CT Appearance of Uterine Leiomyomas

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Uterine leiomyomas, commonly known as fibroids, are one of the most common pelvic tumors found in women. Ultrasonography is the primary modality for evaluating leiomyomas. However, frequently these tumors are not accompanied by symptoms, and they are found incidentally during computed tomographic (CT) examinations performed for other indications. Because leiomyomas may first be noted on CT scans, radiologists should become familiar with their characteristic appearance. The authors describe the CT findings of uterine leiomyomas and their secondary changes, including cystic degeneration, calcification, infection, necrosis, fatty degeneration, and sarcomatous degeneration.

INTRODUCTION

Uterine leiomyoma, one of the most common pelvic tumors in women, is often encountered as an incidental finding on computed tomographic (CT) scans obtained for other indications or in the workup of patients with a pelvic mass. It is therefore important for radiologists to become familiar with the spectrum of their appearance.

In our 6-year experience, which encompasses over 6,000 CT scans of the abdomen and pelvis, we have encountered 97 cases of histologically proved uterine leiomyomas. The purpose of this article is to review the CT findings of these tumors, with emphasis on the significance of different degrees of attenuation detected within them.

GENERAL CHARACTERISTICS

Uterine leiomyomas are commonly called fibroids, although they derive not from fibrous tissue but from smooth muscle cells of the uterus (1). They occur more frequently among black and other dark-skinned populations (2).

Clinically, uterine leiomyomas are commonly symptomless, but they may occur as a palpable mass, accompanied by bleeding or pain, or with symptoms secondary to compression of the mass on the bladder, uterus, or rectum. Patients with leiomyomas may present with hypermenorrhea, although the exact mechanism by which these tumors produce abnormal bleeding is still unknown. Hypermenorrhea is a common indication for surgery; other indications include rapid tumor growth, symptoms of compression or invasion of surrounding structures, and bleeding at menopause.

Index terms: Myoma. 854.315 • Uterine neoplasms. 854.315 • Uterine neoplasms. CT. 854.1211 • Uterus. CT. 854.1211


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growth, pelvic pain, pressure, and impaired fertility (1, 2). The presence of multiple leiomyomas during pregnancy increases the frequency of malpresentation, retained placenta, and premature uterine contractions (3). Leiomyomas can markedly enlarge, a characteristic that makes differentiation of these tumors from other pelvic or abdominal masses sometimes difficult. Almost any intrapelvic abnormality needs to be differentiated from this condition.

Leiomyomas are usually sharply circumscribed, unencapsulated but discrete, round, firm, gray-white masses; cut specimens have a characteristic whorled surface. These tumors are commonly multiple and of various sizes. A solitary leiomyoma is found in only 2% of patients, and the number of these tumors may reach the hundreds. They rarely develop after menopause.

The location of leiomyomas in the uterus is variable (Fig 1). Those embedded within the myometrium are referred to as intramural (Fig 2). When they occur beneath the covering peritoneum of the uterine corpus, they are called subserosal (Fig 3). Some leiomyomas occur in immediate proximity to the endometrium and are designated as submucosal. Frequently, the subserosal and submucosal masses protrude from the outer contour of the uterus and into the endometrial cavity, respectively. Such leiomyomas may become
pedunculated. The subserosal type may protrude into the broad ligament to create an intraligamentous leiomyoma (1).

Hyaline degeneration is seen in almost all uterine leiomyomas. Other secondary changes include cystic degeneration, calcification, infection, necrosis, fatty degeneration, or sarcomatous transformation (1,2).

### NORMAL ANATOMY OF THE UTERUS

The uterus is a pear-shaped organ, usually identified on CT scans in the midline between the bladder and the rectum, depending on the degree of bladder and rectal distention and on normal anatomic variations (Fig 4) (4). On CT scans obtained after intravenous administration of contrast material, normal myometrium enhances more than other pelvic tissues (Fig 4b, 4c) (5). At soft-tissue window settings, the normal uterus appears smooth in contour and uniform in attenuation, although central uterine fluid may be seen in the absence of disease or in the postpartum uterus (Fig 5).

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**Figures 4, 5.** (4) CT scans of the normal uterus (U). B = bladder. (a) Unenhanced CT scan demonstrates the uterus. (b) In a CT scan of the pelvis obtained before intravenous administration of contrast material, the attenuation of the uterus (cursor 1) is 77.7 HU. (c) On the contrast-enhanced scan, the attenuation of the uterus has increased to 126.5 HU. Attenuation of the soft tissues (cursor 2) has not significantly changed (55.3 HU in b vs 51.9 HU in c). (5) CT scan of postpartum uterus (U) reveals fluid in endometrial cavity (F and arrow).
Figures 6–9. (6) CT scan shows enlarged uterus (U), with a lobulated contour, secondary to a leiomyoma (arrow). (7) CT scan of another patient demonstrates a submucosal leiomyoma (arrow) producing deformity of the endometrial cavity. (8) CT scan obtained due to hydrocolpos secondary to cervical stenosis incidentally reveals a small calcified uterine leiomyoma (arrow). (9) CT scan obtained through the midabdomen in a patient with increasing abdominal girth demonstrates a giant abdominopelvic soft-tissue mass (M) and associated bilateral hydronephrosis (H).
Figures 10, 11. (10) CT scan demonstrates hyaline degeneration of uterine leiomyomas. Arrow indicates cystic areas. (11) CT scan shows a leiomyoma with atypically high attenuation. No malignant cells were found in pathologic specimen.

CT CHARACTERISTICS OF UTERINE LEIOMYOMAS

- Uterine Enlargement with Contour Deformity
An enlarged uterus and a deformed uterine contour are the most common CT findings of leiomyomas (Fig 6). Leiomyomas usually have a uniformly solid consistency, with attenuation values similar to those of uninvolved uterus (6). Although uterine enlargement may be a prominent feature, minimal uterine enlargement is difficult to diagnose with CT; therefore, uterine size alone is not a useful criterion for the differential diagnosis of leiomyoma (4). Alterations in contour or lobulations are identified more often in the uterine fundus; however, such changes may be seen in the body or in the lower segment of the uterus. Leiomyomas can also occur as an intracavitary mass obliterating the uterine cavity (Fig 7).

Leiomyomas can be small (Fig 8) or giant (Fig 9), homogeneous or inhomogeneous, pelvic or abdominopelvic masses. The growth of uterine leiomyomas is estrogen dependent. They do not appear until after menarche and usually diminish in size after menopause. They can increase suddenly in size during pregnancy or if the patients are taking birth control pills (1,3,5). Calcification or cystic changes may be noted within large masses.

- Hyaline and Cystic Degeneration
Hyaline degeneration is the most common of all secondary changes seen in cases of leiomyomas (1,2,4). It may involve broad areas of the tumor. The tendency of hyaline degeneration is toward liquefication, and in extreme cases practically all of the original tumor is thus involved and converted into a large cystic cavity, a state that clinically simulates pregnancy or an ovarian cyst. A leiomyoma with necrosis or degeneration may be seen on CT scans as a low-attenuation mass in the uterus (Fig 10). Occasionally, areas of high attenuation may be seen in atypical leiomyomas of the uterus (Fig 11).
Figures 12–14. (12) CT scan demonstrates enlarged uterus (U) and popcorn calcifications in a leiomyoma (arrow). Note bilateral ovarian cysts (c). (13) CT scan of a 41-year-old patient shows multiple subserosal and intramural uterine leiomyomas; most of them are calcified (arrows). (14) CT scan reveals uterine leiomyoma with calcification of solid mass type (arrow). Contour deformity of the uterus caused by other smaller leiomyomas (arrowheads) is also evident.

- Calcification
Calcification is likely to occur in leiomyomas in the presence of circulatory disturbances, such as those commonly found in older women (2). This dystrophic calcification of solid mass type usually has a mottled appearance with no well-defined curvilinear rim (Fig 12). There are, however, calcifications in leiomyomas that have a well-defined, thin, high-attenuation rim with relatively little internal calcification, and they can be mottled, whorled, or streaked (Fig 13).

Although uterine leiomyomas are apt to be multiple in a given patient, calcification may be present in only one of the tumors (Fig 14). The soft-tissue mass of an individual leiomyoma is frequently larger than the volume of the calcification, merely reflecting the fact that calcification may be limited to only a part of the tumor (7).

The presence of calcification in a uterine mass is the most specific sign of a leiomyoma (6); however, this finding is reportedly uncommon (7). In one series, calcifications were found in only 3%-5% of leiomyomas (8). In our experience, 10% of uterine leiomyomas contained calcifications.
Infection and Necrosis

Infection is more common in submucosal leiomyomas because their blood supply is frequently insufficient to support the tumor mass (2). Their exposed position adjacent to the uterine lumen predisposes them to ascending infection. Occasionally, when the leiomyoma is infected, the central core may be filled with purulent material or gas (Fig 15) (8).

Subserosal and submucosal leiomyomas may become pedunculated and may undergo torsion of the pedicle, with subsequent infarction, degeneration, necrosis, and potential infection (Fig 16). Occasionally, such bizarre tumors adhere to surrounding structures or omentum, develop an auxiliary blood supply, and lose their original attachment to the uterus. They are sometimes called "parasitic" leiomyomas (1).
**Figure 17.** CT scans of a leiomyosarcoma. (a) Section through the upper pelvis shows the mass ($M$) to the right of the rectosigmoid ($R$). (b) Sections through the lower pelvis show the mass ($M$) extending into the ischiorectal fossa and displacing the rectum to the left. $B$ = bladder. (c) Pathologic specimen. At surgery, a large mass arising from the lower segment of the uterus and extending into the ischiorectal fossa was found. Leiomyosarcoma was diagnosed from histologic results. There is no reliable way to differentiate a leiomyoma from a leiomyosarcoma on CT scans.

- **Sarcomatous Degeneration**
  Leiomyosarcoma is an infrequent complication of leiomyoma, occurring in less than 1% of cases. Malignancy in a leiomyoma is seldom diagnosed preoperatively because there are no characteristic symptoms. On CT scans, it is impossible to distinguish this entity from a preexisting leiomyoma. Sudden accelerated growth of a previously static tumor or postmenopausal enlargement of a uterine mass should suggest this possibility (Fig 17) (8).

- **CONCLUSION**
  This report illustrates the various CT appearances of uterine leiomyomas, with emphasis on the significance of various degrees of attenuation that may be seen within them. Although uterine enlargement and contour deformity are the most common CT findings of these masses, calcification is the most specific CT sign of a leiomyoma.
  Noncalcified leiomyomas may be confused with other pelvic masses on CT scans. Distinguishing between such leiomyomas and a malignant uterine neoplasm is difficult. Differentiation of interstitial leiomyoma from
uterine adenomyosis is also difficult, especially since these two lesions are frequently associated (9), and is probably beyond the current resolution of CT. Other pathologic conditions involving the uterus, such as endometrial or cervical carcinoma, may also coexist with uterine leiomyomas. In addition, extraterine masses, in particular, a variety of solid or cystic ovarian tumors, may be misdiagnosed as subserosal or pedunculated uterine leiomyomas (Fig 18).

Although it is useful to be familiar with the different appearance of uterine leiomyomas on CT scans, it is important to remember that CT is not the primary modality for evaluating or diagnosing leiomyomas. Ultrasonography (US) is the first-line imaging study. When findings from US are indeterminate, magnetic resonance imaging is the next choice, because it offers greater sensitivity (10) and specificity than CT.

Acknowledgments: We thank Bill Burke, radiology department photographer, and Hilda Ceballos, secretary, for their assistance in the preparation of this manuscript.

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