Imaging Features of Leiomyoma in the Genitourinary Tract: Beyond the Uterus

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Learning objectives

1. Describe the various clinical and imaging manifestations of leiomyoma in the genitourinary tracts.

2. Identify the unusual manifestations, growth patterns and locations.

3. Correlate imaging features with clinical and pathologic features.
Background

Uterine leiomyomas represent the most common gynecologic and uterine neoplasm. The imaging diagnosis of usual uterine leiomyomas is straightforward, given their imaging features and common clinical manifestations. Although the usual imaging features of uterine leiomyoma are well known to radiologists, various unusual imaging features can be particularly misleading; therefore, both usual and unusual imaging features should always be carefully assessed.
Findings and procedure details

In this presentation, we describe unusual imaging features: unusual manifestations (edema and cystic degeneration, red degeneration, subtype leiomyoma, and high uptake leiomyoma in PET), unusual growth patterns (intravenous leiomyomatosis, benign metastasizing leiomyomatosis, peritoneal disseminated leiomyomatosis, retroperitoneal leiomyomatosis, diffuse leiomyomatosis, pedunculated uterine cervical leiomyoma, and parasitic leiomyoma) and unusual locations in the genitourinary tract (ovary, vagina, vulvar, bladder, urethra, renal capsular leiomyoma and tunica albuginea of scrotum). We also correlate imaging features with clinical and pathologic features.

Usual Imaging Features of Uterine Leiomyoma

Leiomyomas are benign tumors that may arise from any smooth muscle-containing structure or organ. Uterine leiomyomas are the most common uterine tumor, occurring in 20%-30% of women of reproductive age (1-3). They are classified as submucosal (projecting into the endometrial canal), intramural(within the substance of the myometrium), or subserosal (beneath the serosa) (Fig. 1); the latter may become pedunculated and simulate ovarian tumors. This classification is of clinical significance because the symptoms and treatment vary among these subtypes of leiomyomas. Although submucosal leiomyomas are the least common, representing approximately only 5% of the uterine leiomyomas, they are most commonly symptomatic; women with leiomyomas present with symptoms such as dysmenorrhea, menorrhagia, and infertility (1).

Leiomyomas are usually well circumscribed and surrounded by a gray-white fibrous pseudocapsule. The cut surface bulges and exhibits a whorled pattern. On microscopic examination, the tumor is seen to consist of smooth muscle spindle cells arranged in interlacing bundles with varying admixtures of fibrous, often hyalinized, connective tissue (1). US shows frequently hypoechoic mass and may be heterogeneous from degeneration. CT shows enlarged uterus and deformed uterine contour. MR imaging is currently considered the most accurate imaging technique for detection and localization of leiomyomas. The vast majority of leiomyomas appear as well-circumscribed, homogeneous low SI masses on T2-weighted images (1, 2)

Usual Type of Degeneration

As leiomyomas enlarge, they may outgrow their blood supply. This results in various types of degeneration (1). The most common type of degeneration is hyalinization. Hyaline degeneration involves the presence of homogeneous eosinophilic bands or plaques in the extracellular space, which represent accumulation of proteinaceous tissue (1). Leiomyomas with hyaline or calcific degeneration have low SI on T2-weighted images (Fig. 2). Myxoid degeneration involves the presence of gelatinous intratumoral...
foci at gross examination that contain hyaluronic acid-rich mucopolysaccharides (1). Leiomyomas with myxoid degeneration show very high SI on T2-weighted images and enhance minimally on contrast-enhanced images (Fig. 3).

Unusual Manifestations of Uterine Leiomyoma

Unusual Type of Degeneration

Edema may change into various degree of collagen deposition and cystic degeneration. Cystic degeneration may be considered an extreme sequela of edema and is observed in about 4% of leiomyoma. The cystic space appear as round, well-demarcated areas with the SI characteristic of fluid: low on T1-weighted images and high on T2-weighted images without enhancement (Fig. 4). Red degeneration is a subtype of hemorrhagic infarction of leiomyoma and characterized by a red (hemorrhagic) appearance of the leiomyoma at gross examination. Leiomyomas with red degeneration may be associated with pregnancy and use of oral contraceptives. They may show peripheral or diffuse high SI on T1-weighted images (Fig. 5).

Subtype of Leiomyoma

There are also subtypes of leiomyomas such as cellular leiomyoma and lipoleiomyoma (1). Cellular leiomyomas, which are composed of compact smooth muscle cells with little or no collagen, can have relatively high SI on T2-weighted images (Fig. 6) and demonstrate enhancement on contrast-enhanced images. Lipoleiomyoma contains a substantial amount of fat. The reported prevalence is about 0.8% (2). It is considered to represent fatty metamorphosis of leiomyoma. On MR imaging, the fatty tissue demonstrates SI similar to that of subcutaneous fat with all sequences (Fig. 7).

High Uptake Leiomyoma in PET

Normal physiologic uptake is seen in the brain and myocardium and, to a lesser extent, in the liver, spleen, bone marrow, gastrointestinal tract, testes, and skeletal muscles (4). Other less frequent sites of uptake include the endometrium, breast, major and minor salivary glands, and brown fat in the supraclavicular and paraspinal regions (4, 5). Because FDG is excreted by the kidneys, intense activity is normally seen in the renal collecting system, ureters, and bladder (4, 5). Benign tumors or lesions are the common causes of pitfalls of FDG PET. Increased uptake at FDG PET has been reported in many benign pelvic processes, including uterine leiomyomas, endometriosis, and even the normal menstrual cycle (4, 5).

Uterine leiomyomas are one of causes in false positive of PET (5, 6). In a previous study by Lin et al (6), the FDG uptake in the uterine region is Grade I (FDG uptake less than liver uptake) in three of these 22 females (13.65%), Grade II (FDG uptake equal to liver uptake) in 16 (72.7%), and Grade III (FDG uptake greater than liver uptake) in 3 (13.65%) (Fig. 8).
Unusual Growth Patterns of Uterine Leiomyoma

Intravenous Leiomyomatosis

Intravenous leiomyomatosis is a rare disease that is characterized by the intraluminal growth of leiomyomas in intrauterine and systemic veins (2, 3). These lesions are implants from coexistence or previously resected uterine leiomyomas. Tumor growth into the venous channels of myometrium and parametrium occurs in an estimated 80% of cases, and cardiac involvement is seen in 10%-40% of cases (3). The typical appearance is low to intermediate SI on T1-weighted images and low SI on T2-weighted images (3). Convoluted, wormlike masses growing within the veins are the hallmark (Fig. 9) (2). The presence of coexistent uterine leiomyomas or history of surgery for uterine leiomyomas is highly suggestive of intravenous leiomyomatosis (3). The most important entity to be considered in the differential diagnosis is leiomyosarcoma arising from the wall of the IVC (30). Leiomyosarcoma cannot be differentiated from leiomyoma on the basis of imaging findings alone, unless it has progressed to an advanced stage with visible infiltration and invasion of the abdominal viscera (3).

Benign metastasizing leiomyomatosis

This rare condition is characterized by numerous well-differentiated leiomyomas at sites distant from the uterus (Figs. 10, 11, 12, 13) (2, 3). Metastases most often affect the lungs (Fig. 11), whereas the heart, brain, lymph nodes, bone, and skin are more rarely affected. A history of hysterectomy for uterine leiomyoma may be indicative (Figs. 10, 13), with the mean reported interval between hysterectomy and the appearance of pulmonary nodules ranging from 3 months to 20 years (3).

It is now largely accepted that the lesions arise as hematogeneous metastases from benign tumors. The primary uterine lesions are classified as smooth muscle tumors of unknown malignant potential because of the limitations of current histopathological test (Figs. 12, 13) (3).

Peritoneal disseminated leiomyomatosis

This exceedingly rare benign condition is characterized by multiple vascular leiomyomas growing along the submesothelial tissues of the abdominopelvic peritoneum (3). It is initiated or promoted by hormonal factors: many of the reported cases have been associated with pregnancy (2, 3).

These masses may show homogeneous or heterogeneous attenuation with a variable enhancement pattern similar to that of uterine leiomyomas. MR imaging features include multiple masses with SI similar to that of skeletal and smooth muscle on both T1- and T2-weighted images and with homogeneous enhancement (Figs. 12, 13). The most important entity in the differential diagnosis is peritoneal carcinomatosis, which typically manifests with weight loss, ascites, and disease progression observed (2, 3). By
contrast, the absence of metaastaclinical symptoms and of a known primary malignancy characterized by insidious, asymptomatic development is suggestive of a benign cause such as diffuse peritoneal leiomyomatosis (3).

**Retroperitoneal leiomyomatosis**

Multiple leiomyomatous masses are usually seen in the pelvic retroperitoneum in women with a concurrent uterine leiomyoma or a history of uterine leiomyoma. Rarely, the extrauterine masses may extend to the upper retroperitoneum, as high as the level of the renal hilum. More than 40% of patients affected by this retroperitoneal condition have a concurrent uterine leiomyoma or a remote history of hysterectomy for treatment of a uterine leiomyoma (3).

**Diffuse leiomyomatosis**

Diffuse leiomyomatosis involves development of innumerable small leiomyomas, which produce symmetric enlargement of the uterus (2).

**Pedunculated uterine cervical leiomyoma**

The mass show pedunculated large mass and attached with stalk-like structure (Fig. 14).

**Parasitic (Broad ligament) leiomyoma**

Occasionally, leiomyomas become adherent to surrounding structures (e.g. the broad ligament (Fig. 15), omentum, or retroperitoneum) develop an accessory blood supply, and lose their original attachment to the uterus, thus becoming “parasitic.” Clinically, these lesions may manifest as extrauterine pelvic masses (1).

**Unusual Locations in Genitourinary Tract**

**Ovarian Leiomyoma**

Primary ovarian leiomyom is one of the rarest solid tumors of the ovary, constituting only 0.5%-1% of benign ovarian neoplasm (3). The tumors most commonly occur in middle-aged women, usually are unilateral, and frequently (80%) are coexistent with uterine leiomyomas (3, 7).

MR imaging is potentially useful for the diagnosis of ovarian leiomyomas, which, like uterine leiomyomas, have intermediate SI on T1-weighted images and low SI on T2-weighted images (Fig. 16). Ovarian fibrothecomomas the most important entity to consider in the differential diagnosis. The early contrast enhancement of leiomyomas (Fig. 16) may aid in their differentiation from other fibrous ovarian tumors such as fibrothecomas, which usually demonstrate delayed weak enhancement (8).

**Vagina and Vulvar Leiomyoma**
Vaginal leiomyoma usually arises in the midline anterior vaginal wall with size ranging from 1 to 5 cm (Fig. 17), although any site in the vagina is possible. Urinary tract symptoms, including bladder outlet obstruction, are thus recognised symptoms. Imaging features are variable; they may appear as typical leiomyomas that are homogeneous low SI on T1 and T2, similar to myometrium. However, high SI on T2 and marked contrast enhancement on early dynamic phase have been reported and are thought to be related to increased vascularity (9). At US, the tumors appear homogeneous, solid, and smooth walled. A typical whorled appearance may be observed and is useful for preoperative diagnosis (Fig. 17) (3).

Rarely, extrauterine leiomyomas may be seen along the labia majora. The lesions may enlarge during pregnancy (3). A characteristic finding of low SI mimicking that of smooth muscle on T2-weighted images is the key to diagnosis.

**Bladder and Urethra Leiomyoma**

Leiomyoma is the most commonly occurring benign neoplasm in the urinary bladder; however, leiomyomas represent only 0.4% of all bladder tumors (3). Leiomyomas may occur in the intravesical (51.1%) (Fig. 18), intramural (30%), and extravesical (16.7%) locations in the bladder (10). Common symptoms (occurring in 15%-20% of cases) are related to voiding; they include dysuria, frequency or hesitancy in urination, dribbling, and hematuria.

Like uterine counterparts, typical nondegenerative leiomyomas of the urinary bladder appear as solid homogeneous masses with intermediate SI on T1-weighted images and low SI on T2-weighted images and show variable enhancement (Fig. 18) (3). Their smooth surface, with intact muscularis and mucosal layers, help differentiate them from transitional cell carcinoma, which have an irregular surface and mucosal breach (11).

Urethral leiomyomas are rare and originate from circular smooth muscle fibers of the urethra. The tumors primarily occur in women of reproductive age, enlarge during pregnancy, and regress post partum, characteristics that are indicative of their hormonal dependency (3). The tumor may manifest as a mass that protrudes into or through the urethra (Fig. 18). At US, the tumors appear homogeneous, solid, and smooth walled. A typical whorled appearance may be observed and is useful for preoperative diagnosis (3).

**Renal Capsular Leiomyoma**

The majority of male genitourinary tract leiomyomas are found in the renal capsule (Fig. 19), but this tumor has also been reported in the epididymis, spermatic cord, and tunica albuginea (Fig. 20) (12).

Renal leiomyomas are rare benign smooth muscle neoplasms that mostly occur in adults as incidental findings (13). Renal capsule is the most common target site of leiomyomas; rarely, leiomyomas originate from the renal pelvis or cortex.
Leiomyomas of the kidney commonly appear as well-circumscribed, homogeneous, exophytic solid masses that show uniform enhancement on contrast-enhanced CT. Calcification is uncommon. However, the CT findings of leiomyomas of the kidney may be variable and may include cystic, complex cystic-solid, or purely solid morphology (13, 14). Renal leiomyomas may show hypervascularity on catheter angiography because they are predominantly supplied by capsular vessels (15). T2 low SI may be clue the diagnosis of renal leiomyoma (Fig. 19).

**Testicular Leiomyoma**

*(Leiomyoma arising from the tunica albuginea)*

Testicular leiomyoma is a rare benign tumor. On US, leiomyomas have been reported as a whirling pattern with multiple narrow areas of shadowing without obvious calcifications in the solid mass (Fig. 20) (12).
Fig. 1: Imaging features of uterine leiomyoma according to the classification

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Fig. 2: A 47-year-old woman with calcified uterine leiomyoma

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Fig. 3: A 42-year-old woman with myxoid degenerative uterine leiomyoma

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Fig. 4: A 39-year-old woman with cystic degenerative uterine leiomyoma

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Fig. 5: A 27-year-old woman with red degenerative uterine leiomyoma

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**Fig. 6:** A 38-year-old woman with cellular uterine leiomyoma

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Fig. 7: A 58-year-old woman with uterine lipoleiomyoma

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Fig. 8: A 35-year-old woman with high uptake uterine leiomyoma

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Fig. 9: A 43-year-old woman with intravenous leiomyoma

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**Fig. 10:** A 36-year-old woman with benign metastasizing leiomyoma to the left pelvis

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Fig. 11: A 37-year-old woman with benign metastasizing leiomyoma to the lung

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Fig. 12: A 44-year-old woman with peritoneal disseminated leiomyomatosis-1

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Fig. 13: A 44-year-old woman with peritoneal disseminated leiomyomatosis-2

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**Fig. 14:** A 32-year-old woman with pedunculated uterine cervical leiomyoma

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**Fig. 15:** A 54-year-old woman with broad ligament leiomyoma

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**Fig. 16:** A 66-year-old woman with left ovarian infarcted leiomyoma

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Fig. 17: A 40-year-old woman with vaginal leiomyoma

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Fig. 18: A 52-year-old woman with bladder and urethral leiomyoma

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Fig. 19: A 46-year-old woman with left renal capsular leiomyoma

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Fig. 20: A 31-year-old woman with tunica albuginea leiomyoma of the testis

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Conclusion

The major teaching points of this exhibit are:

1. Unusual leiomyoma may mimic malignant tumors. It is important to know unusual manifestations, growth patterns of uterine leiomyoma and unusual locations in the genitourinary tract (Fig. 21).

2. Familiarity with the clinical setting and imaging features of leiomyoma in the genitourinary tract will facilitate prompt and accurate diagnosis and treatment.
Fig. 21: Summary

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