PICTORIAL ESSAY

Review of diagnosis, differential diagnosis, and management of retroperitoneal lymphangioma

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Abstract

Lymphatic malformation (LM) is the currently preferred term for what was previously known as lymphangioma. Retroperitoneal LMs are extremely rare, benign, cystic masses that arise from lymphatic vessels. They can be challenging to diagnose because they resemble other retroperitoneal cystic tumors. The development of treatment strategies for rare diseases, including retroperitoneal LM, requires the acquisition of new knowledge to enhance our understanding of the disease progression. Therefore, we present an update regarding fundamental and advanced issues associated with retroperitoneal LM. This review describes the epidemiology, histopathology, biomedicine, clinical manifestations, radiological features, differential diagnosis, and management of this lesion.

Keywords Abdominal masses · Cystic lesion · Lymphatic malformation · Retroperitoneal lymphangioma · Vascular malformations

Introduction

Although the term lymphangioma can be found in both previous and present literature, it can be confusing [1, 2], and the currently preferred term for this disease is lymphatic malformation (LM) [3, 4]. Recent literature has provided evidence to suggest that this entity represents a true malformation of the lymphatic system instead of being a tumor. The International Society for the Study of Vascular Anomalies (ISSVA) has adopted a basic classification system for differentiating vascular tumors from vascular malformations [5], in which LMs are local or diffuse soft-tissue lesions that are classified as slow-flow malformations. Three types of LM have been described based on clinical and diagnostic

imaging results: macrocystic, microcystic, and mixed (Figs. 1, 2) [6].

Etiology

LMs are benign proliferations that typically manifest as fluid-filled cysts. LMs appear to arise from the isolation of localized lymphatic tissues that are unable to communicate with the normal lymphatic system of the body [7] and are thought to be congenital [8]. Although some acquired etiologies, such as fibrosis, trauma, and tumors, have also been associated with LMs, these relationships are not clear [9]. The spread of lymphatic lesions is primarily caused by the excessive stretching of fluid follicles [10]. However, LM development has also been hypothesized to occur due to proliferation [11]. Some authors have hypothesized that LMs represent an anomaly of lymphatic system development but concluded that they also have proliferative potential because of the identification of intrusive germ seeding in the peripheral tissues of resected lesions [12, 13]. Recently, low-level hyperplasia has been demonstrated by fertility markers [14, 15]. Therefore, LMs (in addition to arterial or venous malformations) may grow and regenerate due to retained proliferative abilities [16, 17].


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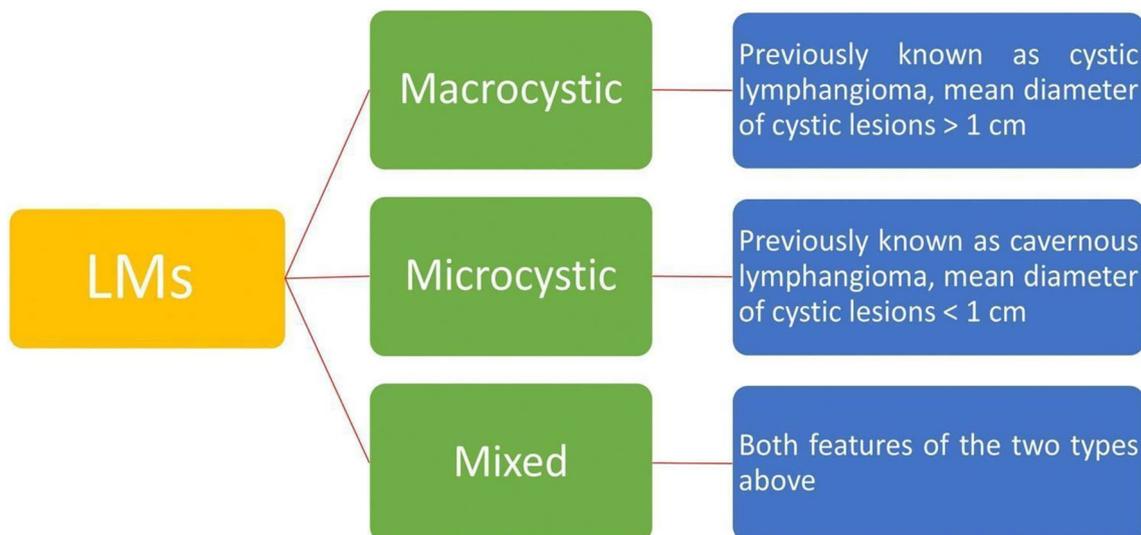
Fig. 1 LMs can be classified into three types: macrocystic, microcystic, or mixed

Fig. 2 Illustration of three types of LMs based on the size of cyst compartments
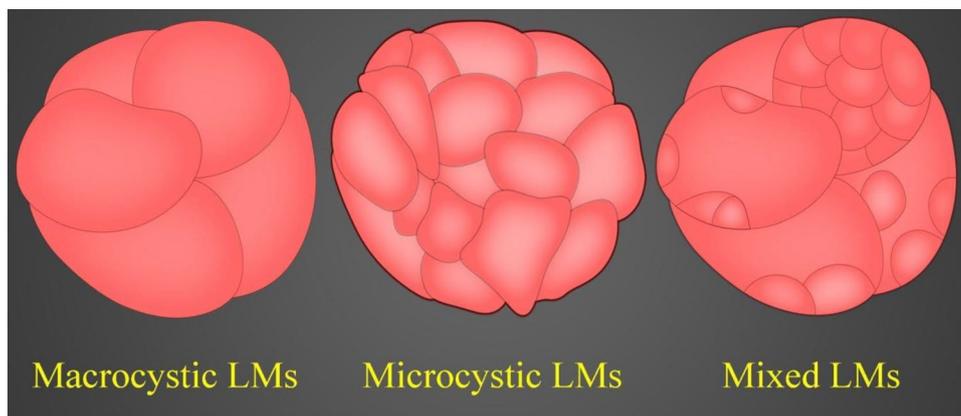

Epidemiology

LMs are uncommon malformations of the lymph vessels [9]. LMs typically occur in children [18] and are commonly located in the head and neck region, but they can occur in any location throughout the body [19–21]. Usually, tumors present in the retroperitoneum are mostly malignant tumors [22], and cystic masses that develop in the retroperitoneal space are rare [23, 24]. Intra-abdominal LM represents 3–9.2% of all LMs [25, 26]. In the abdomen, LMs occur most commonly in the mesentery, omentum, and mesocolon [27]. Retroperitoneal LMs are very rare, accounting for fewer than 1% of all LM cases [28, 29].

Histopathology

Specimens of LMs are characterized by vascular channels of various sizes with an impaired endothelial lining, although cubic endothelial regions may also be observed (Fig. 3) [28, 30]. The smallest channels are only lined by the endothelium, whereas the larger channels may exhibit an irregular and dissimilar smooth muscle layer. The wall thickness can be variable, and many of the lumens are empty [31], although some lumens contain pale proteins, lymphocyte clusters, blood, blood clots, or hemosiderin (Figs. 3, 4, and 5) [2, 32]. These lumen contents may be
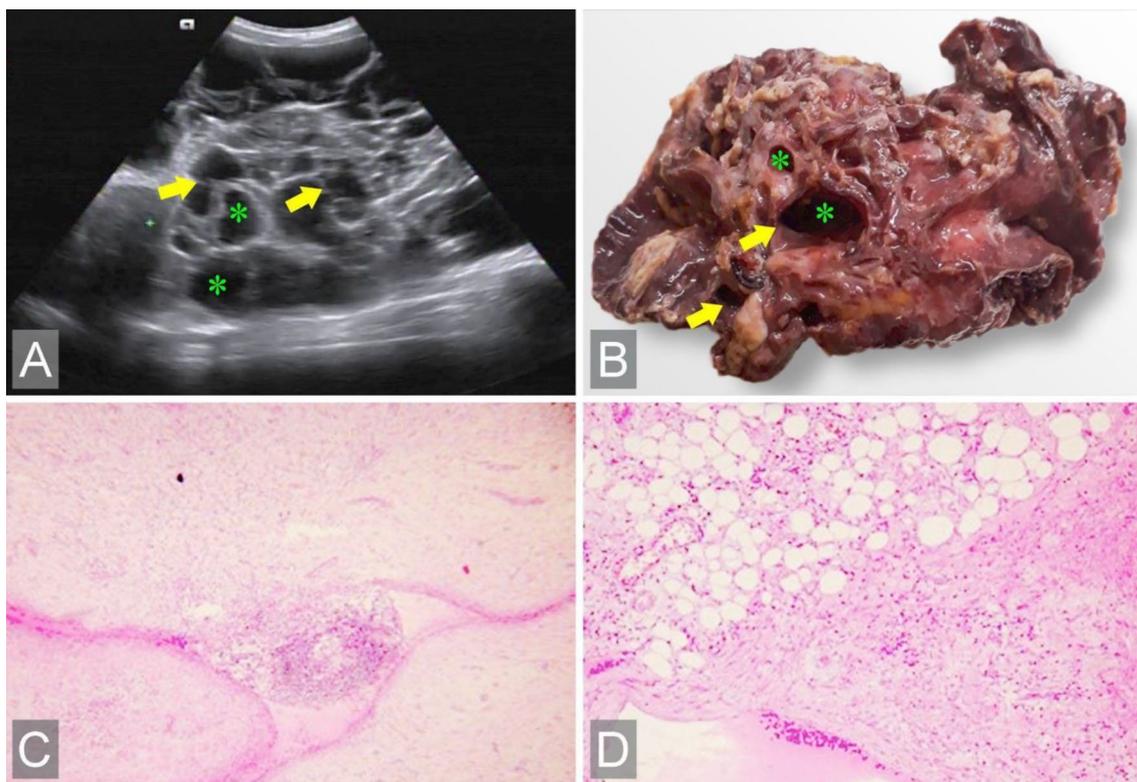
Fig. 3 LM in a 26-year-old male patient admitted to the hospital with a fever of unknown cause. A transverse ultrasound image of the abdomen (**A**) showed a cystic mass sized $17 \times 20 \times 36$ cm, which occupies most of the left abdomen. The cystic mass had a multilobed shape and a thin wall, with many thin septa inside the mass. Photograph (**B**) showed a gross LM specimen, with multiple cysts and intersecting septae. Photomicrographs ($\times 50$ and $\times 200$; hematoxylin–eosin stain) (**C**, **D**) showed multiple, large, irregular, cystic luminal spaces. The cystic spaces were lined by a single layer of benign, flattened endothelium. The stroma showed a dense lymphocytic infiltration, with the formation of lymphoid follicles, and a dense fibro-cellular layer supporting the cystic spaces
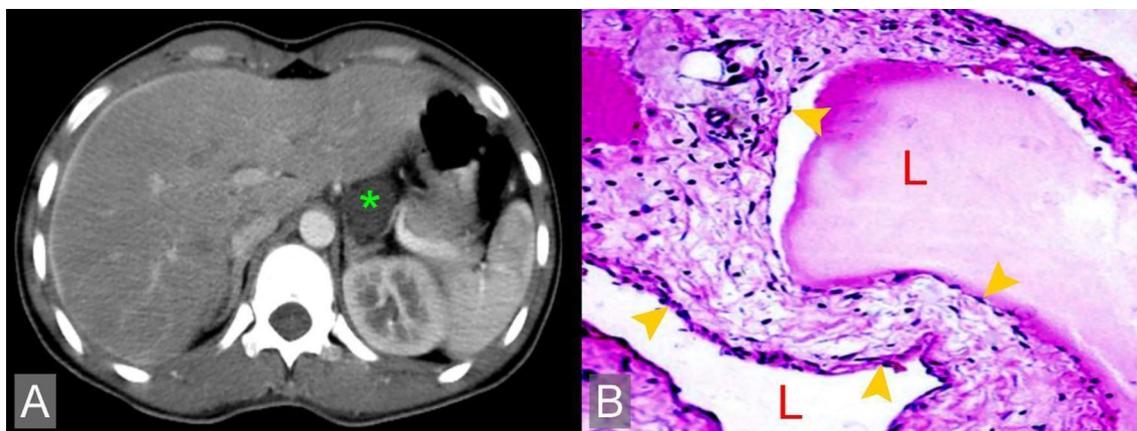
Fig. 4 Cavernous LM in a 23-year-old female patient with dull epigastric pain. Comprehensive clinical and laboratory testing ruled out a pancreatic pseudocyst. Her condition did not improve, so she underwent laparoscopic surgery to remove the lesion. Axial CT image (**A**) showed a cystic lesion (asterisk) in the epigastric retroperitoneal space. Micrograph using H and E stains at $\times 100$ magnification (**B**) showed spaces (Ls) lined by flat endothelial cells (arrowheads)

Fig. 5 LM in a young male patient who complained of dull pain in the left abdomen for 14 days. Axial contrast-enhanced CT image (**A**) showed a large cystic mass in the left abdomen with multiple thin septa. Microscopic (**B**, ×200; **C**, ×400; hematoxylin–eosin stain) images showed multiple, large, irregular, cystic luminal spaces. The cystic spaces were lined by a single layer of benign, flattened endothelium. The stroma showed a dense lymphocytic infiltration and the formation of lymphoid follicles. The cystic spaces are supported by a dense fibro-cellular layer
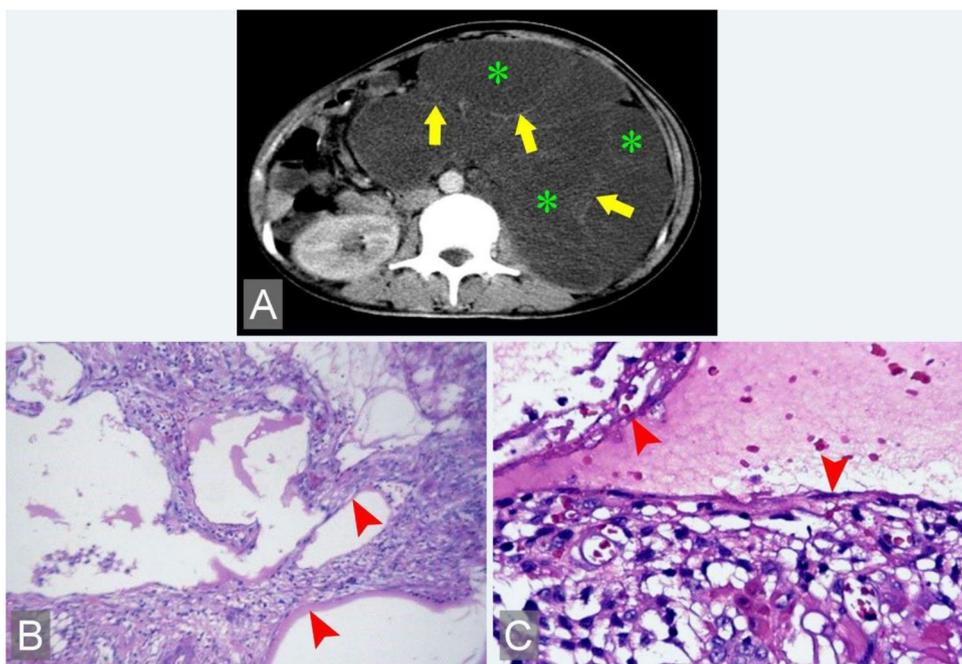
the results of spontaneous bleeding, trauma, surgery, or connection to the venous system [33, 34].

Macrocystic LMs typically feature a single, thick-walled compartment containing fibrous muscle tissue, a few smooth muscle cells, and an interstitial matrix. The endothelium is usually absent. Superstructure studies of small vascular channels have revealed endothelial cells that are collapsed with an incomplete basal layer and fibrils that bind the basal cells with the underlying connective tissue [35–37].

Lymph endothelial cells can be identified using several antibodies, such as anti-Prox1 and anti-vascular endothelial growth factor receptor (VEGFR)-3, which are superior to the anti-podoplanin antibody D2-40 or anti-lymphatic vessel endothelial hyaluronan receptor (LYVE-1) antibodies. In particular, large circuit channels often appear to be partially stained, either without all the antibodies or without D2-40 and LYVE-1 antibodies. Arteries and veins do not feature endothelial cells. The response to anti-CD31 antibodies tends to be unsystematic, and CD34 is often faint or absent [38–40]. Miettinen and Wang also noted the detection of Prox1 in vascular malformations associated with veins and the lymphatic system [35, 41].

Molecular biology

Recently, DNA analysis studies of LM tissue have identified pre-zygotic somatic mutations as an underlying cause of LMs [42, 43]. Novel approaches to DNA sequencing have facilitated the detection of post-zygotic somatic mutations that have clarified the causes of LMs [44–47]. Unlike genetic

mutations, which occur in every cell, somatic mutations can have local effects at many different anatomic locations, often resulting in mosaic patterns [48].

A functional somatic mutation in phosphatidylinositol-4,5-bisphosphate 3-kinase catalytic subunit alpha (PIK3CA) affects the phosphoinositide 3-kinase (PI3K)/protein kinase B (AKT) pathway in the LM tissue. Activated PIK3CA promotes cell proliferation, growth, angiogenesis, and protein synthesis [49, 50]. This molecular pathway is correlated with tissue overgrowth and the persistence of malformed lesions [51, 52]. The increased understanding of the role played by this pathway in the development of LMs has introduced the potential of molecular medicine-based treatments for patients with LMs [42] and the development of novel treatment options [43].

Genetics of LMs

Hereditary LMs are caused by inadequate lymphatic drainage, defects, or hyperplasia in lymphatic vessels. The first locus identified for hereditary LMs was mapped to chromosome 5q35, and the pathogenic gene was eventually identified as FLT4, which encodes VEGFR-3 [53, 54].

Hereditary LMs associated with VEGFR-3 mutations are typically characterized as type-I, which are early-onset, often occurring at birth or shortly after birth. Hereditary type-II LMs are late-onset, with little infiltration, altered phenotypes, and other characteristics, including pigmentation disorders, visceral prolapse, cleft palate, yellow nails, and congenital heart problems. Type-II LMs are thought to be

caused by mutations in the gene encoding MFH1 on chromosome 16q24.3 [54, 55].

Physiological studies of LMs have been aided by remarkable progress in the overall understanding of the factors that regulate the development of the lymphatic and vascular systems. Furthermore, technical advances, such as immunohistochemistry staining using excellent markers, such as glucose transporter 1 (GLUT1), D2-40, and PROX1, have facilitated the identification of vascular malformations [41, 56]. Staining against VEGFR-3 can be used to distinguish lymphatic vessels from arteries and veins [56, 57].

Genetic factors play important roles in the pathogenesis of LMs. Recently, significant advances have been made toward identifying the genetic and molecular factors associated with a variety of vascular malformations, and several genes associated with LM development have been identified [58, 59].

Clinical manifestations

The clinical presentation of LMs depends on the anatomic location, size, and characteristics of the lesion. Most patients are asymptomatic, and LMs are often detected incidentally during imaging evaluations or surgery for other indications [60, 61]. However, a minority of LMs can cause symptoms and present as a palpable abdominal mass that compress adjacent structures or as an internal cystic hemorrhage, causing abdominal pain, intestinal or ureteric obstruction, and hematuria [62, 63]. When LMs are combined with other vascular malformations, such as venous malformation or capillary malformation, symptoms may vary depending on the number of involved blood vessels [64, 65].

Imaging findings

Ultrasound is often used as the initial diagnostic tool for the evaluation of cystic abdominal masses and can be used to identify LM properties [66]. LMs are categorized as macrocystic when individual malformed channels are larger than 10 mm, whereas LMs are categorized as microcystic when the individual channels are smaller than 10 mm, and both sizes can be present together. Macrocystic LMs present as multilobular cystic lesions, whereas microcystic lesions are ambiguous and hyperechoic due to multiple interfaces between small follicular walls. Microcystic forms typically manifest with more infiltration and internal bleeding tendency. Mixed lesions include both cystic and solid components, which are related to the size of the cyst and their shape on ultrasound (Figs. 3, 6, and 7) [5, 67]. Color Doppler ultrasound may show vascular channels inside the septum, including normal veins and arteries, which can be confirmed by spectral Doppler analysis (Fig. 8) [68]. In cases of hemorrhagic or inflammatory complications, fluid–fluid levels can be observed in the follicles [69, 70].

On computed tomography (CT), most LMs appear as homogeneous cystic components, but some may appear heterogeneous due to the presence of proteinaceous, fluid, blood, or fat components within the lesions [13]. Cystic LMs are typically well-defined, multicystic, and may show mild enhancement of the septa or the wall after intravenous


Fig. 6 Macrocystic LM in a 33-year-old male patient who presented with mild abdominal pain in the left abdomen. Grayscale ultrasound (**A**, **B**) and post-contrast CT (**C**, **D**) images showed a multilobed cystic lesion in the retroperitoneal space in front of the left kidney. The fluid compartments (asterisks), the inner septa of the lesion (arrows). The lesion was diagnosed by histopathology
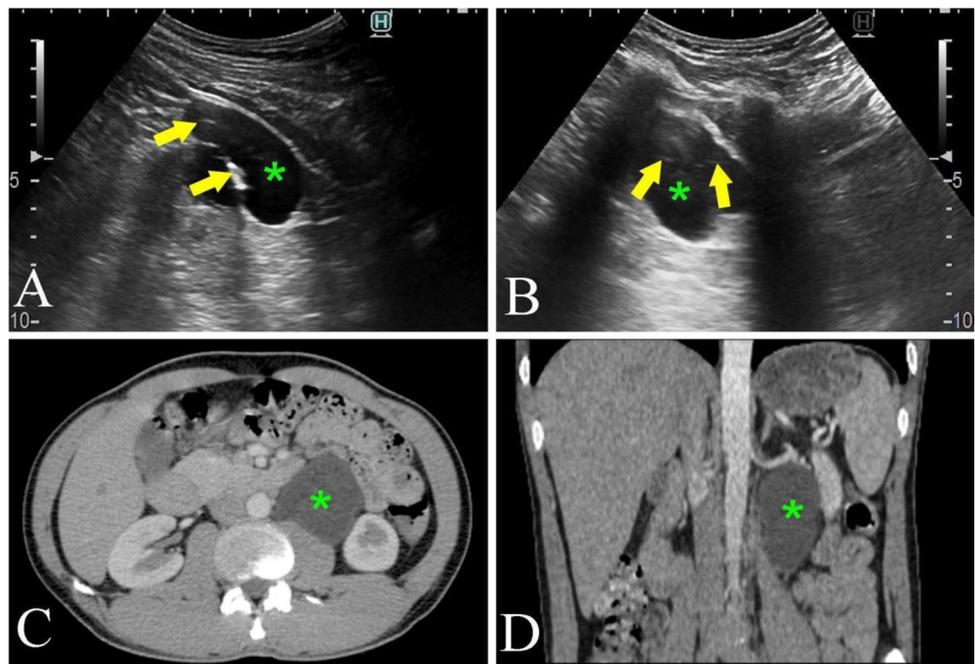
Fig. 7 Macrocystic LM was detected incidentally in a 26-year-old patient. Grayscale (**A**) and color Doppler ultrasound (**B**) images showed a large well-defined multiseptated cystic lesion at the posterior right kidney of retroperitoneal space. Contrast-enhanced CT images with the arterial (**C**) and delayed (**D**) phases showed a cystic lesion that is adjacent to the right kidney and does not enhance after contrast injection. The fluid compartments (asterisks), the inner septa of the lesion (arrows)
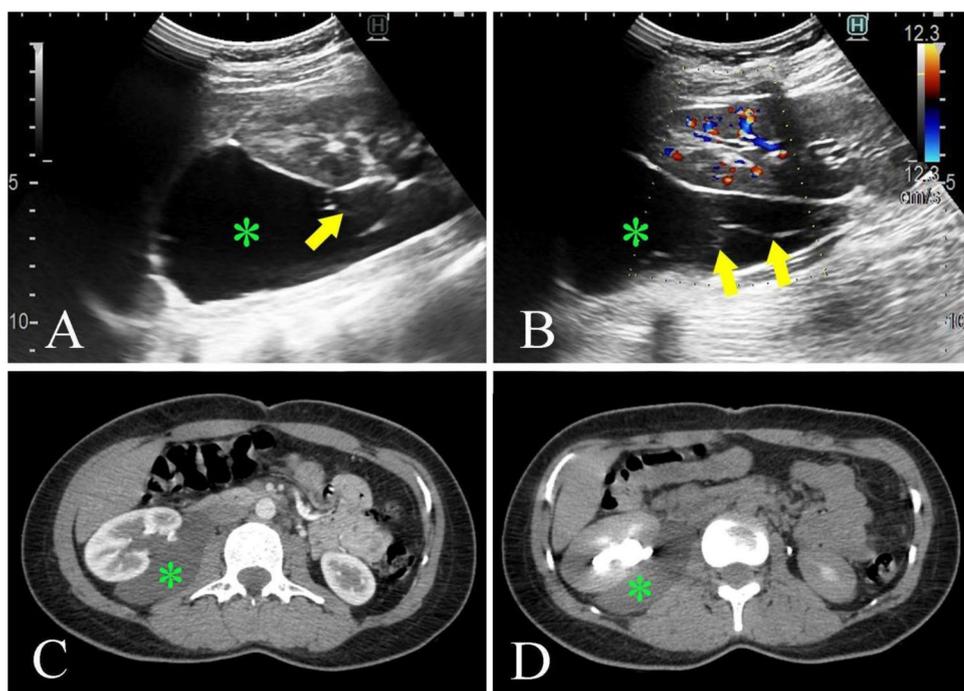

Fig. 8 Mixed LM in a 55-year-old female patient presented with a right retroperitoneal cystic mass. She had no remarkable history. Color Doppler (**A**) and grayscale (**B**) ultrasound images showed a large mixed cystic mass in the right retroperitoneal space with multiple vascularly signaled walls. The lesion was surgically removed because of suspected malignancy. Pathology confirmed the lesion to be mixed LM
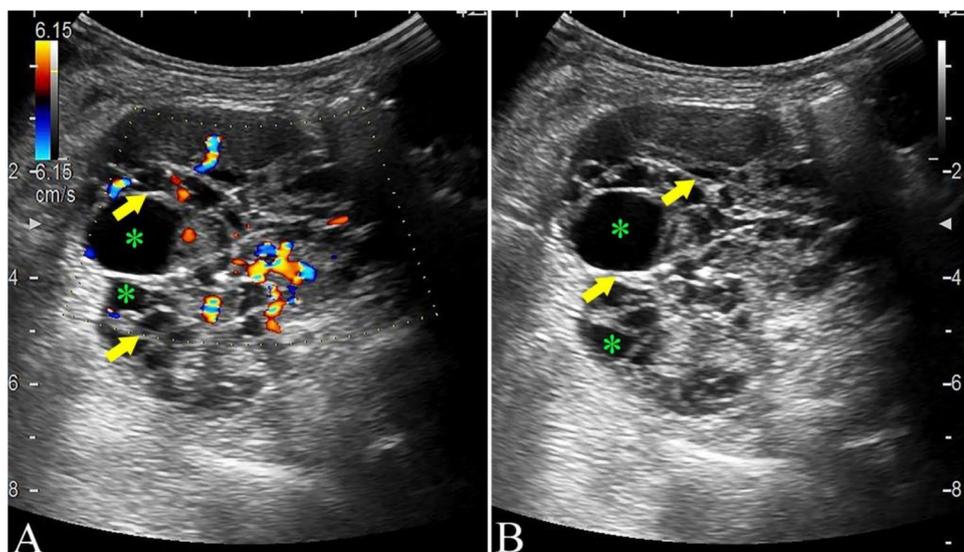
contrast agent administration [66]. They may also form unilocular or multilocular cystic masses, which may not be limited to a particular abdominal compartment and may displace intra-abdominal organs and vessels (Figs. 4, 5, 6, 7) [71, 72].

On magnetic resonance imaging (MRI), the lesions present a multilobular septal form [73]. They have iso-intensity to hypointensity on T1-weighted images and hyperintensity on T2-weighted and short tau inversion recovery (STIR) images, as these cystic lesions can be of various sizes and are often filled with fluid (Fig. 9, 10) [74, 75].

Internal fluid–fluid levels can be observed. To detect blood components in the lesion can use basic sequences combined with magnetic sensitive sequences. Similarly, for fat component detection, fat suppression imaging, or chemical shift imaging can be used. Pure LMs do not enhance inside after contrast agent administration and consist entirely of fluid storage spaces that are unconnected to the venous system. Contrast agents can enhance the peripheral walls and septa of the lesion [76, 77], and the enhancement of capsules and walls is especially apparent in macrocystic
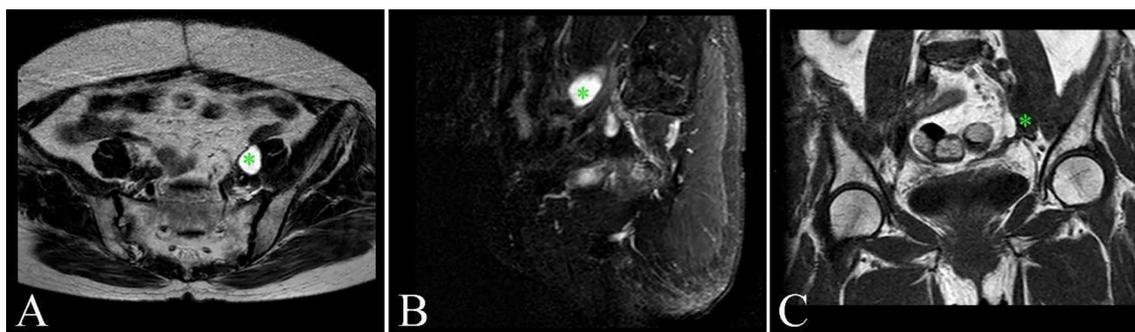
Fig. 9 Axial T2-weighted (**A**), sagittal T2-weighted fat-suppressed (**B**), coronal T1-weighted (**C**) images of a 43-year-old woman who was detected incidentally during pelvic examination show a small well-defined, unilocular, thin-walled cystic lesion adjacent to left psoas muscle. The lesion appeared as homogeneous hyperintense on the T2-weighted image and homogeneous hypointense on the T1-weighted image. The lesion was treated conservatively and was likely to be diagnosed as retroperitoneal LM. During subsequent follow-ups, no growth was observed
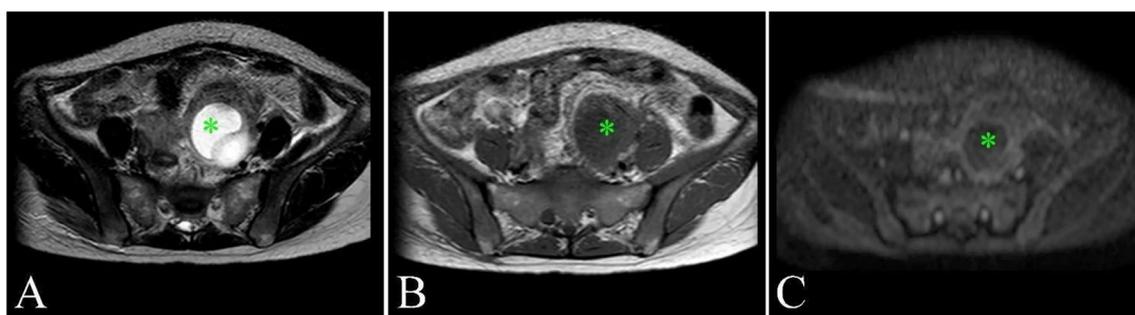
Fig. 10 Macrocystic LM in a 37-year-old woman presenting with periumbilical abdominal pain. Axial T2-weighted (**A**), T1-weighted (**B**), and DWI (**C**) images of the pelvis showed a well-defined multi-locular cystic lesion in the left pelvis with mass effect on the adjacent organs (asterisks). It appears heterogeneously hyperintense on the T2-weighted image, hypointense on the T1-weighted image, and no diffusion restriction. The lesion was resected by laparoscopic surgery. Histopathology confirmed as macrocystic LM. This lesion initially was misdiagnosed as a left ovarian cyst

LMs. Microcystic LMs do not enhance significantly. Surrounding lymphoedema may also be observed [13, 78].

Differential diagnosis

The retroperitoneal space is the region between the peritoneum and the posterior parietal wall of the abdominal cavity, which extends from the pelvic floor to the diaphragm [79]. Masses of retroperitoneal origin include a heterogeneous and diverse group of lesions [80]. Retroperitoneal masses can be classified as solid or cystic, depending on their radiological appearance [81]. Solid lesions can be categorized into four groups according to the origin: germ cell, neural, mesenchymal, and lymphoproliferative [80, 81].

Retroperitoneal cysts can be classified into two predominant types. The first type is epithelial cysts arising from the major retroperitoneal organs (kidney, pancreas, colon, duodenum, adrenal glands). The latter arises from the retroperitoneal space but outside the major organs. Among cystic lesions, the most common are LMs, mesothelial cyst, enterogenous cysts, urogenital cyst, or cystic neoplasms [81, 82].

Many of the retroperitoneal masses are malignancies, approximately 75% of which have mesenchymal origins [22]. The differential diagnosis of a cystic lesion in the retroperitoneum can be malignant or benign, which is important for treatment plans [22, 80]. Identifying the site of origin of any mass (compartment or organ) is important in determining the differential diagnosis.

Table 1 Differential diagnosis of retroperitoneal neoplastic cystic masses

Neoplastic cystic lesions

Lymphatic malformations (LMs)

Vascular malformations that present as unilocular or multilocular cysts and may feature wall calcification. Surgery is the optimal treatment choice

Lymphangiomatosis (cystic angiomatosis)

Diffuse, multisystemic lymphangiomas that are locally infiltrative and grow along tissue planes. Histology can be used to subdivide them into simple, cavernous, and cystic subtypes. Imaging findings show well-defined cystic lesions that do not enhance. They can be calcified as fine specks. Mesentery can be thickened, and the involvement of multiple organ systems is typical. The chest and bones are the most commonly involved anatomical locations

Lymphangioleiomyoma, lymphangioleiomyomatosis

Lymphangioleiomyoma is generated by lymphatic obstruction caused by the proliferation of smooth muscle cells. Lymphangioleiomyomatosis is a perivascular, epithelioid cell tumor subtype that most commonly occurs in women. All patients have lung cysts. Dilated thoracic ducts and chylous ascites are often observed. Imaging findings show a cystic mass with a well-defined wall. The fluid inside is quite homogeneous. After contrast agent administration, peripheral enhancement is observed during the early arterial phase. Homogeneous enhancement can be observed in the center during the delay phase. Diet, time of the day, and gravitational factors may alter the lesion size. A retroperitoneal lymphangioleiomyoma is often revealed when clinical signs suggest an abscess or tumor

Cystic teratoma

A well-differentiated mixture of dermal cells derived from the three germ cell layers: ectoderm, mesoderm, or endoderm. Radiological images reveal solid tissue, fat, calcified, and cystic components. The cystic septations can be enhanced. Surgery is performed immediately with good results

Epidermoid cysts

Congenital ectodermal cysts are caused by the desquamation of epithelial cells. They are more common in women. Cysts are lined by stratified squamous epithelium and contain water, desquamated debris, keratin, and cholesterol. They are most commonly found in the presacral space. Radiological findings show a unilocular, thin-walled cyst. Surgery is the optimal treatment strategy

Mucinous cystadenoma

Rare cystic masses that occur in women with normal ovaries. Pathogenesis is hypothesized to be associated with coelomic metaplasia from the invagination of the peritoneal mesothelial layer, resulting in cyst formation. Radiological findings typically reveal a homogeneous cystic mass with a unilocular form. Exploratory laparotomy and the complete excision of the lesion are usually applied to both diagnosis and treatment. Early diagnosis of this disease is significant because it can transform into malignancy

Cystic mesothelioma

Benign lesions of mesothelial origin arise from the serous lining of the pericardial, pleural, or peritoneal space. The incidence in women is more common than in men. They may recur locally but do not metastasize. Image analysis displays a multilocular or unilocular cyst with thin walls and containing watery secretions. They are difficult to distinguish radiographically from lymphangiomas

Müllerian cysts

Benign urogenital cysts arising from aberrant Müllerian duct remnants in the retroperitoneum. Abnormal hormone stimulation results in cyst proliferation. They can be classified as mesonephric, pronephric, or metanephric types. Radiological findings show a thin-walled unilocular or multilocular cyst containing clear fluid. The clinical properties often allow distinction from other cystic neoplasms

Tailgut cysts

Lesions that originate from embryonic hindgut remnants are typically asymptomatic and often occur in middle-aged women. Histologically, they are lined with diverse types of epithelium. Radiological findings show a well-defined multilocular cystic mass in the presacral space. The composition can vary from fluid to solid tissue and occasionally appears calcified. Surgical resection is required immediately because of the risk of malignant transformation. Radiological manifestations show the involvement of adjacent structures and the loss of marginal continuity

Bronchogenic cysts

Rare, benign, congenital cysts that arise from the abnormal budding of the developing tracheobronchial tree. Although they frequently occur in the mediastinum, they may also occur in the retroperitoneum. If they occur in the retroperitoneal space, they are typically located in the subdiaphragmatic space. They are typically asymptomatic and are often detected when they are perforated, infected, or grow to a large size. Imaging findings show well-circumscribed, rounded cysts without enhancement, and they can be calcified

Cystic degeneration in solid lesions

Retroperitoneal cystic degeneration often occurs in solid lesions, including paragangliomas, neurilemomas, and sarcomas. (1) Paragangliomas often cause clinical symptoms because they produce catecholamines. On radiological imaging, they typically display homogeneous soft-tissue density, and central areas may contain cystic degeneration. (2) Neurilemoma is usually located in the presacral pelvic or paravertebral space of the retroperitoneum. Cystic changes are caused by necrosis due to insufficient blood supply to the lesion center. (3) Sarcomas can also display cystic characteristics after chemotherapy or radiotherapy due to lesion hemorrhage or necrosis. Degenerative neuroendocrine tumors can also sometimes mimic LMs

Perianal mucinous carcinoma

Rare lesions that result from an anal duct, an anal fistula, or a duplicated duct. They produce abundant mucin, creating organized mucinous pools. They penetrate the soft tissues around the anus, but the overlying anorectal mucosa lining remains intact. Radiological images show a calcified perirectal mass with the deviation of the adjacent rectum

Table 1 (continued)

Pseudomyxoma retroperitoneal

Typically occurs in the peritoneal cavity but can also occur in the retroperitoneal cavity. They arise from the rupture of appendiceal or ovarian mucinous lesions, resulting in the accumulation of gelatinous material in the intraperitoneal cavity. They occur in the retroperitoneum due to the rupture of retrocecal appendiceal mucinous lesions and become fixed to the posterior abdominal wall. Imaging findings appear as multicystic masses with thick septa or walls. They induce the displacement, distortion, or scalloped indentation of the surrounding structures. They typically feature little calcification and cause recalcitrant mucinous ascites

Cystic lesions of retroperitoneal organs

Usually, if a lesion is located in an organ, it can be easily diagnosed. However, if a lesion is too large to extend beyond the border of that organ (e.g., renal cyst, pancreatic cyst, adrenal cyst, mucinous cystic pancreatic neoplasms, pancreatic serous cystadenomas) or if a cystic lesion is adjacent to that organ, the diagnosis is more difficult. At this point, LM should be included in the differential diagnosis of this cystic lesion

Cystic lesions from peritoneal organs extending to retroperitoneal space

Retroperitoneal LM also sometimes needs to be differentiated from splenic, omental, mesenteric, and enteric cysts

Table 2 Differential diagnosis of retroperitoneal non-neoplastic cystic masses

Non-neoplastic cystic lesions

Pancreatic pseudocysts

Pancreatic pseudocysts are encapsulated collections of pancreatic fluid enclosed by a complete wall of fibrous tissue, typically located around the pancreas. A pseudocyst requires four or more weeks to develop. Diagnosis is based on clinical symptoms, pancreatic enzyme tests, or radiological findings. A pancreatic pseudocyst manifests on imaging findings as a round or oval fluid collection with a thin or thick wall. Percutaneous drainage is an effective treatment

Nonpancreatic pseudocyst

Nonpancreatic pseudocysts are rare cystic lesions that occur in the omentum or mesentery. They usually have a thick fibrous wall and often contain pus, hemorrhage, or serous fluid. They are not associated with pancreatic enzyme levels in the cystic fluid. Histologically, the cyst wall contains fibrous tissues without an epithelial lining. The radiological findings show multilocular or unilocular fluid-filled cystic lesions with thick walls

Lymphocele

Lymphoceles are fluid-filled lesions without an epithelial lining. They usually occur after renal transplant surgery or lymphadenectomy. Retroperitoneal lymphoceles may cause venous obstruction, edema, or thromboembolic complications. Radiological images show a cystic mass. No fat density within the fluid is rare but highly suggestive of a lymphocele. Wall calcification can be observed but is very rare. Clinical history can be helpful to establish the diagnosis

Hematoma

Hematomas are often associated with trauma, blood disorders, anticoagulation therapy, or ruptured abdominal aortic aneurysms. On CT, acute or subacute hematomas appear as hyperdense. However, chronic hematomas show decreased attenuation due to the breakdown of blood products. MRI can also be used to detect hematomas using T2*-weighted imaging

Urinoma

Urinomas are encapsulated collections of previously extravasated urine. They are typically located in the perirenal space but may be observed in other locations. Hydronephrosis is present in most patients. Radiological findings manifest as a fluid collection. They may appear during the delay phase after intravenous administration of contrast agent because contrast-enhanced urine becomes collected. Percutaneous drainage may allow both diagnosis and treatment

Cystic lesions can be classified as neoplastic and non-neoplastic lesions (Tables 1, 2) [83, 84]. Neoplastic cystic lesions include lymphangiomatosis (Fig. 11), lymphangioleiomyoma, lymphangioleiomyomatosis, cystic teratoma (Fig. 12), epidermoid cyst, mucinous cystadenoma (Fig. 13), cystic mesothelioma (Fig. 14), Müllerian cyst (Fig. 15), tailgut cyst (Fig. 16), bronchogenic cyst (Fig. 17), perianal mucinous carcinoma, pseudomyxoma retroperitonei, cystic lesions of retroperitoneal organs (Figs. 18), cystic lesions from peritoneal organs extending to retroperitoneal space (Figs. 19, 20), and cystic degeneration in solid lesions. Non-neoplastic cystic lesions include pancreatic pseudocyst (Fig. 21), nonpancreatic pseudocyst, lymphocele (Fig. 22), hematoma, and urinoma (Fig. 23) [83–86]. Other rare non-neoplastic diseases include retroperitoneal cystic fibrosis, extramedullary hematopoiesis, and non-Langerhans histiocytosis [87].
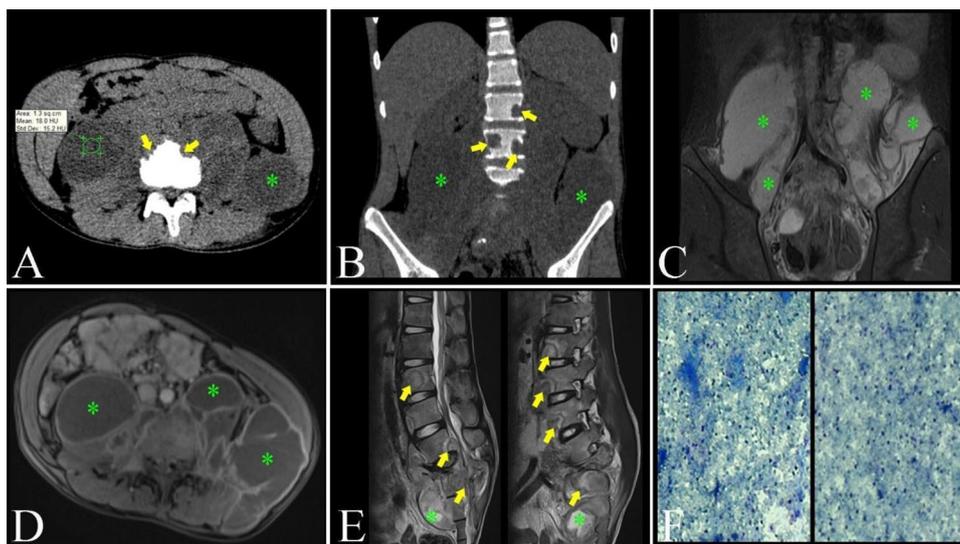
Fig. 11 Generalized lymphangiomatosis in a 16-year-old male with a large mass over the left lower back area growing progressively for 3 months and pain in the right pelvic and bilateral lower back radiating into lower limbs. Non-enhanced axial (**A**) and coronal CT (**B**) images showing multilocular cystic lesions within bilateral psoas muscles, left extensor muscles and left lower back subcutaneous region (asterisks). There was an osteolytic of the spine with a sclerotic margin (arrows). MRI coronal STIR (**C**) and axial T1W Vibe Dixon Gado (**D**) show multilobar fluid signal lesion (asterisks) with moderately thickened septa with post-gadolinium enhancement. Sagittal T2W image (**E**) shows hyperintense lesions over lumbosacral vertebrae (arrows) extending into the spinal canal that results in nerve root compression of cauda equina and cystic lesions are also observed in the lower abdominal region anterior to the sacrum (asterisks). Cytopathological examination (**F**) of yellowish fluid obtained by ultrasound-guided fine-needle aspiration of the psoas muscle revealed a homogeneous population of small and round lymphocytes with some interstitial histiocytes. Some centrosomes, centroblasts, and plasma cells were also observed. All showed a heterogeneous population of mature lymphocytes and chylomicrons with no suspect malignant cells, consistent with the diagnosis of generalized lymphangiomatosis (Giemsa stain, at 40× magnification). The patient was treated conservatively and the patient was symptom-free after 1 month

Management

The treatment of choice for retroperitoneal LMs is complete surgical resection, in most cases, including asymptomatic cases, due to the risk of future complications. However, aspiration and the injection of sclerosing agents have also been recommended [88, 89]. Indications for the treatment of LMs depend on the degree of disfigurement, malformation size, evidence of chronic lymph fluid leakage, and the frequency of inflammatory episodes. During the surgical treatment of LM lesions, injury to important adjacent structures should be avoided, particularly because LM lesions are benign [90, 91].

The identification of disordered genetic pathways in LM tissue has encouraged clinicians to use a variety of treatments for LMs associated with the PIK3CA mutation and tissue overgrowth. Rapamycin can inhibit a component of the PI3K/AKT1 pathway called mammalian target of rapamycin (mTOR) [92]. Rapamycin is a macrolide antibiotic that affects various pathological processes that require the activation of mTOR and is often used to suppress immunity during organ transplantations or autoimmune lymphoproliferative syndrome [93, 94].

Recently, a phase II clinical trial demonstrated that the empirical use of rapamycin in patients with complex LMs was safe and reduced the incidence of cellulitis, days of treatment, and infection. Side effects include gastrointestinal disturbances, lipid metabolism disorders, and blood and bone marrow abnormalities [95, 96]. The response to treatment included pain relief and decreased bleeding, although a complete response was infrequent. The complete lack of response is unclear, and future studies remain necessary to determine the optimal therapy for patients with LMs. Corticosteroids can help reduce inflammation associated with LMs [97, 98].

Basic and clinical research is currently being performed to enhance the reliability of non-surgical treatments, which will hopefully result in increased options for the medical and biological therapy of LMs. As this develops, the methods supporting the standardization will produce more than expected results [94–99].
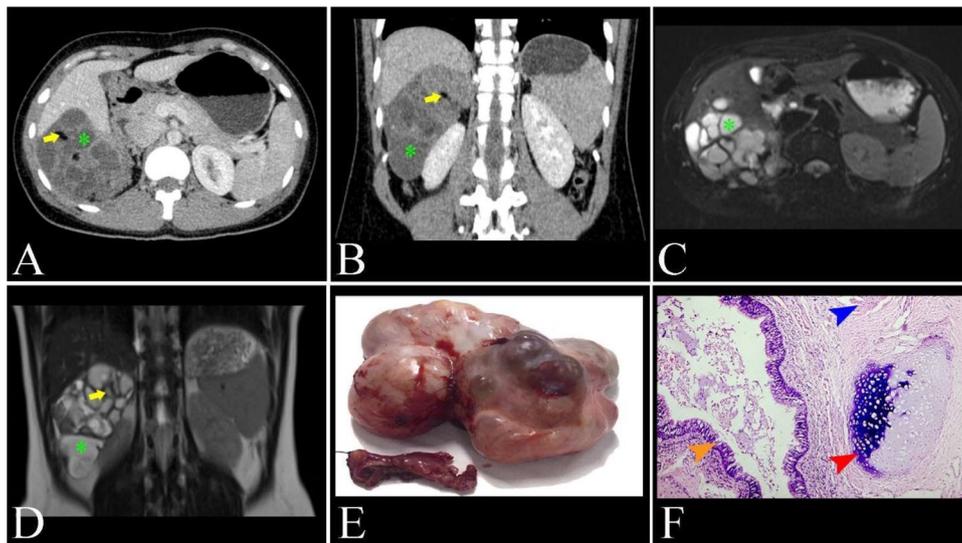
Fig. 12 Retroperitoneal mature cystic teratoma in a 22-year-old patient attending with right hypochondria and a history of left ovary dermatome cysts removal. Axial (**A**) and coronal (**B**) CT images show a multilobular cystic lesion (asterisk) with fat components inside (arrow). The lesion is a large retroperitoneal mass covered in the middle of the liver and right kidney with $120 \times 80 \times 65$ mm. It is composed of both cystic and solid elements, but no calcification density was found. MRI gives images similar to CT Scan with a large multilobed cystic mass with mild enhanced smooth wall and thin septations and little non-enhanced solid contents. The cystic has a hemorrhagic heterogeneous signal intensity in sites with many different phases. MRI of a tumor in the axial plane on T2 TSE FS (**C**) and in the coronal plane on T2 Haste (**D**) show a multilocular lesion with the signal intensity of greasy components (asterisk). Wall and septum of the tumor show enhancement (arrow). (**E**) The surgical specimen after Kocher's laparotomy demonstrated a multilobed cystic mass well-circumscribed with smooth borders and rubbery consistency. Cut sample of the mass showed multilocular cystic spaces, whitish-gray walls, scattered yellowish adipose tissue collections, and mucus secretions. The cyst wall was up to 4 mm thick. (**F**) A cross-sectional micrograph of a part of the lesion shows that the lesion includes stratified squamous epithelium (orange arrowhead), cartilaginous tissue (red arrowhead), and muscle tissue (blue arrowhead). The diagnosis of mature cystic teratoma was made up as final with no mark of malignancy or immature elements. The patient then had a 2-week follow-up with no development of ailment nor significant complications
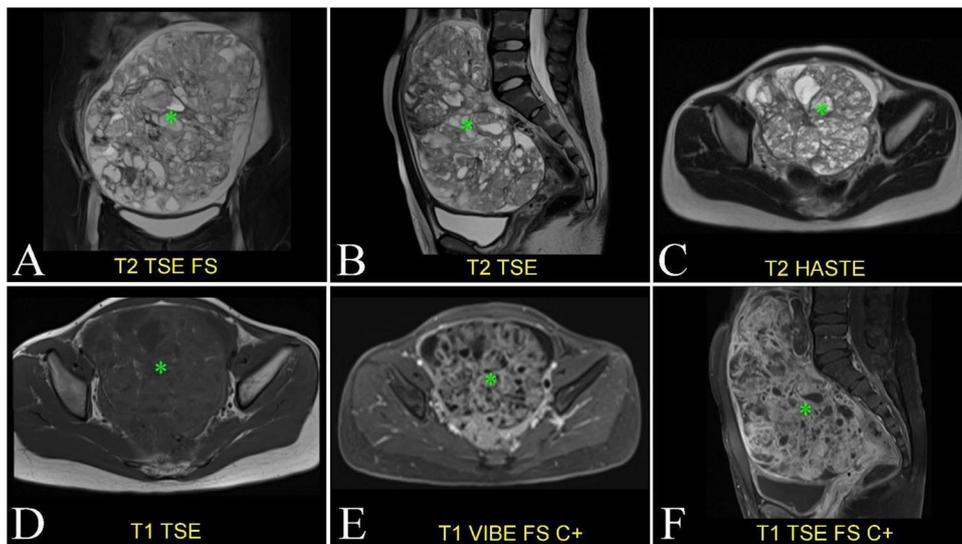

Fig. 13 Retroperitoneal primary mucinous adenocarcinoma in a 23-year-old female patient presenting with progressive abdominal distension and weight loss within 4 months. She had no significant past medical histology or family history of the disease. Laboratory data showed high levels of the carcinoembryonic antigen and carbohydrate antigen. MRI (**A–F**) revealed a large multilobed cystic mass in the abdominal cavity with enlarged lymph nodes along the aorta. The wall and septum of the lesion are strongly enhanced after using contrast agents (asterisks). Lesions located in the retroperitoneal space were confirmed by surgery. Pathology confirmed the diagnosis as mucinous adenocarcinoma. The patient was stable thereafter and no recurrence was observed after 1 year of follow-up
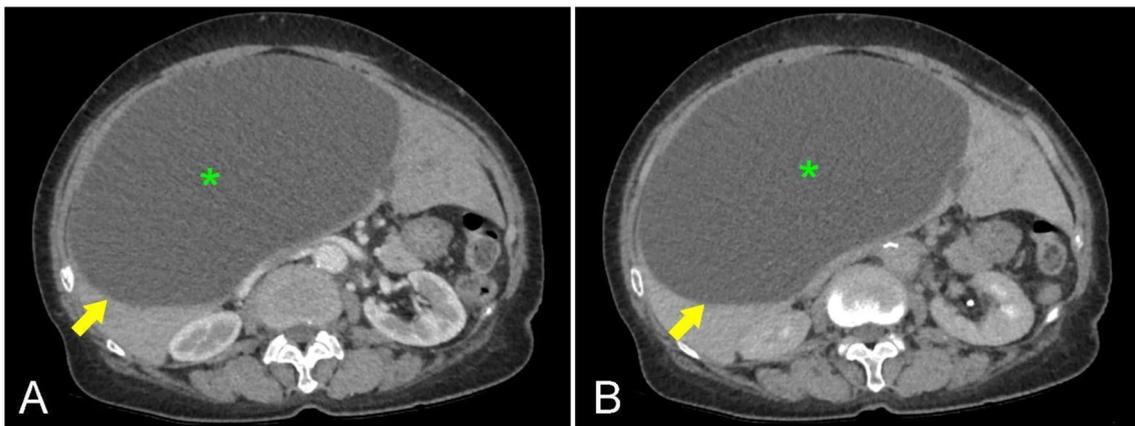
Fig. 14 Retroperitoneal cystic mesothelioma in a 53-year-old woman presenting with mild right upper quadrant tenderness. Axial CT images in the late arterial (**A**) and delayed (**B**) phases after contrast administration show a single-lobed cystic mass in the right abdomen (asterisks). The mass did not show enhancement and displaced intestinal loops, contacts, and compresses the liver parenchyma (arrows) and gallbladder. A simple hepatic cyst was diagnosed initially and laparoscopic surgery was subsequently performed to avoid the risk of rupture. However, no intraperitoneal masses were seen and a large multiloculated retroperitoneal cyst was detected, in contact with the right adrenal gland and colon. This mass was completely aspirated and excised. The lesion was confirmed by histopathology
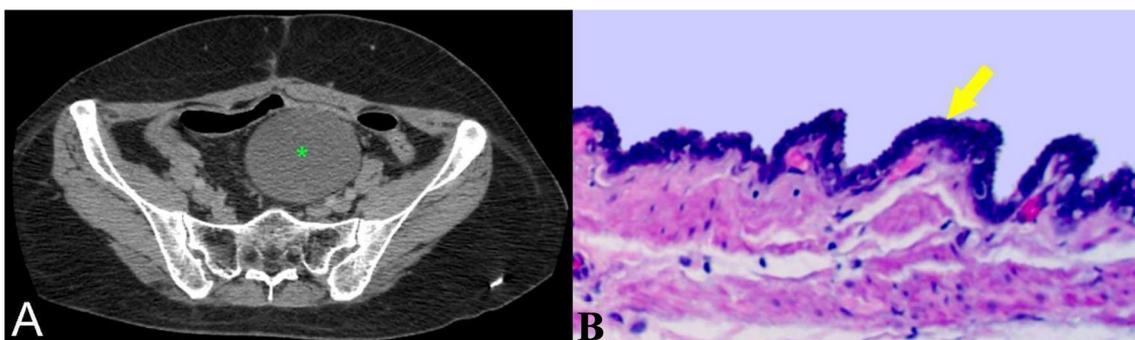

Fig. 15 A retroperitoneal Müllerian cyst was detected incidentally in a 57-year-old asymptomatic woman. **A** Axial CT image shows a cyst in the retroperitoneal region of the left iliac bundle (asterisk). A laparoscopy with cystectomy was performed. **B** Histological image shows an inner cystic lining of ciliated epithelium of Mullerian type (arrow) and some lymphocytic aggregates and smooth muscle cells in the stroma
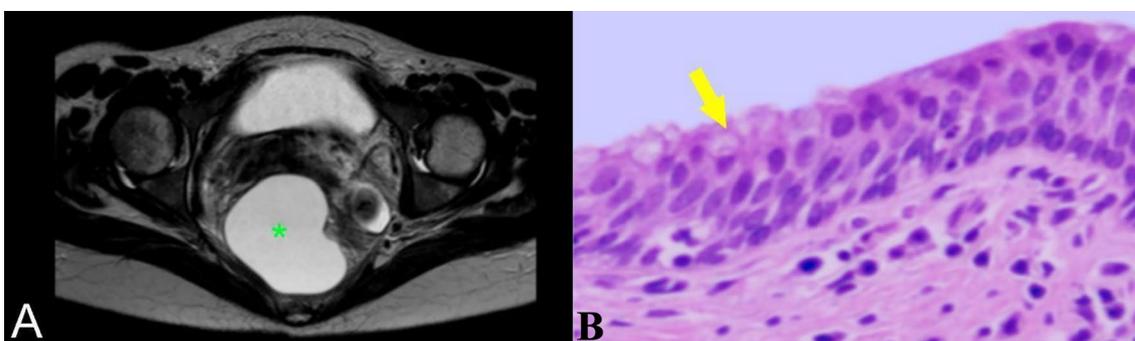

Fig. 16 Retroperitoneal tailgut cyst in a 48-year-old female with a history of dull discomfort in the lower abdomen and constipation. MRI axial T2W image (**A**) showed a well-defined hyperintense cystic mass with a thin wall in presacral space (asterisk). The rectum and uterus were compressed and anteriorly displaced. The photomicrograph of the histologic specimen (**B**) showed the wall of the cyst that was lined with ciliated epithelium (arrow)
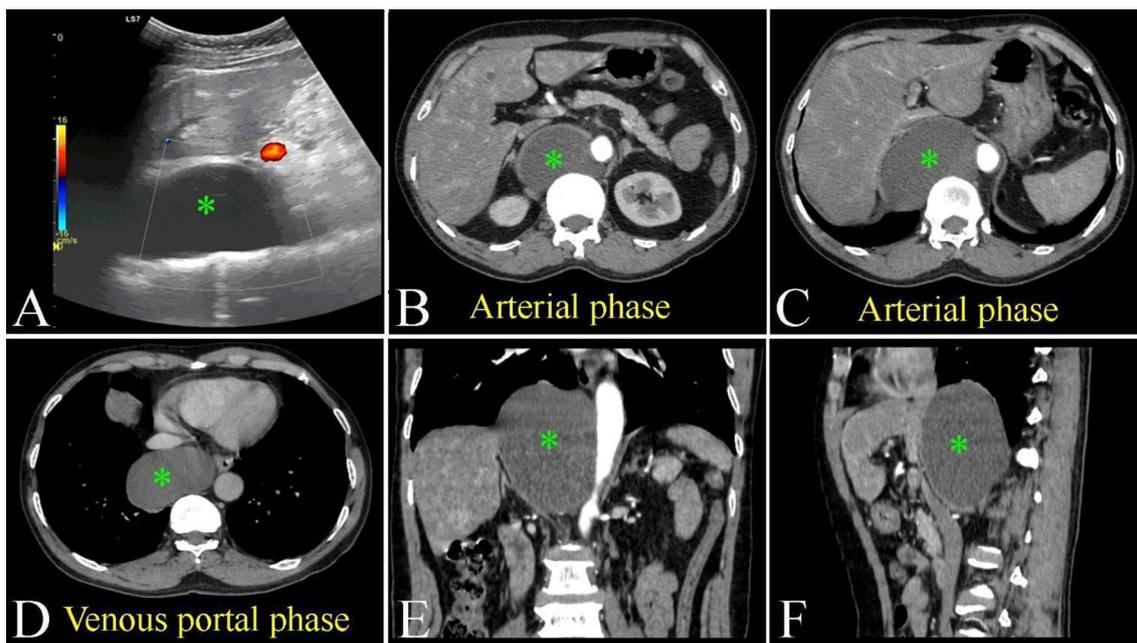
Fig. 17 Retroperitoneal bronchogenic cyst in a 70-year-old male patient who was admitted to the hospital because of abdominal pain in the epigastrium. Abdominal ultrasound (**A**) shows a large well-defined cystic mass in the right epigastrium adjacent to the abdominal aorta (asterisk). A CT survey was performed immediately to rule out abdominal aortic rupture. Axial (**B–D**), coronal (**E**), and sagittal (**F**) CT images revealed a retroperitoneal thin-walled cystic mass with regular margins, located between the spine, vena cava, abdominal aorta, adjacent to the liver and diaphragm. After intravenous contrast injection, no internal septa or nodules were seen (asterisks). Laparoscopic surgery was performed; however, complete resection of the cyst was not achieved due to its adhesion to the aorta and inferior vena cava. Histopathological examination revealed a cystic lesion lined with respiratory epithelium confirming the diagnosis of a bronchogenic cyst
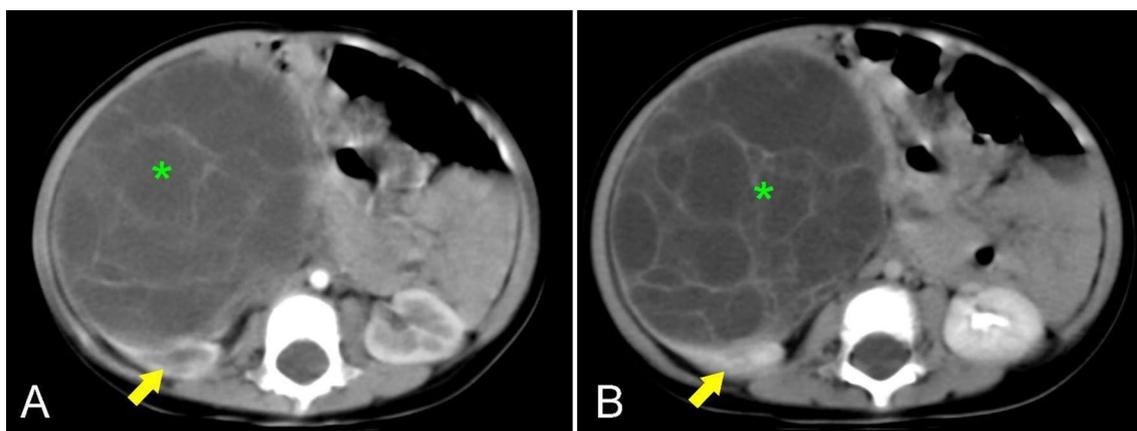

Fig. 18 Cystic Wilms tumor arising from the right kidney mimicked retroperitoneal LM in a 3-year-old boy. Contrast-enhanced CT images in the corticomedullary phase (**A**) and delayed (**B**) phase showed a large cystic mass (asterisks) in the right retroperitoneal abdomen with thin enhanced septa that attached to the right kidney (arrows). Wilms tumor was confirmed by surgery and histopathology

Fig. 19 Coronal (**A**) and sagittal CT (**B**) images of a 47-year-old woman showed a mostly intra-abdominal ovarian cyst (asterisks). Often, very large tumors can be difficult to distinguish whether they are in the peritoneal or retroperitoneal space. However, this cystic mass showed connection to the left ovary (arrow). An ovarian cyst tumor was confirmed by surgery
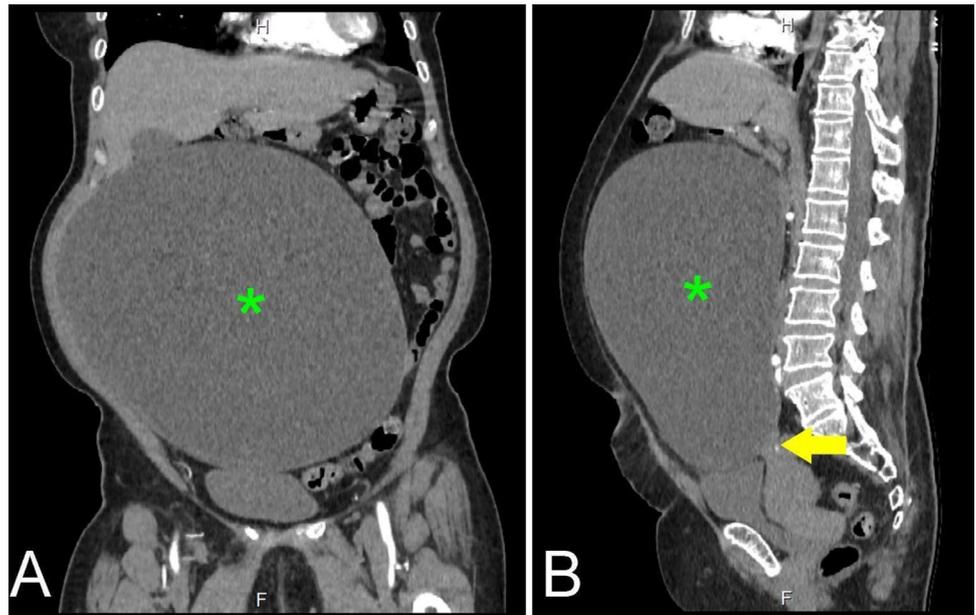

Fig. 20 Esophageal duplication cyst mimicking retroperitoneal LM in a 31-year-old man presenting with abdominal pain. Abdominal grayscale (**A**) and color Doppler (**B**) ultrasound incidentally revealed a cystic structure in contact with the left hepatic posterior surface (asterisks). The CT images (C-F) showed a fluid-dense structure in the epigastrium adjacent to the esophagus (asterisks) with location and appearance most consistent with an esophageal duplication cyst
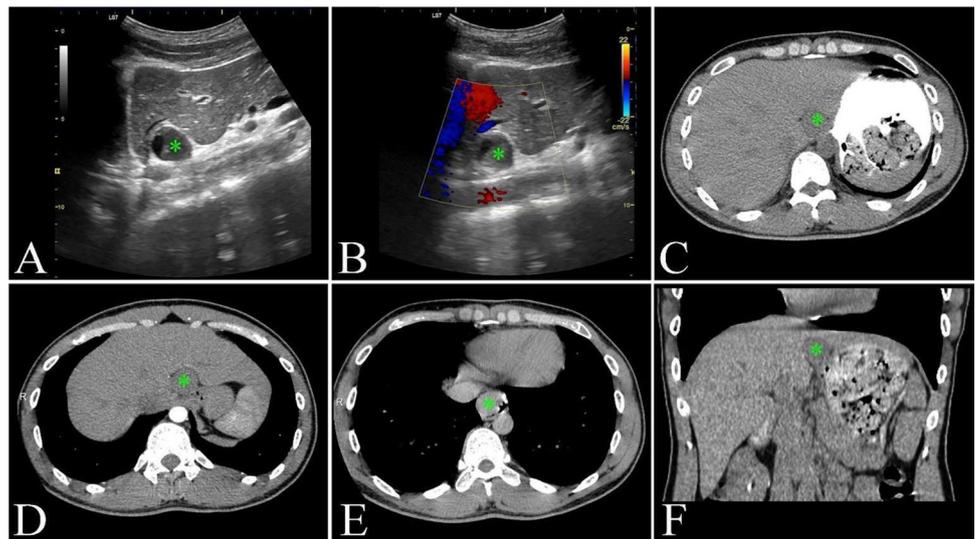
Conclusion

Retroperitoneal LMs are rare clinical entities in adults. Because most LMs are asymptomatic, they are often only detected as incidental findings. The differentiation of cystic LMs from other cystic growths using imaging studies alone is often challenging. Ultrasound is the modality of choice for the initial assessment of LMs, followed by CT scans and MRI to delineate the lesion extension. Surgery is the most recommended option to provide both a definitive diagnosis and treatment. LMs should be considered in children and young adults who present with retroperitoneal cystic masses.
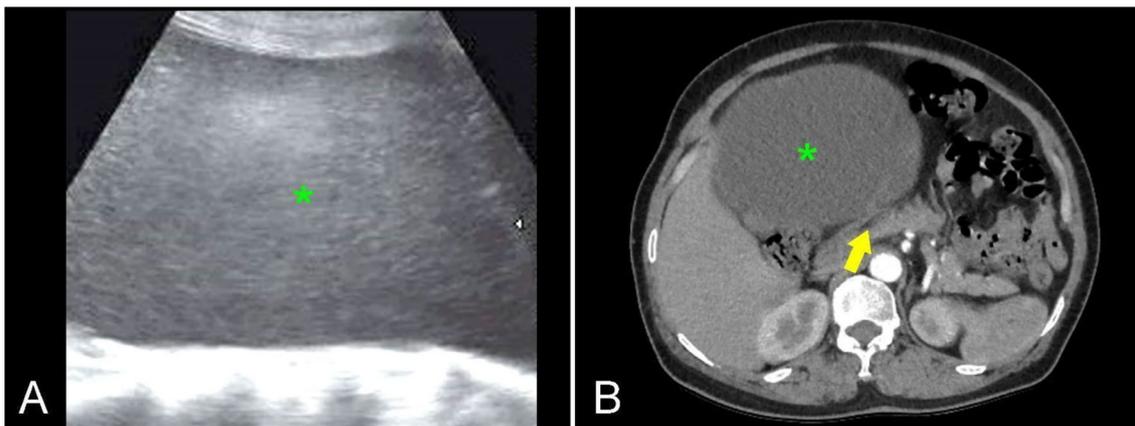
Fig. 21 Pancreatic pseudocyst mimicking LM in a 55-year-old woman presenting with 3-day dull epigastric pain. She had a history of chronic pancreatitis. Ultrasound image (**A**) showed a cystic structure in the epigastrium with echogenic fluid (asterisk). CT image (**B**) showed a cystic structure in the epigastrium slightly to the right (asterisk) and the lesion contacted with the pancreas (arrow). The patient was treated conservatively. During follow-up, the cyst size gradually decreased in size and stabilized. With history and image studies, the final diagnosis was confirmed as a pancreatic pseudocyst

Fig. 22 Intraperitoneal and retroperitoneal lymphocele mimicking LM in a 46-year-old female patient with a history of pelvic trauma 7 days ago and presenting to abdominal dull pain. CT images (**A–D**) showed hypodense cystic structures in the right mesenteric, retroperitoneal, and hypogastric regions (asterisks). The cystic masses appeared with smooth lobulated contours and regular walls did not show contrast enhancement after intravenous contrast. The patient was not followed up because she refused to be treated at the hospital. However, based on imaging and trauma condition, the most likely diagnosis was lymphocele. Peritoneal inclusion cyst (peritoneal pseudocyst) should also be included in the differential diagnosis
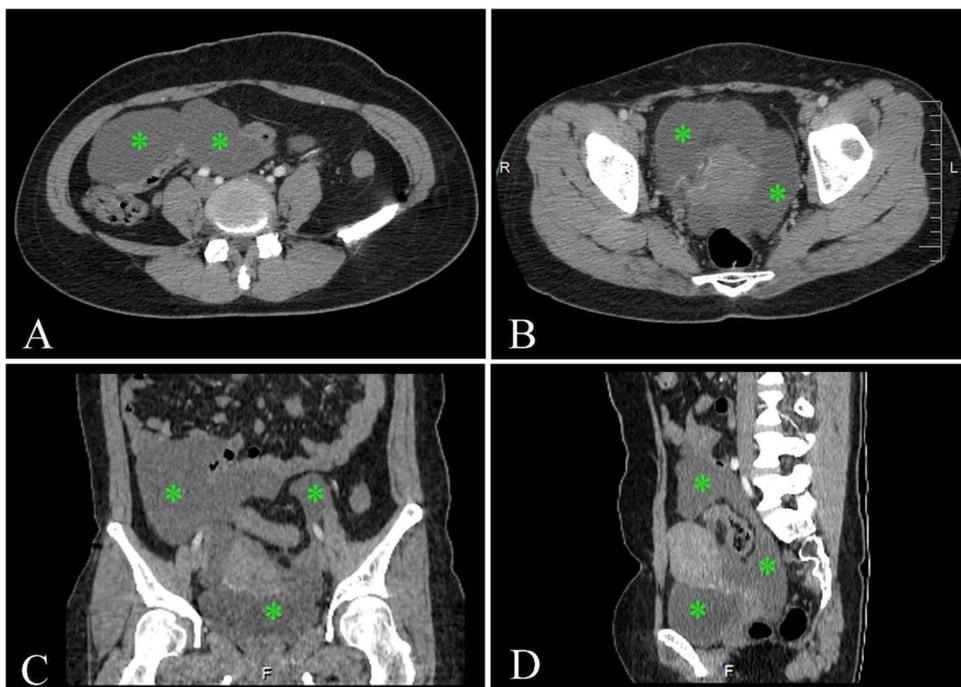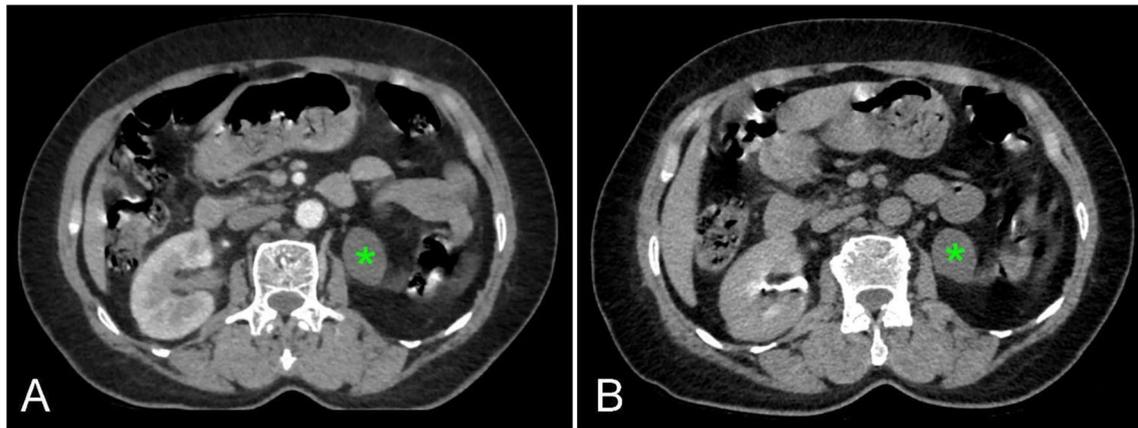
Fig. 23 Urinoma in a 55-year-old female patient presented for general check-ups with a history of blunt trauma to the left kidney 3 months ago. Axial contrast-enhanced CT images (**A**, **B**) showed a well-defined collection of fluid (asterisks) in the retroperitoneal space adjacent to the left ureter. No contrast extravasation from blood vessels or ureters was seen. The lesion was stable and decreased in size in the next follow-ups. Based on the trauma history and imaging studies, the final diagnosis was urinoma. In many cases, urinomas can mimic LM if there is no well-documented clinical history

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The manuscript does not contain patient information.

Informed consent Written informed consent was obtained from all individual participants included in the study.

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