesocolon: The transverse mesocolon is a peritoneal fold that attaches the transverse colon to the retroperitoneum and contains the middle colic vessels. In patients with pancreatic head cancer, it is an important possible source of local extension. Because of its numerous vessels, vascular control is difficult, and extension into the mesocolon renders pancreatic cancer inoperable. [10]

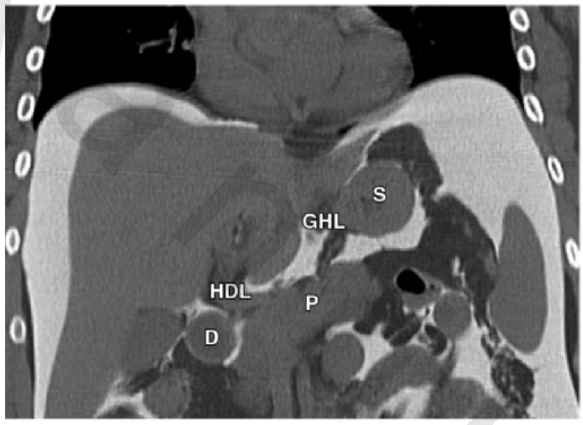
(V) Small Bowel Mesentery: It attaches the small bowel to the retroperitoneum and extends from the ligament of Treitz to the ileocecal valve. It contains the superior mesenteric vessels and their branches, which mark its position at contrast-enhanced CT. Inflammation and tumor may involve the mesentery directly (eg: from the pancreatic body or jejunum) or by way of the neurovascular plexus or lymphatic channels that run within it.[11]

(VI) Sigmoid Mesocolon: The sigmoid mesocolon is a peritoneal ligament that attaches the sigmoid colon to the posterior pelvic wall and contains the hemorrhoidal and sigmoid vessels.[11]

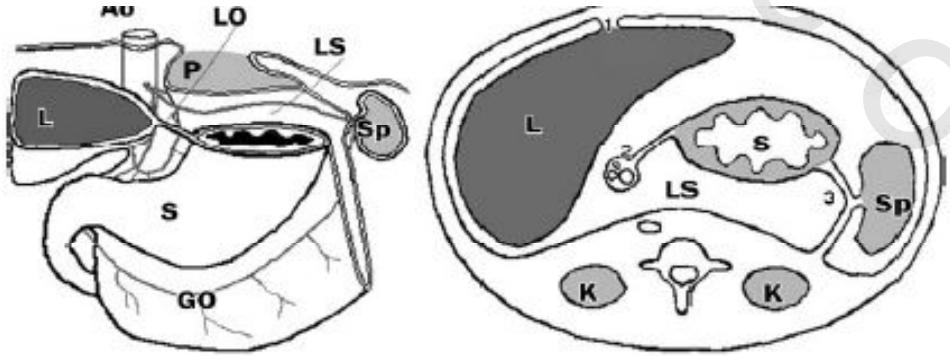


(a) (b)

Figure(3): Falciform ligament. (a)Diagram illustrating the falciform ligament separating between the right and left subphrenic spaces.(b)Axial CT of a patient on peritoneal dialysis with high attenuation dialysate solution filling the right subphrenic (RSP)space, and the arrow points to the falciform ligament. [2]



Figure(4): Peritoneal ligaments. Coronal CT of a patient on peritoneal dialysis with high attenuation dialysate solution outlining the gastrohepatic (GHL)and hepatoduodenal (HDL) ligament, stomach (S), pancrease (P),and duodenum(D). [2]



Figure(5): Anatomy of the greater and lesser omenta. Greater omentum(GO), lesser omentum (LO), lesser sac(LS), spleen(SP), stomach(S). [9]

Peritoneal Spaces:

Knowledge of the peritoneal spaces and the routes of communication between them is important. The transverse mesocolon divides the peritoneum into the supramesocolic and inframesocolic spaces; the bilateral paracolic and pelvic spaces are also peritoneal spaces.[2]

I) Supramesocolic Spaces:

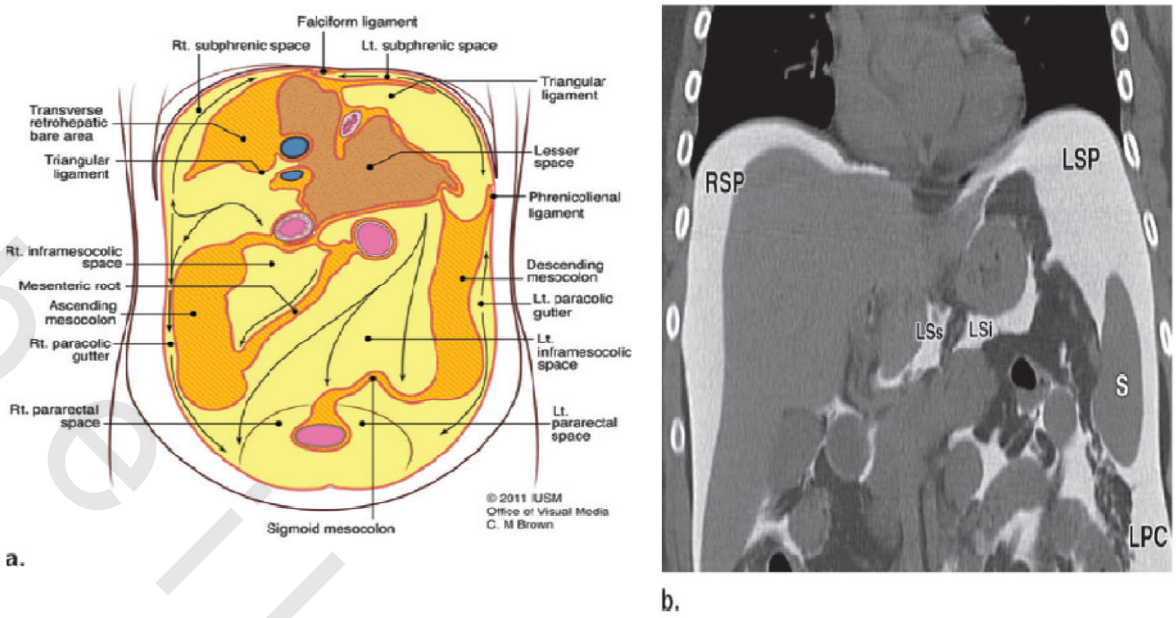
A) Left Supramesocolic Spaces: include the left subphrenic, and perisplenic spaces. The phrenicocolic ligament is a relative but incomplete barrier to the spread of pathologic processes from the left paracolic gutter to the left subphrenic space (Fig 6). [2]

B) Right Supramesocolic Spaces: include the right subphrenic space, the Morison pouch (subhepatic or hepatorenal space), and the lesser sac . The right subphrenic space is separated from the left perihepatic space by the falciform ligament (Fig 6). The lesser sac communicates with the subhepatic space through the foramen of Winslow. [2]

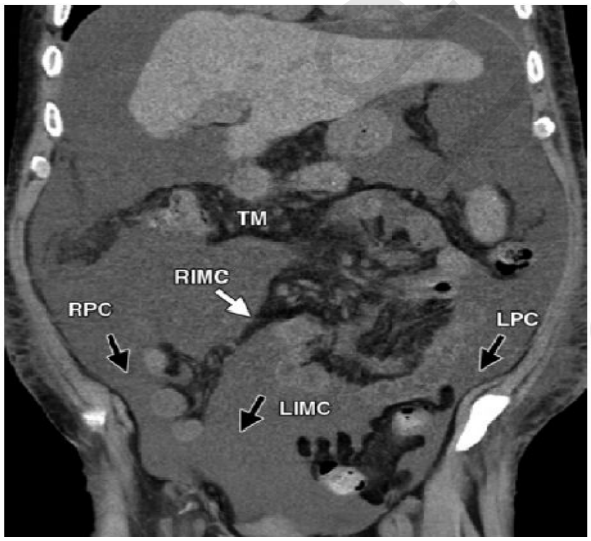
II) Inframesocolic Spaces: The right and left inframesocolic spaces are separated from the supramesocolic spaces by the transverse mesocolon and from the paracolic gutters laterally by the ascending or descending colon (Fig 7).The left inframesocolic space communicates with the pelvic space.[2]

III) Paracolic Spaces: The paracolic spaces are located lateral to the peritoneal reflections of the left and right sides of the colon (Fig 7). The right paracolic gutter is larger than the left and communicates freely with the right subphrenic space. The connection between the left paracolic gutter and the left subphrenic space is partially limited by the phrenicocolic ligament. Both the right and left paracolic gutters communicate with the pelvic spaces. [2]

IV) Pelvic Space: In men, the most gravity-dependent site for fluid accumulation is the recto-vesical space. In women, it is the retro-uterine space (the pouch of Douglas).[2]



Figure(6): Peritoneal spaces. (a)Diagram showing the peritoneal spaces and the direction of flow of normal amount of peritoneal fluid.(b)Coronal CT image of patient on peritoneal dialysis with high attenuation dialysate solution.The left subphrenic space (LSP) communicates with left paracolic space (LPC). Superior (LSs) and inferior (LSi) recesses of lesser sac are separated by fold containg the left gastric vessels.(S)spleen,(RSP) right subphrenic space. [2]



Figure(7): Inframesocolic peritoneal space. Coronal CT image of a patient with ascites showing the right inframesocolic (RIMC), left inframesocolic (LIMC), right paracolic (RPC) and left paracolic spaces (LPC). [2]

Imaging Modalities of peritoneal and mesenteric tumors:

Multidetector computed tomography (MDCT), magnetic resonance imaging (MRI), positron emission tomography (PET) and combined PET/CT have become the mainstay of peritoneal imaging in clinical practice. Although ultrasonography plays a small role in imaging of peritoneal malignancy, it is often an important modality of choice for image-guided biopsy to achieve a histological diagnosis. [12,13]

A) Ultrasonography (US):

Ultrasonography detects peritoneal collections or ascites and is used to guide drain-age of ascites. A specific advantage of US is its portability. Compared with computed tomography (CT), other advantages of US are its lack of ionizing radiation and lower cost. However, US does not provide global assessment of abdominal or pelvic anatomy. [2]

B) Computed Tomography(CT):

CT enables accurate evaluation of the complex peritoneal cavity anatomy, which is the key to understand the pathologic processes that occur there. To fully delineate peritoneal anatomy and the extent of disease, we perform isotropic imaging with coronal and sagittal reformations. Imaging after administration of intravenous contrast and water density oral contrast is usually all that is required to allow detection of small peritoneal deposits.[14]

Overall, contrast-enhanced MDCT offers 25-100% sensitivity and 78-100% specificity in the preoperative staging of peritoneal carcinomatosis and remains the imaging modality of choice in this setting.[15-18]

Tumor deposits measuring less than 5mm and those in certain anatomical locations (e.g. root of mesentery, lesser omentum, left hemidiaphragm and serosal surface of the small bowel) were associated with significantly reduced detection sensitivities with CT (11-48%). [15,18,20]

C) Magnetic resonance imaging (MRI):

Usage of MR imaging to detect peritoneal disease is increasing. Disadvantages of MR imaging include motion artifacts caused by respiration and peristalsis and chemical shift artifacts at the bowel-mesentery interface. Patients who are ill and have peritoneal carcinomatosis, acute pancreatitis, or intraabdominal sepsis may not tolerate prolonged MR imaging examinations (which usually require 30–45 minutes to scan the entire abdomen and pelvis) and the multiple breath-hold sequences that are required. In contrast, an isotropic CT examination of the abdomen and pelvis conducted with a multidetector scanner of 16 or more rows may be completed within 15 seconds. [21]

However, MR imaging lacks ionizing radiation making it suitable for usage in children and young adults, particularly those who need repeated imaging. Newer MR imaging techniques such as diffusion-weighted imaging are reported to be useful in detection of small peritoneal metastases and metastatic disease in apparently normal-sized lymph nodes by showing restricted diffusion. [22,23]

DWI has been shown to improve detection of peritoneal disease when combined with conventional contrast-enhanced MRI. Sensitivity and specificity of 90% and 95.5% have been reported.[24]

The high contrast conspicuity of fat-suppressed and delayed gadolinium enhanced MRI makes it the imaging modality of choice in detection not only subcentimetre deposits (including those of a size 5 mm), but also deposits in anatomically difficult sites (e.g. subphrenic, mesenteric and bowel serosa).[25]

MRI is the imaging modality of choice in local staging of primary pelvic / gynaecological malignancies due to its superior contrast resolution.[1]

D) Positron emission tomography/computed tomography (PET/CT):

The fusion of functional and anatomic information with positron emission tomography and computed tomography can be used to diagnose peritoneal carcinomatosis with greater confidence. The reported sensitivities of FDG PET/ CT for the detection of peritoneal carcinomatosis are 78%–100%, with the highest sensitivities in patients with clinically suspected recurrent tumor because of elevation in tumor markers. [26-28]

Classification of peritoneal tumors: Peritoneal tumors are classified into primary and secondary tumors, secondary tumors are much more common than primary tumors. [29]

Secondary tumors include: [29]

- Peritoneal carcinomatosis
- Pseudomyxoma peritonei
- Peritoneal lymphomatosis
- Peritoneal sarcomatosis

Primary tumors include: [29]

- Mesothelial tumors:
    - Peritoneal malignant mesothelioma
    - Well differentiated papillary mesotheliom
    - Multicystic mesothelioma
    - Adenomatoid tumor
- Epithelial tumors:
    - Primary peritoneal serous carcinoma
    - Primary peritoneal serous borderline tumor
- Smooth muscle tumor:
    - Leiomyomatosis peritonealis disseminata
- Tumors of uncertain origin:
    - Desmoplastic small round cell tumor
    - Solitary fibrous tumor

The peritoneal ligaments, mesenteries, and omenta serve as conduits for disease spread. Peritoneal metastases spread in four ways:[29]

A. Direct spread along peritoneal ligaments, mesenteries and omenta .
B. Intraperitoneal seedling via ascitic fluid.
C. Lymphatic extension.
D. Embolic haematogenous spread.

A) Direct spread

Direct invasion from primary tumors to noncontiguous organs occurs along the peritoneal reflections, These include: [30,31]

- Eight ligaments — the right and left coronary, falciform, hepatoduodenal, duodenocolic, gastrosplenic, splenorenal, and phrenicocolic ligaments.
- Four mesenteries — the small bowel mesentery, the transverse mesocolon, the sigmoid mesocolon, and the mesoappendix.
- Two omenta — the lesser and greater omentum.

Spread along these peritoneal reflections is commonly seen with malignant neoplasms of the stomach, colon, pancreas and ovary. [30,31]

B) Intraperitoneal seedling:

Intraperitoneal fluid is constantly circulating throughout the abdomen influenced by gravity and negative intraabdominal pressure, produced beneath the diaphragm during respiration. It allows transcoelomic dissemination of malignant cells. Their deposition, fixation and growth are encouraged in particular sites due to relative stasis of ascitic fluid.[32]

The most common tumors to spread in this fashion include ovarian cancer in females and malignancies of the gastrointestinal tract in males, especially cancer of the stomach, colon, and pancreas. [32]

The sites most commonly involved by peritoneal seedling are: [32]

- The pelvis, especially the pouch of Douglas.
- The right lower quadrant at the inferior junction of the small bowel mesentery.
- The superior aspect of the sigmoid mesocolon.
- The right paracolic gutter.

C) Lymphatic metastases:

Lymphatic metastases play a minor role in the intraperitoneal dissemination of metastatic carcinoma, but is very important in the spread of lymphoma to mesenteric lymph nodes. Almost 50% of patients with non-Hodgkin's lymphoma will have mesenteric nodes at presentation, compared to only 5% of patients with Hodgkin's disease.[33]

Large conglomerations of lymph nodes may surround the superior mesenteric artery and vein on CT and demonstrate the so-called 'sandwich sign'. [34,35]

D) Embolic metastases:

The abdomen is a common site for haematogenous metastases from both intra-abdominal and extra-abdominal primary tumors. The tumor emboli spread via the mesenteric arteries to deposit on the antimesenteric border of the bowel in the smallest arterial branches, where they grow into mural nodules. The most common tumors that metastasise embolically to bowel and the peritoneal reflections are melanoma, breast and lung cancer. These metastases often occur several years after treatment of the primary neoplasm. Occasionally bowel obstruction or intussusception, as a consequence of embolic metastases, may be the first manifestation of an occult malignancy. [36]

Imaging and pathological features of Secondary peritoneal tumors:

i) Peritoneal Carcinomatosis:

Carcinomas from the gastrointestinal tract (stomach, colon, appendix, gallbladder, and pancreas), ovary, breast, lung, and uterus may metastasize to the peritoneal surface [37,38].

Patients with peritoneal carcinomatosis may be asymptomatic at the onset of the lesions, but progressive involvement of the peritoneum will cause them to complain of abdominal enlargement from ascites or nausea, vomiting, and abdominal pain from bowel obstruction. Bowel obstruction is most frequently reported in patients with peritoneal carcinomatosis from colorectal carcinomas. [39]

Imaging Features: CT is the imaging modality of choice for evaluating patients with diffuse abdominal disorders and for staging malignancies that may involve the peritoneal cavity. [39,40]

Because ascites is a common finding in peritoneal carcinomatosis, the discovery of new-onset ascites should lead to a careful search for findings that would indicate a malignant etiology.[41]

Thickening, nodularity, and intravenous contrast material enhancement of the peritoneum are also suggestive of a malignant process. In a patient with a known primary malignancy , careful inspection of the anatomic regions of peritoneal cavity where stasis of peritoneal fluid occurs is important during staging because peritoneal tumors can be subtle and difficult to identify. The pouch of Douglas or retrovesical space, ileocecal region, paracolic gutters, subhepatic space, right subdiaphragmatic space, and root of the small bowel mesentery are important sites of occult tumor (Fig 8) .[42]

The imaging findings of peritoneal carcinomatosis vary from multifocal discrete nodules to infiltrative masses. Infiltration of the small bowel mesentery with carcinomatosis may produce characteristic pleated or stellate patterns that occur as the soft tissue tumor replaces normal mesenteric fat. When viewed in cross section at CT, this pattern appears like stars in the sky and is referred to as a *stellate mesentery* .[41,43,34]

Pathologic Features*:*

Grossly Tumor nodules studding the peritoneal surfaces occur in peritoneal carcinomatosis. A fibrotic response may occur as the tumor grows along the peritoneal surface or invades into the subperitoneal tissues. Consequently, omental fat may be replaced with tumor and fibrosis, producing the classic gross appearance often referred to as omental caking (Fig 9a). Transperitoneal spread of tumor may also result in ovarian metastasis (Krukenberg tumors).Occasionally, peritoneal carcinomatosis exhibits a sheet like pattern of growth that encases intraperitoneal viscera and produces a gross appearance similar to that of malignant mesothelioma.(44)

The histologic characteristics of peritoneal carcinomatosis vary depending on the primary tumor. Adenocarcinomas are the most frequent types (Fig 9b). On occasion, carcinomas may histologically resemble malignant mesothelioma.The use of immunohistochemical staining assists in differentiating between carcinomas and mesothelial lesions.(44)

Common primaries of peritoneal deposits include: ovarian cancer ,gastric cancer ,colorectal cancer ,appendiceal malignancies ,gallbladder carcinoma ,pancreatic carcinoma ,breast cancer ,lung cancer and malignant melanoma.(44)

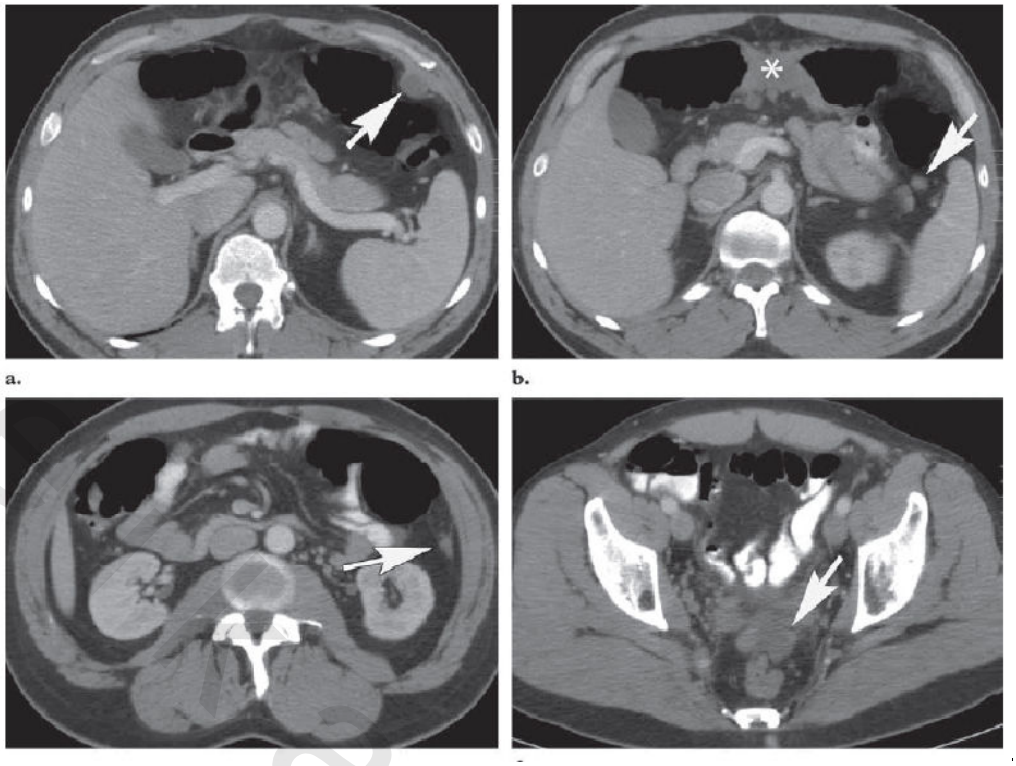
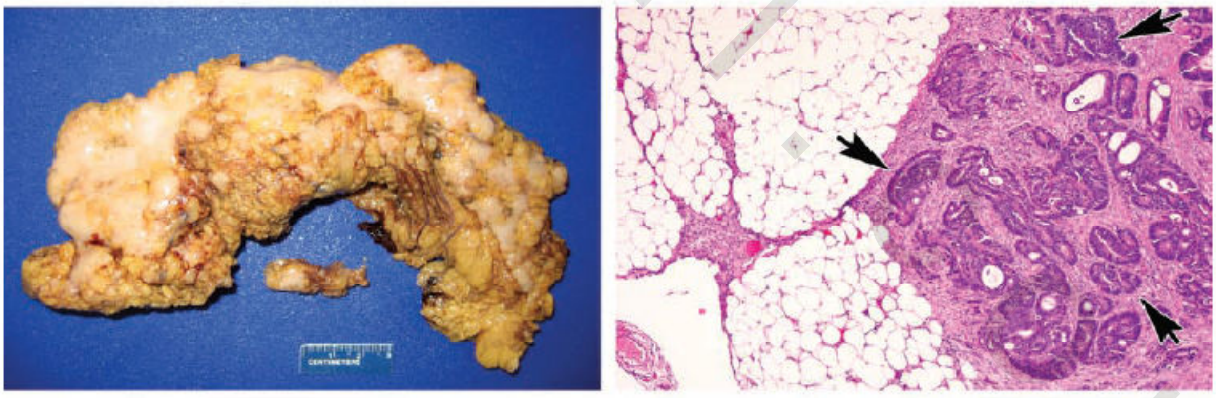


Figure (8): CT showing sites of occult peritoneal carcinomatosis in case of colonic adenocarcinoma. CT images with IV and oral contrast shows the primary colonic carcinoma at the transverse colon (* in b),nodular peritoneal thickening in the left upper abdomen (a),and other peritoneal nodules at the left paracolic and rectovesical spaces (c,d). (44)



(a) (b)

Figure(9): Pathology of peritoneal carcinomatosis from colonic adenocarcinoma. (a) The resected greater omentum shows tumor nodules that stud the omental surface and replace normal fat.(b) Glands of metastatic adenocarcinoma (arrows) are seen adjacent to the fat surrounded by dense desmoplastic response (H&E,x100). (44)

ii) Pseudomyxoma Peritonei:

Pseudomyxoma peritonei is a rare condition which occurs more commonly in women than men. The mean age of patients at diagnosis is 49 years (range, 23–83 years). [45,46]

The term *pseudomyxoma peritonei* is a radiologic description rather than a pathologic diagnosis. The classification as well as the association of pseudomyxoma peritonei with various tumors is controversial. Many authors suggested that pseudomyxoma is divided into two categories. The first category is defined as pseudomyxoma peritonei, which contains benign or borderline-appearing epithelial cells or cells from well-differentiated (low-grade) mucinous carcinomas and was referred to by some as disseminated *peritoneal adenomucinosis*, this form of pseudomyxoma peritonei does not invade the stroma and appears to spread along the peritoneal surfaces, characteristics that make it amenable to surgical debulking.[47–49]

The second category is peritoneal *mucinous carcinomatosis*, which is characterized by invasive, high grade, moderately or poorly differentiated mucinous carcinoma with large extracellular pools of mucin. This second type originates from a mucinous carcinoma of the gastrointestinal tract, gallbladder, pancreas, or ovary, and its clinical course is fatal. It is now widely accepted that the majority of cases of classic pseudomyxoma peritonei develop from low-grade mucinous carcinomas that arise in the appendix and penetrate or rupture into the peritoneal cavity .[50]

The relationship between appendiceal and ovarian mucinous tumors has long been observed and continues to be one of the ongoing controversies when patients have pseudomyxoma peritonei and synchronous manifestation of ovarian and appendiceal tumors. The ovarian tumors frequently occur on the right side or are bilateral. Some authors believe that the ovarian tumors represent metastases of an appendiceal primary tumor, whereas others do not.[51,52]

Imaging Features. Abdominal radiography shows increased opacity throughout the abdomen, with poor definition of the intraabdominal organs and obliteration of the psoas margins. Focal collections of mucin in the right subhepatic space may obscure the inferior hepatic margin or contribute to medial displacement of the liver tip (Hellmer sign).[53] Occasionally, faint, curvilinear, or amorphous calcifications may be present within pseudomyxoma peritonei. [54,55]

Scalloping of the visceral surfaces of the intraperitoneal organs is an important diagnostic finding that helps differentiate pseudomyxoma from simple ascites, it represents the indentations that occur on the capsular margins of the intraperitoneal organs from the extrinsic pressure of the intraperitoneal mucinous implants (Fig10). It is most commonly observed along the margins of the liver and spleen. [56]

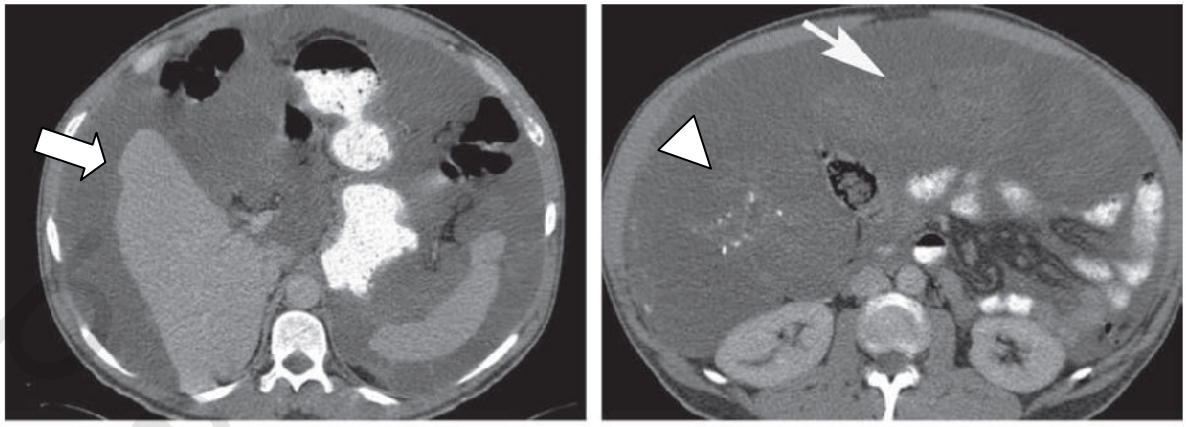
Pathologic Features:

Abundant mucin produced by the tumor causes the gross appearance of pseudomyxoma peritonei, which manifests with gelatinous material covering the peritoneal surface and mucinous ascites (Fig 11). [57]

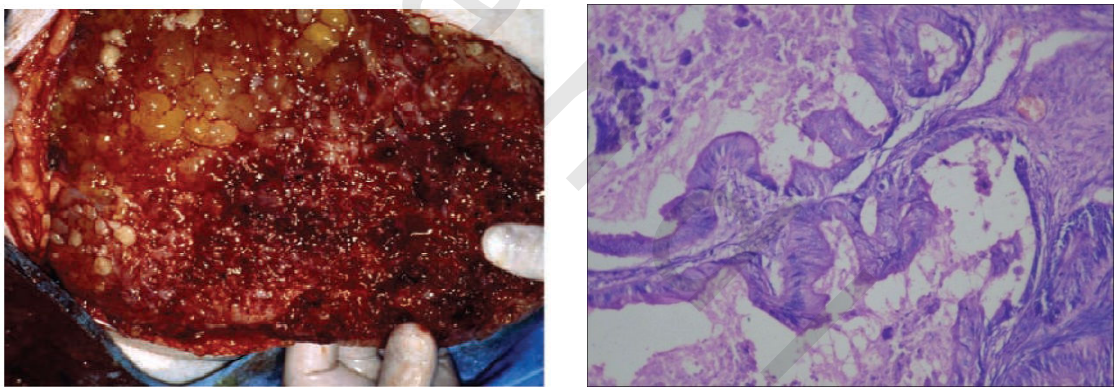
The classic pseudomyxoma peritonei shows mucin pools which may have few tumor cells, and when present, the tumor cells can be cytologically bland rather than frankly malignant. Hyalinized collagenous tissue may be admixed with the mucin or extend through the lobules of omentum. Benign appearing cells with slight nuclear atypia or those of a low-grade or well-differentiated carcinoma may be found lining the mucin pools (Fig 11b),the cellular areas may be very sparse or focally distributed. Scattered lymphocytes and histiocytes may be present.[52]Invasion and infiltration through the underlying peritoneal surface is typically not present. [52,58]

In contrast, mucinous carcinomatosis from a high-grade malignancy is characterized by abundant cellularity with moderately to poorly differentiated cells with or without mucin pools throughout the omentum and invading into the subperitoneal tissues [51].

Signet ring cells are commonly present. Although it may be difficult to distinguish pseudomyxoma peritonei from mucinous carcinomatosis at gross inspection, the distinction is important clinically because patients with pseudomyxoma peritonei from an appendiceal low-grade mucinous neoplasm have a 5-year survival rate of 50% and those who have mucinous carcinomatosis have a 5-year survival rate of less than 10%. [48]



Figure(10): CT of pseuomyxoma peritonei. Axial cuts of CT with IV and oral contrast shows (a) low attenuation mucinous ascites with scalloping of the liver and spleen (arrow) (b) shows calcifications(arrow head) and the greater omentum shows increased attenuation due to infiltration (arrow). [44]



(a) (b)

Figure (11): Pathological appearance of pseudomyxoma peritonei. (a) mucin globules in greater omentum (b) shows well-differentiated glandular cells that line the peritoneal surface without invading the stroma. [44]

iii) Peritoneal Lymphomatosis:

Lymphomas may involve the peritoneal surfaces as a primary or secondary process. Nodal or extranodal non-Hodgkin lymphomas, such as B-cell lymphoma and Burkitt lymphoma, may have secondary peritoneal involvement. (44)

Secondary peritoneal involvement may occur in the patients with lymphoma as well as in immunocompromised patients. Primary lymphomas of the peritoneum are uncommon and nearly exclusively found in immunocompromised patients, most of whom are infected with the human immunodeficiency virus, human herpes virus 8 (HHV-8) and Epstein-Barr virus. (59)

Imaging Features: Peritoneal lymphomatosis secondary to a preexisting lymphoma is characterized by diffusely thickened peritoneal surfaces with multifocal nodules and masses that mimic peritoneal carcinomatosis (Fig 12). Other CT features include ascites, peritoneal enhancement and thickening, omental caking, infiltration of the small bowel mesentery, and fine nodularity in the mesenteric and omental fat. (60,61)

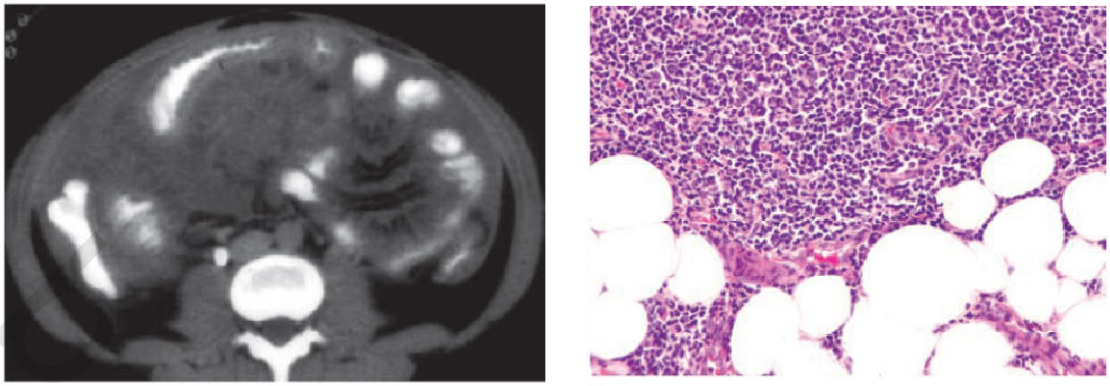
The presence of extensive adenopathy in lymph node chains typically involved with lymphoma, such as those in the retrocrural region and small bowel mesentery, may suggest lymphomatosis over carcinomatosis. In contrast, the most common imaging manifestation of primary effusion lymphoma in the peritoneal cavity is malignant ascites without associated lymphadenopathy, organomegaly,or masses. (62,63)

Pathologic Features.—Lymphomas that secondarily involve the peritoneum have the same histologic characteristics and immunophenotypic expression as lymphomas in any other location (Fig 12). The tumor cells are large to pleomorphic, with large round to irregular nuclei, prominent nucleoli, and a modest amount of basophilic cytoplasm. Some cells can have plasmacytoid appearance with a distinct area of pallor directly adjacent to the nucleus, a finding that is often referred to as a perinuclear hoff. The lymphoma cells are of B-cell origin and stain positive for CD20, CD79a, and CD10. (64)

iv) Peritoneal Sarcomatosis:

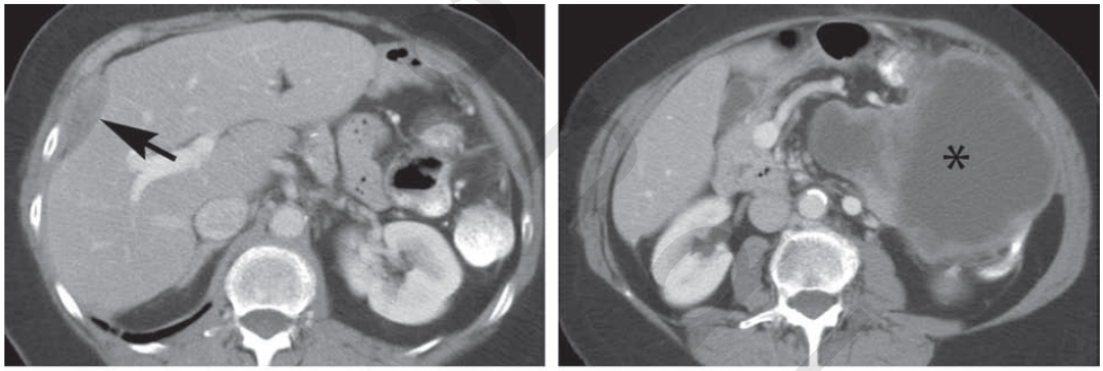
Sarcomas are a heterogeneous group of malignant neoplasms that arise from tissue derived from mesoderm. Metastasis of sarcomas to the peritoneal cavity, termed peritoneal sarcomatosis, is unusual and occurs through hematogenous route.(65)

Sarcomas arising from the gastrointestinal tract, namely malignant gastrointestinal stromal tumors, commonly spread to the peritoneum.(66) It is postulated that peritoneal spread of gastrointestinal stromal tumors occurs by extension of the tumor through the serosal surface of the bowel and direct seedling in the peritoneal cavity. Peritoneal sarcomatosis are focal soft-tissue masses, nodules. Visceral implantation may occur, which results in soft-tissue masses on serosal margins of the liver and spleen (Fig 13). Ascites is generally minimal and occurs late in the course of disease .(67)



(a) (b)

Figure (12): Peritoneal lymphomatosis. (a) Intravenous and oral contrast-enhanced CT scan shows soft tissue diffusely infiltrating through the peritoneum, encasing the small bowel, ascites and diffuse peritoneal thickening. **(**b**)** Photomicrograph shows the lymphoid cells (H&E,x200).[44]



a. b.

Figure (13): Gastrointestinal stromal tumor metastatic to the peritoneum. Intravenous and oral contrast-enhanced CT scans show a metastatic deposit of Gastrointestinal stromal tumor on the serosal surface of the liver (arrow in **a**) and a large, partially cystic metastatic deposit in the left mid abdomen (***** in **b**). [44]

Imaging and pathological features of primary peritoneal tumors:

i) Peritoneal Malignant Mesothelioma:

Malignant mesothelioma is an uncommon malignant neoplasm that arises from mesothelial cells of the pleura, peritoneum, pericardium, or tunica vaginalis of the testis. The majority of malignant mesotheliomas originate in the pleura. Peritoneal primary mesotheliomas account for 6%–10% of malignant mesotheliomas. [67]

Classifying malignant mesotheliomas into diffuse and localized subtypes has prognostic significance. Diffuse malignant mesotheliomas are highly aggressive and, with a few exceptions such as well-differentiated papillary mesotheliomas that occur in women, are incurable. In contrast, patients with localized malignant mesotheliomas usually have a good prognosis following complete surgical excision of the lesion. [68]

The association between malignant mesothelioma and asbestos exposure is well established.[69]Other etiologic factors include exposure to therapeutic irradiation, and in rare cases chronic pleural or peritoneal irritation. [67,70]

Imaging Features:

Peritoneal malignant mesothelioma produces two distinct patterns on cross-sectional images that reflect its gross pathologic appearance: *(a)* diffuse involvement of the peritoneal cavity and *(b)* focal intraperitoneal mass.

The diffuse pattern (Fig14a) is characterized by tumor infiltrating and thickening the peritoneum in a sheetlike fashion. The focal pattern (Fig14b) is characterized by moderate to large-sized intraperitoneal masses with associated peritoneal studding. In addition to the primary tumor, omental caking and ascites are usually present [71-74].

Calcification within peritoneal malignant mesothelioma is considered rare, however, calcified pleural plaques and other asbestos- related changes such as pleural thickening and masses may be present within the chest. Nodal metastases are uncommon in malignant mesothelioma, therefore, the presence of lymph node enlargement in a patient with diffuse peritoneal disease suggests another etiology, such as diffuse peritoneal carcinomatosis, lymphomatosis, or tuberculous peritonitis. [71,75]

Pathologic Features:

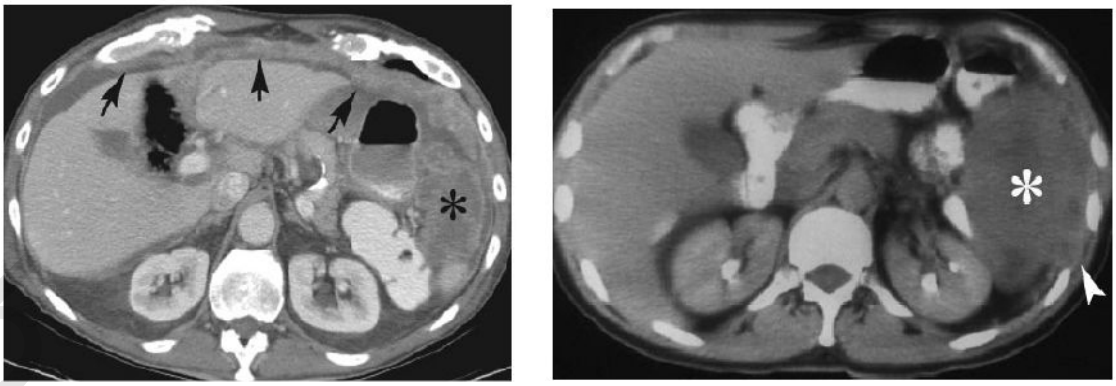
At inspection of gross specimens (Fig15a) **diffuse peritoneal malignant mesothelioma** is often indistinguishable from peritoneal carcinomatosis. It is characterized by multiple, firm, gray or white nodules scattered along the peritoneal surfaces of the mesenteries, omenta, and serosal surfaces of the viscera . [67]

Localized peritoneal malignant mesothelioma forms a focal, circumscribed mass. It may invade locally and extend into adjacent organs, but typically it does not spread diffusely throughout the peritoneal cavity. [67]

Microscopically,malignant mesothelioma can be divided into three forms: epithelial, sarcomatous, and mixed. [68,76]

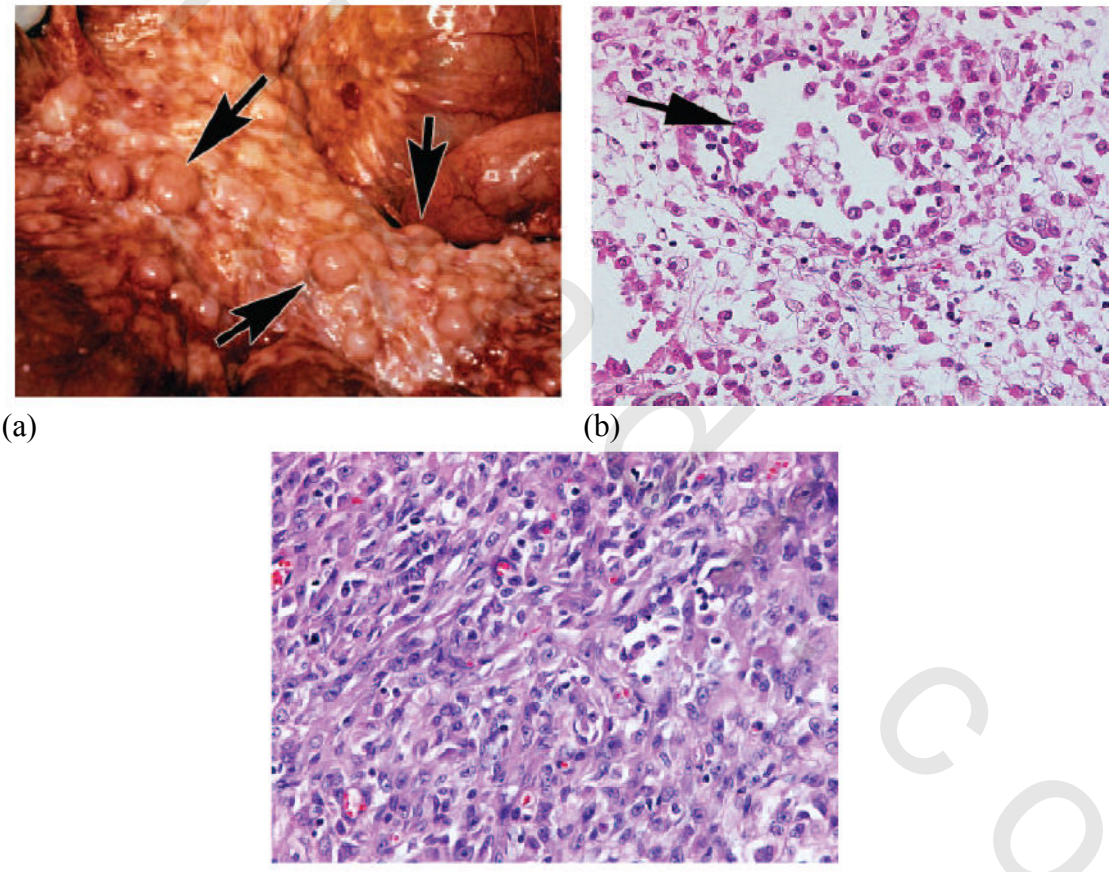
A) Epithelial malignant mesotheliomas are composed of cells that resemble normal mesothelial cells (Fig 15b)[76].It may also exhibit other characteristics, such as prominent secretory change, microglandular patterns, signet-ring cell structure, or desmoplastic responses, that make these tumors difficult to differentiate from adenocarcinomas based on routine histologic analysis alone .[67,77]

B) The sarcomatous pattern of malignant mesothelioma is typically composed of closely packed spindled cells (Fig 15c).The cells may be long and slender with sparse cytoplasm, or they may have a slightly rounded, epithelioid configuration.Mitotic figures may be present. Malignant osteoid, chondroid, or muscular elements may be present within the tumor. Calcification related to the malignant osteoid and chondroid elements may be detectable at computed tomography(CT). [68]



(a) (b)

Figure (14): CT of peritoneal mesothelioma. (a) Diffuse malignant mesothelioma in the form of sheets of peritoneal nodular thickening, ascites and heterogeneous mass at the greater omentum(*).(b) Localized malignant mesothelioma in the form of heterogeneously enhanced mass at the gastrosplenic ligament.[29]



(a) (b)

(c)

Figure(15): Pathology of malignant mesothelioma. (a) Gross image of malignant mesothelioma, innumerable tumor nodules scattered over the omentum.(b) Epithelial malignant mesothelioma, photomicrograph shows a microglandular structure lined by neoplastic cells that are cuboidal and contain prominent nuclei (H&E,x200). (c) Sarcomatous malignant mesothelioma,photomicrograph shows polymorphic spindle cells (H&E,x200).[29]

ii) Multicystic Mesothelioma:

Multicystic mesothelioma is an unusual, multilocular cystic tumor that most commonly arises from the pelvic surfaces of the peritoneum. It occurs predominantly in women (mean age, 37 years). Multicystic mesothelioma has many alternative names, including peritoneal inclusion cyst, multilocular inclusion cyst, and benign multicystic mesothelioma. Some consider it to be a mesothelial neoplasm because it may recur locally and in rare cases may show malignant transformation.[78,79] Other authors believe that it is a non neoplastic, reactive mesothelial proliferation.[80]

Occasionally, multicystic mesothelioma is discovered incidentally at surgery, laparoscopy, or cross-sectional imaging. Women with multicystic mesothelioma often have a history of prior pelvic surgery, endometriosis, or pelvic inflammatory disease, which some authors consider support for a non-neoplastic origin of the lesion. [80]

Imaging Features

In CT, they appear multiseptated, cystic structures that have an intimate anatomic association with the uterus and ovaries, the septae enhance after IV contrast, (Fig 16). Multicystic mesothelioma may completely surround the ovaries such that the ovaries appear entrapped within the cystic lesion. [81]

Pathologic Features

Gossly, multicystic mesothelioma is composed of multiple, translucent, fluid-filled cysts that grow along the pelvic peritoneum in grapelike clusters (Fig 17a). It is usually large at the time of diagnosis (mean diameter, 13 cm). [80]

At histologic analysis, multicystic mesothelioma is composed of multiple, thin-walled, irregularly spaced cysts lined by flattened or cuboidal mesothelial cells (Fig 17b). The cysts may be filled with eosinophilic, serous fluid. Inflammatory cells and fibrous elements may be found within the stroma between the cysts. [79]

iii) Primary Peritoneal Serous Carcinoma:

Primary peritoneal serous carcinoma is an epithelial tumor that arises from the peritoneum. At histopathologic analysis, it resembles a malignant ovarian surface epithelial stromal tumor. It almost always occurs in women (mean age, 56–62 years). [83,84] There are a few case reports of primary peritoneal serous carcinoma developing in men. [85] Patients typically present with complaints of abdominal distention, pain, and fullness; increasing abdominal girth; and gastrointestinal symptoms such as nausea and vomiting. The majority of patients have ascites and elevation of serum levels of cancer antigen CA- 125. [84,86]

According to recent studies, primary peritoneal serous carcinoma is more common than previously thought, with 15% of epithelial ovarian carcinomas actually being primary peritoneal serous carcinomas. [76]

Imaging Features:

Ascites, peritoneal nodules and thickening, and omental nodules and masses are the most common cross-sectional imaging features of primary peritoneal serous carcinoma (Fig 18). [87-90]

Calcifications within peritoneal and omental nodules represent psammoma bodies histopathologically. Psammomatous calcification has been reported to occur in 30% of cases, no detectable adnexal mass is identified at CT in the majority of patients with primary peritoneal serous carcinoma. [87,90]

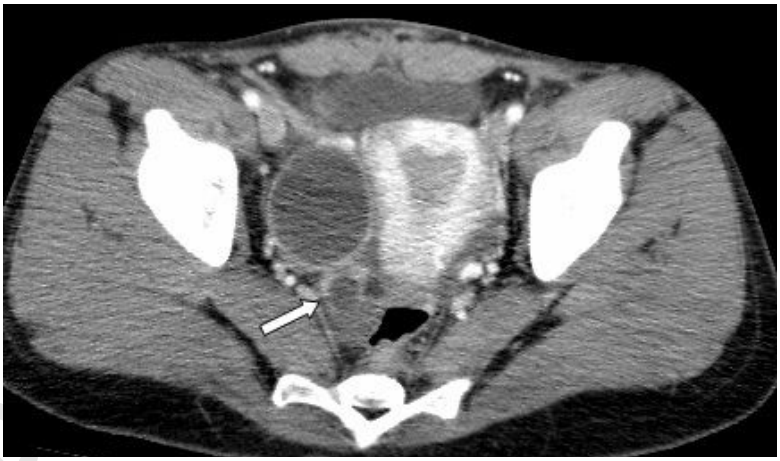
Pathologic Features:

Primary peritoneal serous carcinoma is indistinguishable from metastatic serous ovarian carcinomanoma at gross, histopathologic, and immunohistochemical examination. The primary gross characteristic is multiple nodules on the peritoneal surface and omentum. Omental caking may occur with confluent and large masses. Large masses may also have a papillary appearance grossly. [68]

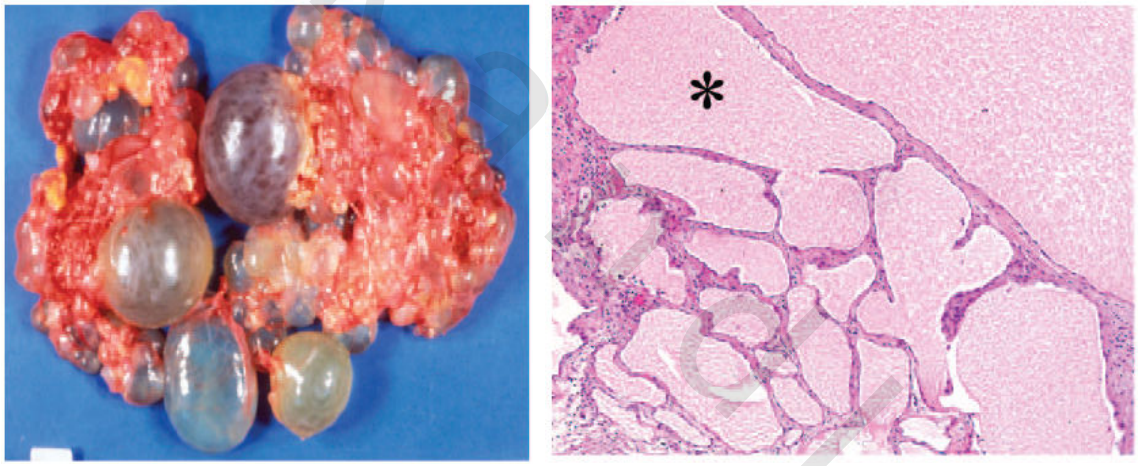
The tumors are histologically composed of irregular, interconnecting clusters of malignant cells that show solid, cribiform, or cystic architecture (Fig 19a).[84]

Papillary formation and gland like areas may be present. The cells are atypical with large nuclei, prominent nucleoli, and frequent mitoses (Fig 19b). Psammoma bodies are commonly present and may be numerous, leading some authors to refer to this tumor as psammoma carcinoma. [68]

The following criteria have been established to make the diagnosis of primary peritoneal serous carcinoma:*(a)* both ovaries are normal; *(b)* the involvement of extraovarian sites must be greater than the involvement on the surface of either ovary; or *(c)* the ovarian involvement is limited to the ovarian surface epithelium, either without stromal invasion or involving the cortical stroma with tumor size less than 5 mm .[66]

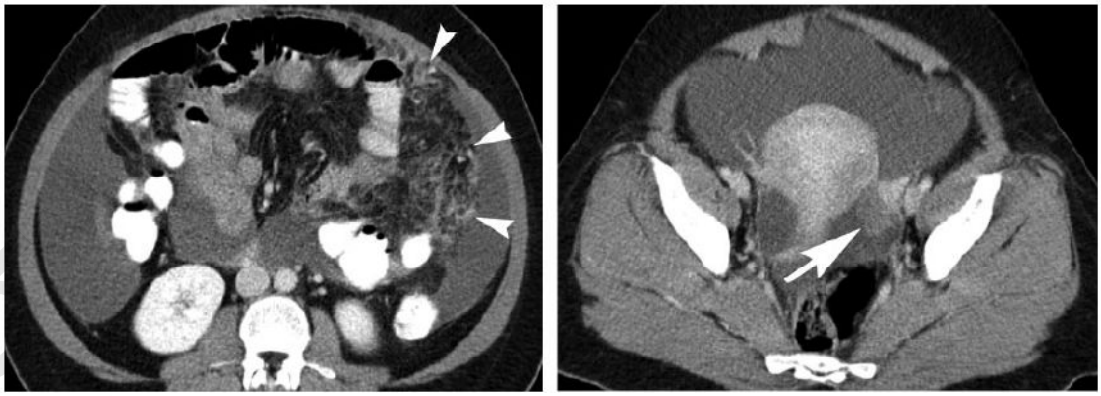


Figure(16): CT of cystic mesothelioma. Axial cut of IV contrast CT shows multilocular pelvic cyst with enhancing septations.[82]

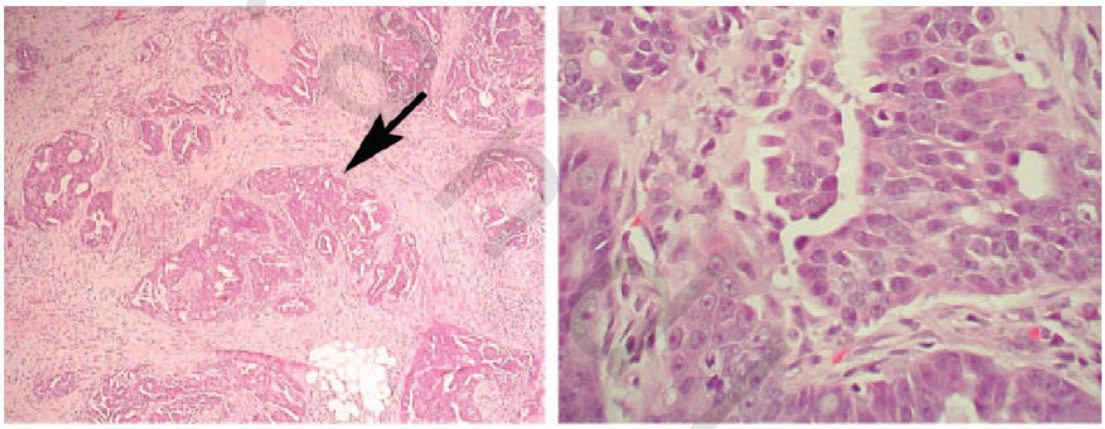


(a) (b)

Figure(17): Pathologic features of multicystic mesothelioma. **(a)** Gross apperance of a resected multicystic mesothelioma shows a grapelike cluster of thin-walled cysts of variable size. (b)Photomicrograph shows multiple, thin-walled, irregularly shaped cysts (*) that contain eosinophilic fluid (H&E,x100). [29]



Figure(18): CT of primary peritoneal serous carcinoma. It shows a moderate amount of ascites, enhancing soft-tissue nodules in the greater omentum (arrowheads in **a**), and normal ovaries (arrow in **b**). [29]



(a) (b)

Figure(19): Microscopic appearance of primary peritoneal serous carcinoma.(a) Photomicrograph shows solid tumor masses with occasionally areas featuring cribiform and papillary architecture (arrow) (H&E,x100). (b) Higher-power photomicrograph demonstrates atypical cells with large nuclei and prominent nucleoli (H&E,x400). [29]

iv) Desmoplastic Small Round Cell Tumor:

Desmoplastic small round cell tumor is a rare malignancy of unknown histogenesis that occurs predominantly in adolescent and young adult males with a mean age of 19 years. Occasionally, the tumor may develop in older and female patients.Patients with desmoplastic small round cell tumor have a universally poor prognosis. The 3-year survival rate, even with treatment, is less than 30%. [91,92,93]

Imaging Features:

Desmoplastic small round cell tumor spreads diffusely throughout the peritoneal surfaces. Consequently, the primary imaging finding is the presence of peritoneal thickening, nodules, and masses. However, a solitary peritoneal mass may be the only finding seen at initial presentation. [94]Intraperitoneal primary masses may be large and bulky may be larger than 10 cm. [95,96]

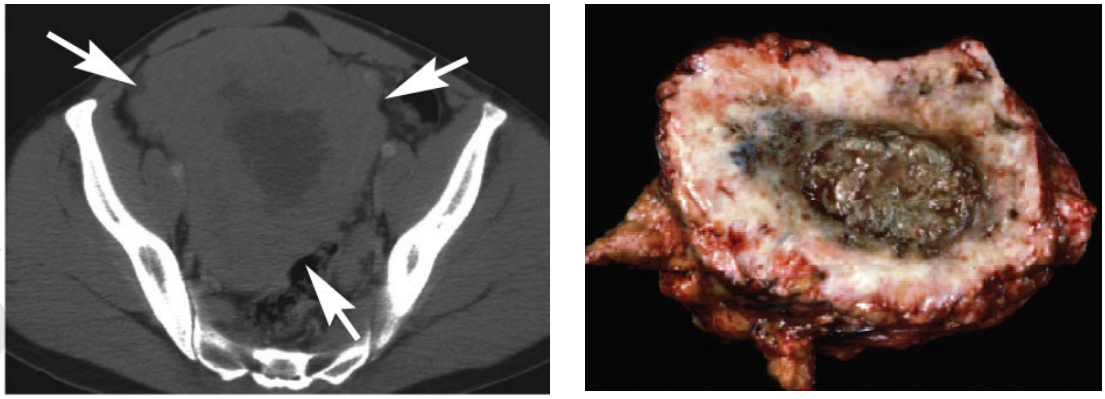
The masses are characteristically heterogeneous in CT attenuation or have centrally located low-attenuation regions, which reflect intratumoral necrosis or hemorrhage

(Fig 20a). [94,96] The tumor masses may contain small, punctate calcifications visible on CT scans. Malignant ascites is frequently present and complications such as bowel obstruction or ureteral obstruction may occur .[95]

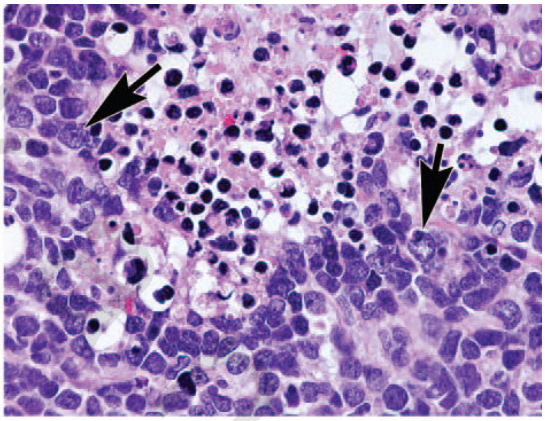
Pathologic Features:

At gross inspection,(Fig 20b) desmoplastic small round cell tumor may be a solitary or multifocal, gray to white, firm nodule or mass that arises from the peritoneal surface. Discrete and confluent peritoneal and omental nodules are often present. [97]

Microscopically,(Fig 20c) cords and nests of undifferentiated, uniform, small, round, malignant cells are surrounded by dense, collagenous stroma (Fig 20). [97] The tumor cells have scant cytoplasm and large, hyperchromatic nuclei with dispersed nuclear chromatin.The presence of numerous mitotic figures and single cell necrosis is characteristic. [97,98]



(a) (b)



(c)

Figure (20): Desmoplastic small round cell tumor. (a) Intravenous and oral contrast-enhanced CT scans of the pelvis shows a large, circumscribed pelvic mass (arrows in a) contains central hypoattenuation, indicative of tumor necrosis. (b) Gross appearance of the resected pelvic mass shows its well defined borders and central tumor necrosis. (c) photomicrograph shows the tumor cells with scant cytoplasm and large, hyperchromatic nuclei (arrows in c) (H&E,x400). [29]

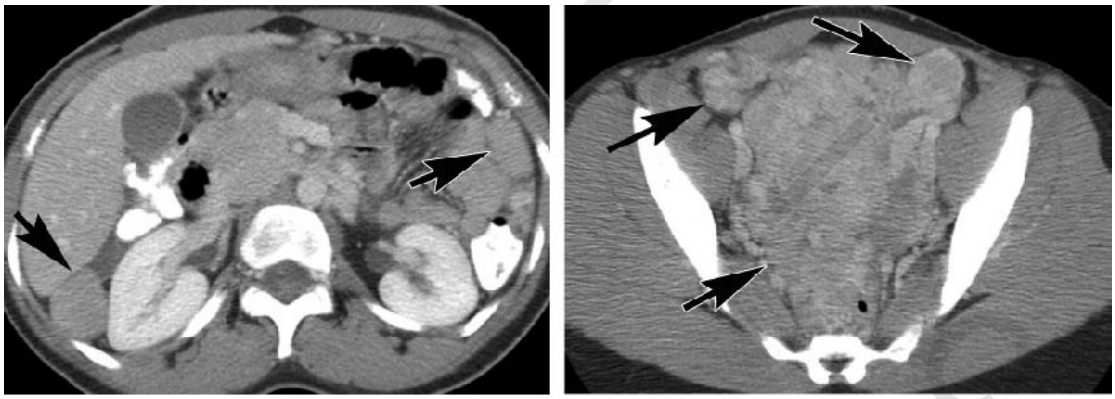
v) <u>Solitary Fibrous Tumor:</u> Solitary fibrous tumors are submesothelial tumors of uncertain origin that most commonly arise in the pleura. Reports of extrapleural solitary fibrous tumors are unusual; in very rare cases, these tumors are reported to occur in the abdomen. [99]

vi) <u>Leiomyomatosis Peritonealis Disseminata:</u>

It is a rare, benign entity characterized by innumerable smooth muscle nodules throughout the peritoneal cavity. The smooth muscle nodules are derived from metaplasia of submesothelial cells, it is usually discovered incidentally during surgery or imaging examinations of women of childbearing age who have uterine leiomyomas. It may be associated with high estrogen states, caused by pregnancy and oral contraceptive use[100],but rare cases in postmenopausal women and men have also been reported. [101,102]

Pathologic and Imaging Features: Cross-sectional imaging studies show numerous well-circumscribed solid masses in the peritoneal cavity that vary in size from several millimeters to many centimeters (Fig 21). The masses are often heterogeneous in CT attenuation and enhance similar to uterine leiomyomas (Fig 21). [103-105]

At gross examination, well-demarcated, firm nodules of varying size are observed throughout the peritoneum. The nodules of leiomyomatosis peritonealis disseminata are histologically composed of closely packed eosinophilic spindle cells in the background of omental or mesenteric adipose tissue. The spindle cells have bland, uniform nuclei, and mitotic figures are absent. [68]



a. b.

Figure (21): CT of leiomyomatosis peritonealis disseminata. (a)&(b) show multiple enhancing masses through the peritonieum (arrows). [29]

Imaging and pathological features of mesenteric neoplasms:

Primary neoplasms arising in the mesentery are rare and usually of mesenchymal origin such as desmoids, lipomas and neurofibromas which are more common than malignant ones, such as fibrosarcoma, liposarcoma, or mesothelioma. Secondary neoplasms are more frequent than the primary malignancies and cystic tumors are more common than solid ones. Malignant tumors tend to be located near the mesenteric root, while the benign tumors tend to arise in the periphery near the bowel wall. (106)

The most common causes of solid mesenteric masses are non-Hodgkin lymphoma and metastatic disease. (107-109)

I) Primary Mesenteric Neoplasms:

Desmoid Tumor (Mesenteric Fibromatosis):

Desmoid tumors are locally aggressive, non encapsulated masses resulting from a benign proliferation of fibrous tissue. Abdominal desmoids can occur sporadically and develop anywhere in the abdomen, including the musculature of the abdominal wall, the retroperitoneum, and the pelvis. However, desmoids forming in the mesentery are especially common in patients with familial adenomatous polyposis (Gardner syndrome), occurring in 9%–18% of cases. (107,110,111) In fact, abdominal desmoids are responsible for a considerable number of life-threatening complications in these patients. Almost 75% of these tumors develop in patients who have undergone previous abdominal surgery. (108)

Abdominal desmoids can be solitary or multiple. Intramuscular desmoids tend to have well-defined or partially well-defined borders with strands radiating into the adjacent mesenteric fat or a "whorled appearance" of fibrosis. Most mesenteric desmoids are iso attenuating relative to muscle (Fig 22), although large lesions may display areas of low attenuation caused by necrosis .(108,109)

CT is useful in planning surgical resection and predicting prognosis. Large size (10 cm or more); multiplicity; and extensive infiltration, tethering, and encasement of small bowel loops and entrapment of the ureters are poor prognostic signs. (109)

Other Primary Mesenteric Tumors:

These neoplasms are quite uncommon including lipomas, schwannomas, smooth muscle tumors, and sarcomas.(109)

A) Lipoma is the second most common primary solid tumor of the mesentery, after fibromatosis. They appear as well-circumscribed homogeneous masses and are easy to diagnose on CT since they are composed entirely of low-attenuation fat .(112)

B) Liposarcoma develops more frequently in the retroperitoneum than in the mesentery or peritoneum. They may have a variable appearance, which merely reflects their tissue composition, ranging from predominantly fat, fluid and soft-tissue elements to entirely soft-tissue density masses .(112)

II) Secondary Mesenteric Tumors:

Major Pathways for the Spread of Tumor to the Mesentery

Tumors originating in the abdomen or elsewhere in the body can disseminate to the mesentery in four major ways: (A) extension via the mesenteric lymphatics, (B) direct spread along the mesenteric vessels and surrounding fat, (C) embolic hematogenous spread, and (D) intraperitoneal seedling. Although convenient, this classification is somewhat arbitrary, since many neoplasms spread by more than one route .[32]

A) Extension via the Mesenteric Lymphatics

Lymphoma: Lymphoma is the most common malignant neoplasm affecting the mesentery.[113] Approximately 30%–50% of patients with non- Hodgkin lymphoma harbor disease in the mesenteric lymph nodes. Marked mesenteric adenopathy can also be present in chronic lymphocytic leukemia. Patterns of mesenteric lymphoma at CT include multiple, rounded, mildly enhancing, homogeneous masses that often encase the mesenteric vessels and produce the "sandwich sign" [35] (Fig 23); a large, lobulated, "cakelike," heterogeneous mass with low-attenuation areas of necrosis displacing small bowel loops or an ill-defined infiltration of the mesenteric fat, particularly after successful chemotherapy.[35,114]Bulky retroperitoneal adenopathy commonly accompanies the mesenteric disease and should be a clue to the diagnosis. [115]

Other Malignancies:Metastases from colon cancer, ovarian carcinoma, breast cancer, lung cancer, carcinoid, and melanoma can spread to mesenteric lymph nodes. However, the degree of nodal enlargement seen in mesenteric metastatic disease is less pronounced than that seen in mesenteric lymphoma, and the distribution of involved nodes is comparatively more localized in metastatic disease. [35]

B) Direct Spread to the Mesentery

Gastrointestinal Carcinoid Tumor: Gastrointestinal carcinoid tumors arise from neuroendocrine cells in the intestinal mucosa or submucosa. Although these slow-growing tumors are rare (representing only 2% of tumors of the gastrointestinal tract), they are the most common malignant neoplasm of the small intestine. [116]

Approximately 40%–80% of gastrointestinal carcinoids spread to the mesentery, either by direct extension or through the local lymphatics. [117,118]The distal ileum is the most frequent location of the primary lesion .[119]

The mesenteric mass is usually discovered first, when patients present with nonspecific abdominal pain. Alternatively, patients with hepatic metastases may present with the carcinoid syndrome caused by the release of vasoactive substances such as serotonin and 5-hydroxytryptophan into the systemic circulation. These patients experience paroxysmal flushing, diarrhea, episodes of wheezing. At CT, the most common manifestation of mesenteric carcinoid tumors is that of an enhancing soft-tissue mass with linear bands radiating in the mesenteric fat.[106]

Radiologic-pathologic correlation has shown that these radiating strands of soft tissue do not generally represent tumor infiltration along neurovascular bundles but rather result from the intense fibrotic proliferation and desmoplastic reaction in the mesenteric fat

and the adjacent mesenteric vessels caused by the release of serotonin and other hormones from the primary tumor.[117]Calcifications are visible in up to 70% of lesions at CT (Fig 24).[117] Thickening of adjacent small bowel loops caused by tumor infiltration or by ischemia owing to sclerosis of mesenteric vessels as well as angulation can be present .[120] The primary tumor is often small, sometimes occult, and only occasionally diagnosed at CT (Fig 24). [121]

Primary mesenteric carcinoid tumors are very rare and solid distant metastasis from carcinoid tumors increases up to 80% to 90% when the size of the tumor is larger than 2 cm .[122]

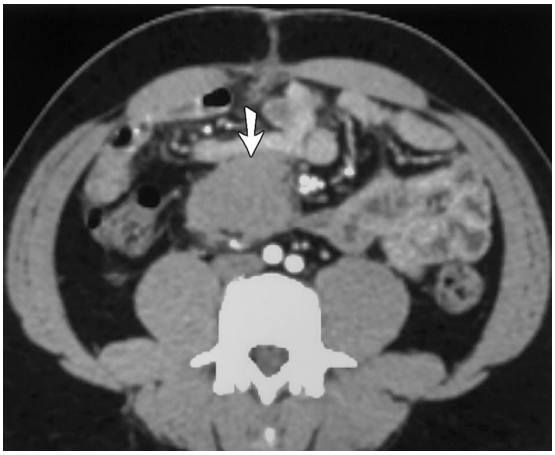
Other Neoplasms: Several intraabdominal malignancies, including gastric, pancreatic, biliary, and colon cancer, may extend directly into the leaves of the mesentery or spread along the mesenteric vessels.[113]

C) Embolic Hematogenous Spread

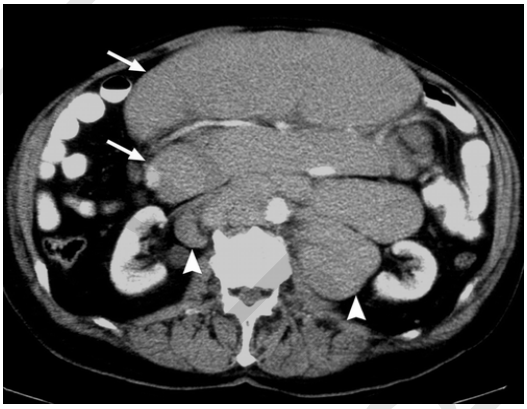
Embolic metastases from melanoma, breast cancer, and lung cancer can reach the anti-mesenteric border of the small intestine through small mesenteric arterial branches. These tumor deposits can act as a lead point for intussusception. The small intestine and its mesentery are the most common site of gastrointestinal metastases from melanoma.[123]Metastases from melanoma classically manifest as enhancing mural nodules protruding into the intestinal lumen or as focal thickening of the intestinal wall.[124]

D) Intraperitoneal Seedling

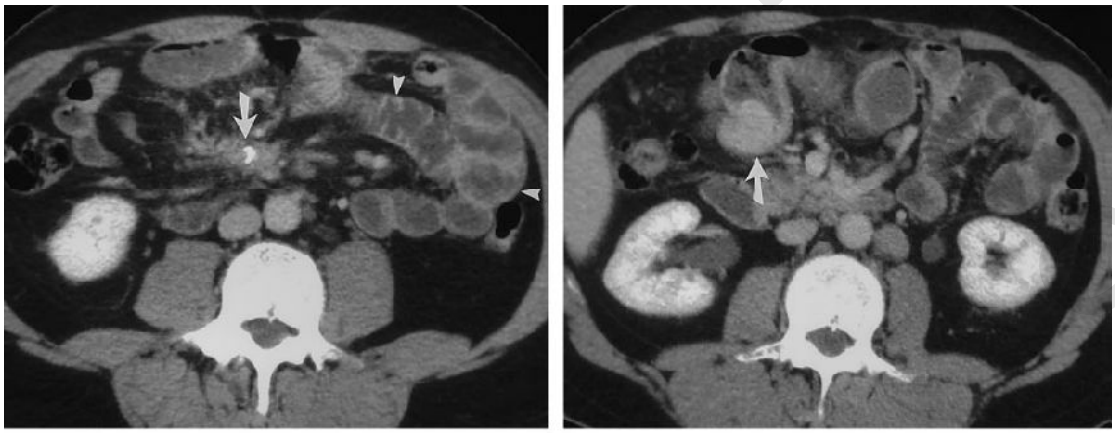
Because of the natural flow of fluid in the peritoneal cavity, the portion of mesentery close to the terminal ileum in the right lower quadrant is a common site of intraperitoneal tumor seedling. Tumor deposits within the mesentery can appear as focal masses or can produce a diffuse infiltration of the mesenteric fat, the so-called stellate appearance of the mesentery.[106]



Figure(22): CT of mesenteric desmoid tumor. Axial CT image shows well defined mesenteric mass isoattenuating to psoas muscle. (106)



Figure(23): CT of lymphoma. Axial images contrast enhanced CT with oral contrast,shows a large soft tissue mass in the mesentery encasing mesenteric vessels (Sandwich sign). (125)



a. b.

Figure(24): CT of carcinoid tumor .(a) Axial image shows ill-defined mesenteric mass with calcifications.(b) Well defined enhancing lesion at the ileum which was proved to be the primary (arrow).(106)