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MR imaging of pelvic extraperitoneal masses: A diagnostic approach

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Abstract Pelvic extraperitoneal pelvic masses are relatively uncommon conditions and generally raise diagnostic imaging challenges. Magnetic resonance (MR) imaging plays a central role in the diagnosis of these masses due to its unique tissue-specific multiplanar capabilities that allow optimal pelvic mass localization and internal characterization. This article reviews the MR imaging presentation of extraperitoneal pelvic masses, gives clues that allow identifying their extraperitoneal and/or specific origin as well as suggests different steps for narrowing the differential diagnosis. These steps include systematic analysis of the clinical context, tumor location, relationships with major pelvic structures and close study of the internal components of the lesions.

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Masses of the pelvic extraperitoneal space are rare but include a broad spectrum of benign and malignant conditions arising from different pelvic components, with various clinical presentations. Reaching a definite diagnosis is often challenging for radiologists but may be possible through a systematic analysis of the clinical context, tumor location, relationships

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with major pelvic structures and internal components. Some histological components such as cystic, myxoid stroma, collagen fibers, calcification, and fat have suggestive or even pathognomonic features on magnetic resonance (MR) imaging. In addition, the patterns of enhancement after intravenous administration (IV) of a gadolinium chelate can reflect the vascularity of masses and may be also useful for the diagnosis, especially for differentiating benign from malignant soft-tissue masses.

The goals of this article were to review the different MR imaging presentation of extraperitoneal pelvic masses, give clues allowing identification of their extraperitoneal and/or specific origin as well as suggest different steps for narrowing the differential diagnosis.

**Clinical background**

Knowledge of the clinical context and analysis of all possible existing distant or local abnormalities are crucial when facing an extraperitoneal pelvic abnormality (Figs. 1 and 2). Pelvic extraperitoneal masses may indeed be part of a more diffuse disease process, including tumoral, infectious or inflammatory conditions. In this regard, retroperitoneal pelvic abscess that may complicate Crohn disease or diverticulitis of the sigmoid colon is easily diagnosed on the basis of clinical signs of infection and specific imaging features. Similarly, the diagnosis of a subperitoneal rectal nodule of endometriosis is generally not a challenge as it is generally associated with suggestive clinical presentation in a woman of reproductive age, retractile involvement of the appendix retroperitoneal fat that is hypointense and of uterosacral ligaments.

**Mass localization**

The pelvis is divided into the extraperitoneal/subperitoneal space and the intraperitoneal space, which are separated from each other by the anterior peritoneal reflection line. The anterior peritoneal reflection line is thus important to identify and is easily recognized on T2-weighted MR images in a midsagittal plane as a thin hypointense line of 1-mm or less in thickness (Fig. 3). Golub and al. have reported that this line can be identified in 74.4% of patients on MR imaging of the pelvis [1]. The tip of the seminal vesicles in men and the uterocervical angle in women were constant landmarks to determine the location of the most inferior point of the peritoneal membrane [1]. The reasons for difficulty in identifying the anterior peritoneal reflection line included
postoperative status, poor image quality, motion artifact, a paucity of pelvic fat planes, retroversion of the uterus and presence of a large, exophytic rectosigmoid tumor [1]. The anterior peritoneal reflection line was particularly well seen in patients who had fluid in the pelvic cul-de-sac (Fig. 4).

The pelvic extraperitoneal space includes three intercommunicating spaces, which are the prevesical, perivesical and perirectal spaces. The first step in the diagnostic approach of a pelvic extraperitoneal mass is to determine its origin and whether the tumor is intra- or extraperitoneal, or whether or not the mass originates from the ovary. Analysis of the displacement of normal anatomic structures is one of the most helpful step to determine the original location of a pelvic mass [2]. Anterior or internal displacement of retroperitoneal organs (i.e., uterus, ureter or rectum), iliac vessels and ilipsoas muscles, encasement of the external iliac vessels as well as mass effect or effacement of the pelvic musculature are indicators of the extraperitoneal origin of a pelvic mass (Fig. 5). On the opposite, lateral or posterior displacement of the uterus, sigmoid colon, ureter or iliac vessels suggests that the mass is intraperitoneal (Fig. 6). However, large extraperitoneal masses may extend into the peritoneal cavity and behave as an intraperitoneal mass with regards to the relationships with neighboring organs.

The identification of the ovaries is another helpful step to determine the origin of a mass. Ovaries have a variable position in the pelvis and even in the same individual patient at different times due to ligamentous laxity. Sometimes, the ovaries are not readily identified on MR imaging and they may be found following the ovarian veins along the psoas muscle down to the suspensory ligament. Identification of the gonadal vein directly joining the pelvis mass indicates an ovarian origin with a sensitivity of 92%, a specificity of 87%, a positive predictive value of 97%, a negative predictive value of 69% and an accuracy of 91% (Fig. 7) [3]. When an ipsilateral normal ovary is identified, it can be concluded that the tumor is extraovarian. Analysis of the relationships between the mass and adjacent organs can also be very helpful to determine the organ of origin (Fig. 8).

**Specific patterns of spread**

Some retroperitoneal masses have specific patterns of growth and extension that can help narrowing the differential diagnosis. For instance lymphangiomas, lymphomas and ganglioneuromas grow and extend into spaces between preexisting structures and encase vessels without compressing them. Lymphangiomia has the ability to cross from one compartment to another.
Figure 7. a–f: axial contrast-enhanced CT images show the course of the ovarian veins. Ovarian veins can be followed along the psoas muscles down to the broad ligament. (Ov indicates ovary; VO indicates ovarian vein; Ur indicates ureter).

Figure 8. Forty-five-year-old woman with a history of right-sided abdominal pain. a: axial contrast-enhanced CT image shows a pear-shaped lesion (arrows) with attenuation consistent with fluid content, medial to the right external iliac axis; b: coronal contrast-enhanced CT image optimally demonstrates that the lesion (arrows) has close relationships with the caecum enabling the diagnosis of appendiceal mucocele, that was histopathologically confirmed after surgical resection.

Tissue characterization

Although some mass components can be easily characterized using computed tomography (CT), their characterization is made easier using MR imaging. The pelvic extraperitoneal masses can be classified into two main distinct categories according to their appearance on MR imaging including cystic and noncystic (or solid) mass [4]. Noncystic masses can be further categorized into four distinct subgroups including fat-containing, myxoid, fibrous and hypervascular masses.

Cystic masses

Presacral cystic masses

Tailgut cyst

Tailgut cysts are rare congenital lesions most commonly found in middle-aged women. They are multicystic masses with small cysts clustered together and adherent to the main cyst resulting in a honeycomb pattern, located in the retrorectal space or in the ischioanal fossa. Attenuation values vary from that of water to that of soft tissue on CT and signal intensity on T1- and T2-weighted MR images varies with the degree of protein content. They have to be surgically removed because of potential complications including infection and more rarely malignant transformation into mucinous adenocarcinoma. Malignant transformation is suspected when irregular margins, wall thickening and enhancement of the cystic mass after IV of contrast material are present (Fig. 9) [5].

Rectal duplication

Rectal duplication is usually discovered in children of less than 2 years old although it can be more rarely found in older patients. On CT and MR imaging, rectal duplication is
seen as a spherical, fluid-filled cyst usually located posterior to the rectum or anus that may communicate with the rectum. Complete surgical excision is the treatment of choice (Fig. 10).

Epidermoid cyst
Pelvic epidermoid cysts are very rare conditions and more commonly observed in the presacral space in middle-aged women. They appear as unilocular, thin-walled lesions with homogeneous low attenuation values on CT, heterogeneous low signal intensity on T1-weighted MR image and high signal intensity on T2-weighted MR image with small hypointense foci due to the presence of keratin (Fig. 11).

Anterior sacral meningocele
Anterior sacral meningocele is a rare developmental disorder occurring when the dural sac herniates into the presacral space secondary to agenesis of a portion of the anterior sacrum. In approximately 50% of patients, associated malformations are found, such as spina bifida, spinal dysraphism, bicornuate uterus, and imperforate anus. CT and MR imaging demonstrate a sacral defect associated with a well-defined unilocular thin-walled, fluid-filled lesion of the retrorectal space with a stalk that may be seen communicating with the thecal sac (Fig. 12).

Tarlov cyst
Tarlov cyst is a presacral cyst caused by a diverticulum of spinal meningeal sac, nerve root sheath, or arachnoid and communicating freely with the subarachnoid space. It appears as a uni- or multilocular cystic mass,
They may originate from the neural foramina. Bone remodeling and enlargement of the neural foramina may be seen. It is best appreciated on MR imaging that demonstrates the connection of the mass with the thecal sac or nerve roots as well as enlarged sacral canal or foramen. Tarlov cysts display low signal intensity on T1-weighted MR images and high signal intensity on T2-weighted images (Fig. 13).

### Cystic mass with vascular or lymphatic origin

**Cystic lymphangioma**

Cystic lymphangioma is a rare, benign, congenital, slow-growing tumor caused by failure of communication between retroperitoneal lymphatic tissue and the main lymphatic vessels. The pelvic extraperitoneal location is unusual as cystic lymphangiomas usually occur in the head or neck. They may be found at any age. They are large, thin-walled, unilocular or multilocular cystic lesions with attenuation values and signal intensity varying from those of fluid to those of fat. Classically they cross more than one compartment (Fig. 14) [6].

### Lymphocele

Lymphoceles occur in 12 to 24% of patients who have undergone pelvic or retroperitoneal radical lymphadenectomy or renal transplantation [7]. CT and MRI show a unilocular, thin-walled cystic lesion. Negative attenuation values due to fat within the fluid can be seen and are highly suggestive of lymphocele. Calcification of the wall may be observed (Fig. 15).

### Cystic changes in solid masses

On rare occasions, cystic changes may occur in solid masses such as paragangliomas, ileal gastrointestinal stromal tumors (GISTs) and lymphadenopaties. Sarcomas may also contain large areas of necrosis and be predominantly cystic on MR imaging.

**Solid (or noncystic) masses**

Solid lesions are classified into four distinct subgroups based on tissue characterization, including fat-containing masses, myxoid masses, fibrous masses or masses derived from muscle and hypertervascularized lesions.

**Fat-containing masses**

Fat-containing masses demonstrate a fatty attenuation on CT, high signal intensity on T1-weighted MR images, high signal intensity on T2-weighted images, loss of signal intensity on fat-suppressed images. This group includes lipoma, liposarcoma, presacral myelolipoma and presacral teratoma.

**Lipoma and liposarcoma**

Lipoma is a benign mesenchymal tumor composed of mature adipose tissue, whereas liposarcoma is its malignant counterpart (30% of retroperitoneal sarcomas). Lipoma is a well-defined homogeneous fatty mass (Fig. 16) whereas predominantly solid soft-tissue component or adjacent organ invasion should raise suspicion for liposarcoma. Imaging appearance of liposarcoma varies depending on the tumor grade. Well-differentiated liposarcomas are well-defined, predominantly fat-containing lesions with minimal soft-tissue attenuation (Fig. 17). Poorly-differentiated liposarcomas appear as locally invasive, predominantly soft-tissue masses with minimal fat. Identification of their...
poorly differentiated component is important for the prognosis.

Presacral myelolipoma
Presacral myelolipoma is a benign tumor composed of mature adipose tissue and interspersed hematopoietic cells. Its diagnosis relies on identification of areas of mature fat on CT or MR imaging [8].

Presacral teratoma
Presacral teratoma is a germ cell tumor with elements originating from more than one germ cell layer. It is commonly seen in infants and children. It shows variable appearance from cystic to solid or mixed areas of solid and cystic components. Internal fat and calcification may also be seen. The sacrum and the coccyx can be involved [8].

Masses with myxoid stroma
Myxoid stroma of pelvic tumors is hypointense on T1-weighted MR images and hyperintense on T2-weighted MR images. After IV of contrast material, the degree of enhancement depends on the extent of the vascular network within the myxoid stroma. Masses that commonly contain myxoid stroma include myxoma, neurogenic tumors (schwannomas, neurofibromas, ganglioneuromas, ganglieneuroblastomas, malignant peripheral nerve sheath tumors), myxoid liposarcomas, aggressive angiomyxoma and myxoid malignant fibrous histiocytoma.

Myxoma
Myxoma is a benign mesenchymal neoplasm occurring more commonly in middle-aged women. Primary retroperitoneal or pelvic myxomas are rare. They have nonspecific appearance on imaging.

Primary pelvic retroperitoneal schwannoma
Primary pelvic retroperitoneal schwannoma is the most common tumor of the peripheral nerves occurring more commonly in young to middle-aged women. It presents as a well-defined, hypoattenuating mass on CT or heterogeneously low signal intensity on T1-weighted MR images and high signal intensity on T2-weighted MR images. Areas of cystic changes, calcification, or hemorrhage may also be seen (Fig. 18) [9]. A "target-like" pattern consisting of peripheral high signal intensity and central low signal intensity may also be seen on T2-weighted MR images.

Plexiform neurofibroma
Plexiform neurofibroma is an unencapsulated neurogenic tumor arising from nerve sheaths. It is a specific subtype of neurofibroma that is almost exclusively seen in neurofibromatosis type 1. Plexiform neurofibromas present as multiple coalescent masses along the course of affected nerves, usually bilateral and symmetric. These features help differentiate these benign neoplasms from malignant nerve sheath tumors [10].

Aggressive angiomyxoma
Aggressive angiomyxoma is a rare, benign, slow-growing, mesenchymal tumor that contains myxoid and vascular components. It occurs in women of childbearing age. Aggressive angiomyxomas are typically located in the
Figure 16. Lipoma of the left ischio-anal fossa smoothly displacing the anal canal to the right in a 60-year-old woman. a: axial T2-weighted (TR = 3190 ms, TE = 96 ms) MR image shows a well-defined, homogeneous mass (arrows) displaying the same signal intensity than that of the adjacent ischioanal fossa fat; b: axial fat-suppressed gadolinium-chelate enhanced T1-weighted (TR = 590 ms, TE = 12 ms) MR image shows loss of signal intensity after fat-suppression (arrows), thus confirming the lipomatous nature of the lesion.

Figure 17. Pelvic liposarcoma in a 83-year-old man. a: axial contrast-enhanced CT image shows a well-circumscribed, fatty heterogeneous pelvic mass (arrows); b: coronal T2-weighted (TR = 3190 ms, TE = 96 ms) MR image shows a well-circumscribed, fatty, heterogeneous pelvic mass (arrowheads) with a solid, poorly-differentiated component (arrow).

Figure 18. Sacral and presacral schwannomas in a 55-year-old man. a: axial T1-weighted (TR = 490 ms, TE = 12 ms); b: axial T1-weighted (TR = 490 ms, TE = 12 ms) and (c), axial T2-weighted (TR = 3190 ms, TE = 96 ms) MR images show two rounded lesions (arrows) with low signal intensity on T1-weighted MR images and high signal intensity on T2-weighted MR image. One of these lesions is enlarging a left sacral foramen and the other one in presacral location is coursing along a pelvic nerve.

perineum, bilateral, smoothly surround the anal canal and display low attenuation values compared to that of muscle on CT. They appear isointense to muscle on T1-weighted MR imaging and hyperintense on T2-weighted MR imaging with a distinctive whorled appearance [11]. After IV of contrast material, they show a characteristic swirled, layered or “onion-peel” appearance (Fig. 19).

Fibrous masses

Fibrous masses with collagen fibers typically demonstrate soft-tissue attenuation values on CT and low signal intensity on T1- and T2-weighted MR images with delayed enhancement after IV. Masses that commonly contain collagen fibers include desmoid tumor, leiomyoma, leiomyomatosis,
leiomysarcoma, malignant fibrous histiocytoma, neurofibroma, ganglioneuroma, malignant peripheral nerve sheath tumor, fibrosarcoma and retroperitoneal fibrosis.

**Desmoid tumor**

Desmoid tumor more commonly occurs in females, from puberty to 40 years old, with a peak in occurrence during the 3rd decade. It may be associated with familial adenomatous polyposis and Gardner syndrome. Imaging appearance is variable depending on internal content (spindle cells, collagen, myxoid matrix) and degree of vascularity. It may present as an infiltrative or mass-like tumor. It is homogeneous with low or intermediate signal on T1-weighted MR images or heterogeneous with intermediate or high signal on T2-weighted MR images with bands of low signal on all sequences. After IV it may be homogeneous heterogeneous with variable degrees of enhancement (Fig. 20) [12].

![Figure 19](image1.png)

**Figure 19.** Aggressive angiomyxoma in a 51-year-old woman with history of perineal pain, discomfort while sitting and swelling of the left buttock. a: axial contrast-enhanced CT; b: sagittal T2-weighted (TR = 3060 ms, TE = 96 ms) and (c), sagittal fat-suppressed contrast-enhanced T1-weighted (TR = 600 ms, TE = 12 ms) MR images show an ill-defined, elongated, heterogeneous lesion (arrows) in the left ischio-anal fossa. The lesion displays a whorled pattern with high signal intensity on T2-weighted image and heterogeneous enhancement after IV.

![Figure 20](image2.png)

**Figure 20.** Desmoid tumor of the right pelvis in a 31-year-old woman with familial adenomatous polyposis. a: coronal T2-weighted (TR = 3190 ms, TE = 96 ms) MR image shows portions of the mass that display hypointense signal (arrows) due to fibrous elements; b: coronal gadolinium-chelate enhanced fat-suppressed T1-weighted MR image (TR = 600 ms, TE = 12 ms) shows mild enhancement after IV (arrows) due to fibrous elements.
Leiomyoma

Retroperitoneal leiomyoma-leiomyomatosis is an unusual growth pattern of leiomyoma. Up to 40% of patients with retroperitoneal leiomyoma have either a concurrent or a remote history of uterine leiomyoma. Retroperitoneal leiomyoma appears as a well-defined homogeneous mass in the pelvic retroperitoneum with low signal intensity on T2-weighted MR images, intermediate signal intensity T1-weighted MR images, and variable degrees of enhancement after IV of contrast material (Fig. 21) [13]. Calcification is rare.

Leiomyosarcoma

Leiomyosarcoma is the second most common primary retroperitoneal sarcoma, representing 28% of all primary retroperitoneal sarcomas. It is more common in women, during the 5th to 6th decades of life. It is extravascular in 62% of patients with this condition or intravascular in 5% or can have a combination of extra and intravascular components in 33%. Small leiomyosarcoma may be homogeneously solid, but large tumor has extensive areas of necrosis and occasional hemorrhage. Rarely, leiomyosarcoma may appear as predominantly or even exclusively cystic. It generally does not show calcification unlike synovial sarcomas or chondrosarcomas. Imaging is performed to detect local extent and distant metastases, for image-guided biopsy or for the follow-up. A multidisciplinary approach in a referral center is recommended. Radical en-bloc resection of the tumor is the only chance for cure. Chemotherapy and radiotherapy may improve survival rate. The major factors of survival are tumor grade and complete resection.

Malignant fibrous histiocytoma

Malignant fibrous histiocytoma is the third most common retroperitoneal sarcoma. It is more common in males, particularly during the 5th and 6th decades. CT and MR imaging appearances are nonspecific. CT and MR imaging demonstrate a large, infiltrating, and heterogeneously enhancing soft-tissue mass with areas of necrosis and hemorrhage, with involvement of adjacent organs. Variable patterns of calcification can be seen in 7% to 20% of cases in the peripheral portions of these tumors [14].

Hypervascularized masses

Solitary fibrous tumor (or hemangiopericytoma)

Solitary fibrous tumor is a mesenchymal tumor of fibroblastic or myofibroblastic origin that may develop in the pelvic peritoneum or in the retroperitoneum. It is a slow-growing, often asymptomatic mass in middle-aged adults, with an equal distribution among men and women. It appears as a well-circumscribed mass with soft-tissue attenuation. Prominent imaging features are intense heterogeneous enhancement during the arterial phase, which persists in the delayed phase because of the fibrous component. Flow void are present on T2-weighted MR images within internal vascular structures (Fig. 22). Complete surgical resection is the treatment of choice [15].

Figure 21. Forty-five-year-old woman with prior history of hysterectomy for uterine leiomyomas presenting with abdominal pain. a: axial T2-weighted (TR = 3190 ms, TE = 96 ms) MR image shows multiple, rounded, well-limited, hypointense masses (arrows) throughout the pelvis and around the uterine cervix that was left in place (arrowhead); b: photograph shows gross specimen after resection.

Figure 22. Solitary fibrous tumor (also called hemangiopericytoma) in a 58-year-old man. Sagittal gadolinium-chelate enhanced fat-suppressed T1-weighted MR image (TR = 600 ms, TE = 12 ms) shows heterogeneous, irregular mass (arrowheads) with marked enhancement after IV. Note the presence of flow void (arrow).
Congenital pelvic arteriovenous malformation (AVM)

Congenital pelvic AVMs are undifferentiated vascular structures that arise due to a stop in the vascular embryonic development. AVMs appear as flow voids on T1- and T2-weighted MR image. MR images obtained after IV of contrast material and conventional angiography usually show multiple tortuous feeding vessels originating from the iliac artery (Fig. 23).

Rectal angiomatosis

Rectal angiomatosis is a rare vascular malformation consisting of an extensive network of vascular lakes growing in the rectal wall and infiltrating the surrounding connective tissues. It occurs in young patients, classically with a history of recurrent episodes of rectal bleeding. On CT and MR imaging, the presence of a markedly thickened rectal wall with high signal intensity on T2-weighted MR images associated with an infiltration of the perirectal fat and serpiginous hyperintense structures in adipose tissue. Phleboliths throughout the pelvic retroperitoneum and in the rectal wall may be seen [16].

Conclusion

Magnetic resonance (MR) imaging plays a central role in the diagnosis of extraperitoneal masses due to its unique tissue-specific multiplanar capabilities that allow optimal pelvic mass localization and internal characterization. Even though a definite diagnosis relies on histopathological analysis, the diagnosis of these masses can often be suggested on the basis of the general context or patient history, tumor location and tissue characteristics.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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