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RESEARCH ARTICLE

RADIOLOGICAL APPEARANCE OF UTERINE LEIOMYOMA

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ABSTRACT

Uterine fibroids, also known as leiomyomas, are the commonest uterine neoplasms. Although benign, they can be associated with significant morbidity and are the commonest indication for hysterectomy. They are often discovered incidentally when performing imaging for other reasons. Usually first identified with USG, they can be further characterized with MRI. Magnetic resonance (MR) imaging is the most accurate imaging technique for detection and localization of leiomyomas. On T2-weighted images, nondegenerated leiomyomas appear as well-circumscribed masses of decreased signal intensity; however, cellular leiomyomas can have relatively higher signal intensity on T2-weighted images and demonstrate enhancement on contrast material–enhanced images. Degenerated leiomyomas have variable appearances on T2-weighted images and contrast-enhanced images. The differential diagnosis of leiomyomas includes adenomyosis, solid adnexal mass, focal myometrial contraction, and uterine leiomyosarcoma. MR imaging also has a role in treatment of leiomyomas by assisting in surgical planning and monitoring the response to medical therapy. Knowledge of the different appearances of fibroids on imaging is important as it enables prompt diagnosis and thereby guides treatment.

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INTRODUCTION

Fibromyoma - more correctly leiomyoma and by general usage fibroid is not only the most common tumor found in the uterus or even in the female genital tract, but in the human body. It is estimated that 20% of all women have one or more present in the uterus at death. The vast majority of these have been symptomless and are often small to the point of insignificance (Novaker *et al.,* 1974; Ten-Teachers *et al.,* 1998). The aetiology is quite unknown, but inevitably the female sex hormones have been incriminated. Experimental Production of myomata has been conspicuously unsuccessful and the tumour Produced by estrogen - stimulation don't persist where the hormone is withdrawn tend to be more Fibrous than myomatous, The theory that the tumours arise from smooth muscle cells is supported by the Tissue - Culture experiments of Miller and Ludovici - 1955. In European women fibroids tend to cause symptoms around the age of 30 and are then more frequently observed until the menopause. Jeff coat - 1962. however, states that they do sometimes grow after the menopause. Pain is not a common symptom, when it occur it is generally an indication that there is associated endometriosis or pelvic inflammatory disease, or of some complication of the tumour such as red degeneration or torsion (Ten-Teachers *et al.,* 1998; Ronald *et al.,* 1985).

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Anatomy of Uterus

Gross anatomy: It is a pear-shaped hallow fibromuscular organ which lies between the bladder and rectum. It is thick walled with a narrow lumen, surrounded by endometrium which is firmly attached to myometrium. The lumen iscontinuous with the fallopian tubes supero-laterelly, and cervical canal and vagina inferiorly". The uterus has fundus, body, isthmus, and cervix. size (9cm.x5cm.x3cm). Arterial supply: by 2 uterine arteries (branches). From internal iliac artery. Lymphatic: 2 sets superficial and deep in uterine wall.

Varieties of Fibromyomata: Fibroids may have a number of locations within or external to the uterus:

- Intra-uterine
  - ✓ intramural leiomyoma: most common
  - ✓ subserosal leiomyoma
  - ✓ submucosal leiomyoma: least common (10-15%)
- Extra-uterine
  - ✓ broad ligament leiomyoma
  - ✓ cervical leiomyoma
  - ✓ parasitic leiomyoma (Cohen *et al.,* 2007)
- Diffuse Uterine Leiomyomatosis

Subserosal fibroids may be pedunculated and predominantly extra-uterine, simulating an adnexal mass. Any fibroid may undergo atrophy, internal hemorrhage, fibrosis, and calcification

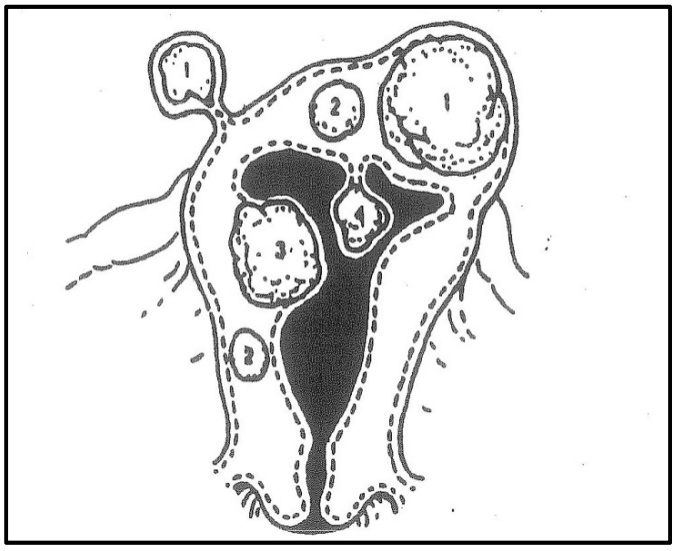

Diagram to show the position which fibromyomata may occupy 1- subserosal 2- interstitial, 3- subendometrial (submucosal) 4- polyp.

Rate of Growth and Secondary changes in fibroid: Giant uterine fibroid demonstrates the growth potential of uterine neoplasm, the largest such tumour reported was (63.6kg) reported by Singhabhadu *et al.* 1973. Such a fibroid may be a single uterine tumour or a mass of leiomyomas virtually replacing the uterus (Harrys-Jonas *et al.,* 1976; Arthur *et al.,* 1979).

1. **Hyaline change:** Due to inadequate blood supply for both the muscle fibers and fibrous tissue (Novaker *et al.,* 1974; Ten-Teachers *et al.,* 1998).
2. **Cystic changes:** Not uncommon especially after the menopause, due to liquefaction of the areas of hyaline change.
3. **Red degeneration (infarction).**This occurs commonly in pregnancy and near the menopause, necrosis either focal or diffuse
4. **Fatty changes:** This is seen most commonly at and after menopause fat globules are deposited mainly in in muscle layer.
5. **Calcification:** Mainly in elderly, after fatty changes called wombstone.
6. **Atrophy:** After climacteric, large fibroid shows only a slight reduction in size.
7. **Torsion of the Pedicle:** Mainly of sub peritoneal fibroid.
8. **Infection:** Mainly of sub endometrial tumour, infection after labour or abortion.
9. **Sarcomatous degeneration:** Novak and Wood ruff in 1974 considered the incidence to be less than 0.5%

Symptomatology:

1. Majority are symptomless.
2. Menorrhagia and I.M.B.
3. Pressure effect may give rise to bladder symptoms.
4. Abdominal swelling my by noted.
5. Pain is not a common symptom unless complicated.
6. Rare association with polycythaemia.

Pathology: Leiomyomas are benign monoclonal tumors (Medikare *et al.,* 2013) predominantly composed of smooth muscle cells with variable amounts of fibrous connective tissue. They are commonly multiple (~85%), and range significantly in size. Uterine wall consists of an: External serosal layer which is layer of peritoneum with areolar tissue. Intermediate muscular layer consists of external longitudinal and internal circular (Smooth muscle). Internal mucosal layer consists of epithelium with connective tissue.

Age and Ratial Factor: Uterine leiomyoma occurs in 20-40y. of women beyond 30-35 years of age. There is an obvious ratial factor in women of negro origin many of whom develop myomata where young and despite having had children incidence 3:1 black: white.

Parity: Tumours are commonest in women who have not borne children (Gordon Stirrat, 1987; Ronald *et al.,* 1985), Leiomyoma with oral contraception: It has been noted that myomata in women receiving hormone treatment usually oestrogenic contraceptive pill have, in some cases enlarged quite rapidly (Ten-Teachers, 1998; Deborah *et al.,* 1979).

Leiomyomas and infertility: Uterine fibroid are associated with numerous Obstetric complications include (Christine *et al.,* 1988):

1. Decrease fertility.
2. Abortion.
3. Premature rupture of membrane.
4. Preterm Labour.
5. Dystocia, uterine inertia.
6. Interference with placental separation and PPH.

Leiomyomas in pregnancy:

1. Fibroid size changes were analyzed on the basis of trimesters. In the second trimester smaller fibroid increase in size whereas larger fibroid decrease in size. In the third trimester a decrease in size was documented regardless of initial size (Novaker *et al.,* 1974; Anna *et al.,* 1987; John *et al.,* 1982).
2. Fibroid located in the lower uterine segment were a companied by a higher frequency of C-section and retained placenta.
3. Fibroid located in the uterine corpus were more frequently associated with early abortion.
4. Multiple fibroid were accompanied by a higher frequency of malpresentation and premature contraction compared with cases with one-two fibroid.

Characteristic of women who develop uterine fibroid

1. More often found in nulli parous women.
2. Three times more frequently in black than in white women.
3. Occurs at an earlier age (mean age 30 year).
4. A large proportion never pregnant.
5. A lower mean number of pregnancies.
6. A large proportion of infertility and increase frequency of abortion compared to the control.
7. Oral contraceptives.
8. No viral a etiology has been suggested as a possible cause.
9. Related to oestrogen so it occurs during reproductive life and regress after menopause.

Although the majority of fibroids are benign, it is thought that some uterine leiomyosarcomas arise in a subset of fibroids

(Walker *et al.,* 1994). Only about 0.23–0.7% of apparently benign uterine fibroids turn out to be leiomyosarcomas on pathological examination (Parker *et al.,* 1994; Leibsohn *et al.,* 1990). Most leiomyosarcomas arise *de novo*. A leiomyosarcoma can be difficult to distinguish from a benign fibroid and this possibility should always be considered in a patient with a rapidly growing uterine fibroid.

Imaging characteristics

Simple X-ray Examination (David Sutton *et al.,* 1998): A plain Film of the abdomen and pelvis may help to confirm the presence of a pelvic mass mainly in an obese patient. Large mass which lie in the midline may cause homogeneous soft tissue density shadow within the pelvis and may extend up into the abdomen and displace gas filled bowel. Small mass may be difficult to differentiate it from a full bladder and it is often possible to see translucent fat – line between the bladder and the uterus. Calcification: seen more in Pedunculated fibroids and also with post menopausal atrophy, the fibroidbecome hard and represents what is called womb stone Fig. 1.

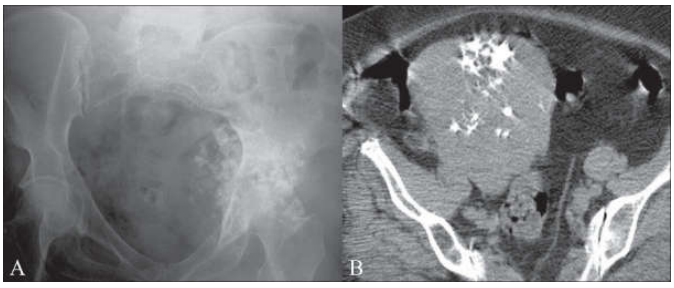

Figure 1. (A, B)

A 58-year-old woman with sacral pain. A frontal pelvic radiograph (A) shows calcification overlying the left hip, initially thought to be suggestive of a chondrosarcoma. A subsequent CT scan (B) reveals an incidental calcified fibroid

Ultrasonography

USG is usually the initial investigation for examining the female pelvis. Ideally, both transabdominal (TA) and transvaginal (TV) scans should be performed. Transvaginal scans are more sensitive for the diagnosis of small fibroids; however, when the uterus is bulky or retroverted, the uterine fundus may lie outside of the field of view. Transabdominal views are often of limited value if the patient is obese. Ultrasonography is highly operator dependent and in skilled hands, fibroids as small as 5 mm can be demonstrated on TV USG. Leiomyomas of lower uterine segments like the cervix may obstruct the uterine canal. Consequently, the accumulation of fluid in the endometrial canal might be easy to notice during the examination (Rashid *et al.,* 2016; Wilde *et al.,* 2009). Typically, fibroids appear as well-defined, solid masses with a whorled appearance. These are usually of similar echogenicity to the myometrium, but sometimes may be hypoechoic. They cause the uterus to appear bulky [Figure 2] or may cause an alteration of the normal uterine contour. Even noncalcified fibroids often show a degree of posterior acoustic shadowing [Figure 3], though this is of course more marked in calcified fibroids. Degenerate fibroids may have a complex appearance, with areas of cystic change. Doppler USG typically shows circumferential vascularity; however, fibroids which are necrotic or have undergone torsion will show absence of flow (Roy *et al.,* 2005). Submucous fibroids are usually clearly visible separate from the endometrium at TV USG, but can be difficult to differentiate from polyps. Sonohysterography is a technique in which sterile saline is instilled into the uterine cavity via a transcervical catheter whilst performing a TV scan. This method allows better visualization of the endometrium and has been shown to be more accurate than traditional TV USG in detecting submucous fibroids and in differentiating them from polyps (Cicinelli *et al.,* 1995). A 46-year-old woman with a history of abdominal pain. Transvaginal (TV) USG image shows a 1.1-cm submucous fibroid (arrow) with posterior acoustic shadowing (arrowheads).

Figure 2. Transabdominal sagittal sonogram shows a heterogeneous but predominately hypoechoic posterior uterine fibroid

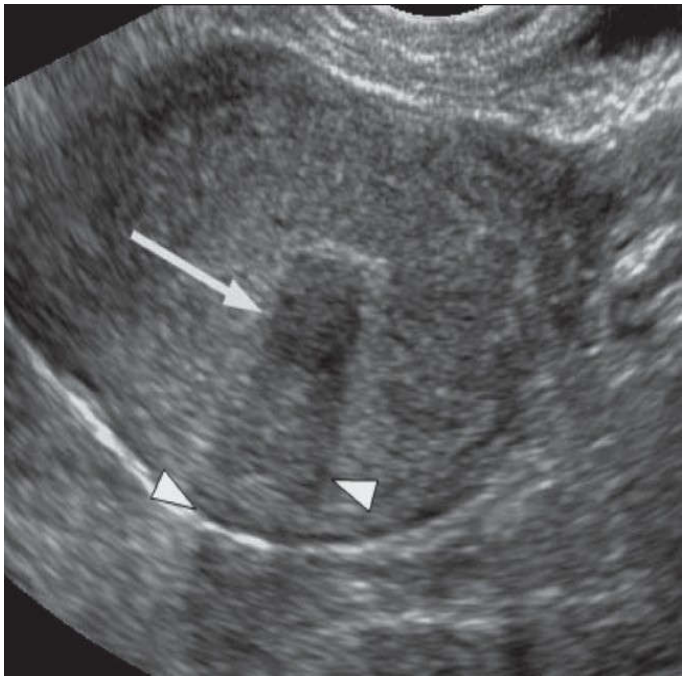

Figure 3.

During the examination of leiomyomas differential diagnosis is extremely important. Some of the most common misdiagnosed pathologies are adenomyosis, solid tumours of adnexa, and endometrial polyps. Adenomyosis is a difficult to diagnose

pathology, due to the lack of significant pathognomonic signs and clinical findings, as well as differences in the histological criteria of adenomyosis recognition. Therefore, intramural leiomyomas are often misdiagnosed as adenomyosis and vice versa. However, some ultrasound features may be helpful in establishing the proper diagnosis. The following findings are suggestive of adenomyosis: globular uterine enlargement without the presence of leiomyomata, cystic anechoic spaces or lakes in the myometrium, subendometrial echoic linear striations, uterine wall thickening, heterogeneous echo texture, obscured endometrial/myometrial border, and thickening of the transition zone (Sakhel *et al.,* 2009). Subserosal fibroids and adnexal masses are pathologies that may be very difficult to distinguish. Sometimes subserosal fibroids can be pedunculated or predominantly extra-uterine. As a consequence, on ultrasound they might look similar to ovarian tumours. Because of the large fibrous component, ovarian Brenner tumours and fibrothecomas might show a low signal on T2W scans, and sometimes the proper diagnosis is not made until surgery. Another very useful tool in the diagnosis of leiomyomas is colour Doppler ultrasonography.

This technique shows circumferential vascularity, blood flow, and arterial supply of the fibroid. Nevertheless, necrotic leiomyomas or those that undergo torsion do not present any blood flow (Wilde *et al.,* 2009; Amant *et al.,* 2009). Intrauterine benign masses, such as endometrial polyps and submucosal fibroids, are sometimes misdiagnosed, which may result in improper treatment and possible harm to the patient. Homogeneous hyperechogenic masses in the uterine cavity on ultrasound are highly suggestive of endometrial polyps, but the myometrial echogenicity of uterine fibroids may vary and be hypoechogenic, isoechogenic, hyperechogenic, or mixed, which depends on the size and nature of the fibroid. Colour Doppler may be useful in distinguishing polyps from submucosal fibroids based on the vascularity of the lesions. Multiple, circular feeding vessels are characteristic for fibroids, whereas a single feeding artery can be observed in most polyps (Rashid *et al.,* 2016; Czuczwar *et al.,* 2019).

CT Scan

CT scan is not the investigation of choice for the characterization of pelvic masses. Uterine fibroids are often seen incidentally on CT scans performed for other reasons. The typical finding is a bulky, irregular uterus or a mass in continuity with the uterus. Degenerate fibroids may appear complex and contain areas of fluid attenuation. Calcification is seen in approximately 4% of fibroids (Ueda *et al.,* 1999) and is typically dense and amorphous. However, calcification can also be confined to the periphery of the fibroid [Figure 4], when it is thought to be secondary to thrombosed veins from previous red degeneration (Ueda *et al.,* 1999).

On contrast-enhanced scans, fibroids usually show low attenuation relative to the myometrium although, occasionally, they may be of the same or of higher attenuation (Ascher *et al.,* 1991). If the fibroid has undergone acute torsion, there may be enhancement of the rim of the fibroid due to obstructed peripheral veins but there will be no enhancement centrally (Roy *et al.,* 2005). Fibroids can occasionally grow to massive sizes and present with symptoms secondary to mass effect, such as hydronephrosis. Fibroids are a rare cause of pseudo-Meig's syndrome and can occasionally present with ascites (Weise *et al.,* 2002).

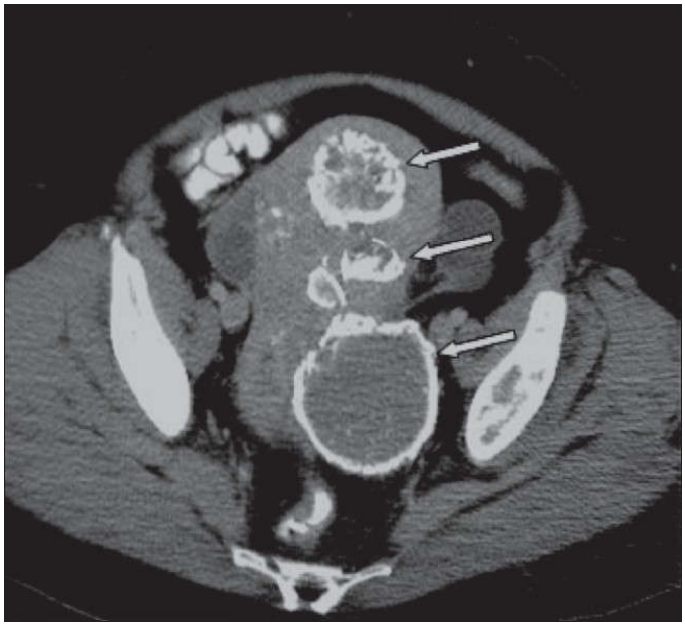

Figure 4.

A 51-year-old woman known to have fibroids, which have been treated by uterine artery embolization 18 months earlier. Axial CT scan shows several fibroids with peripheral calcification (arrows)

MR imaging findings

MR imaging is currently considered the most accurate imaging technique for detection and localization of leiomyomas (Mayer and Shipilov, 1995; Hricak *et al.,* 1986). Because of its ability to clearly demonstrate individual tumors, MR imaging has been shown to be more sensitive than US in detection of leiomyomas (Dudiak *et al.,* 1988). Unlike with MR imaging, accurate assessment of an enlarged, myomatous uterus (>140 cm^3) is not consistently possible with US because of the limited field of view (Zawin *et al.,* 1990). The capability of MR imaging for excellent demonstration of the uterine zonal anatomy enables accurate classification of individual masses as submucosal, intramural, or subserosal (Hricak *et al.,* 1986). MR imaging has been shown to be more accurate than US or hysterosalpingography for determining the presence and location of leiomyomas in infertile women prior to myomectomy (Dudiak *et al.,* 1988). Nondegenerated uterine leiomyomas have a typical appearance at MR imaging: well-circumscribed masses of homogeneously decreased signal intensity compared with that of the outer myometrium on T2-weighted images (Fig. 5) (Hricak *et al.,* 1986; Hamlin *et al.,* 1985). Degenerated leiomyomas have variable appearances on T2-weighted images and contrast-enhanced images (Okizuka *et al.,* 1993). Leiomyomas with hyaline or calcific degeneration have low signal intensity on T2-weighted images, an appearance similar to that of standard leiomyomas. Leiomyomas with cystic degeneration show high signal intensity on T2-weighted images, and the cystic areas do not enhance . Leiomyomas with myxoid degeneration show very high signal intensity on T2-weighted images and enhance minimally on contrast-enhanced images . Necrotic leiomyomas that have not liquefied (ie, hyaline or coagulative necrosis) have variable signal intensity on T1-weighted images and low signal intensity on T2-weighted images. Leiomyomas with red degeneration may exhibit an unusual signal intensity pattern at MR imaging: peripheral or diffuse high signal intensity on T1-

weighted images and variable signal intensity with or without a low-signal-intensity rim on T2-weighted images (Kawakami *et al.,* 1994). The high signal intensity on T1-weighted images is likely secondary to the proteinaceous content of the blood or the T1-shortening effects of methemoglobin (Bradley *et al.,* 1991). When high signal intensity is isolated to the rim of the leiomyoma, it has been hypothesized that the blood products are confined to thrombosed vessels that surround the tumor (Kawakami *et al.,* 1994). Some leiomyomas have a high-signal-intensity rim on T2-weighted images, which represents a pseudocapsule of dilated lymphatic vessels, dilated veins, or edema (Mittl *et al.,* 1991). These histologic findings have been shown to correspond to peritumoral rim enhancement on contrast-enhanced images (Dudiak *et al.,* 1988).

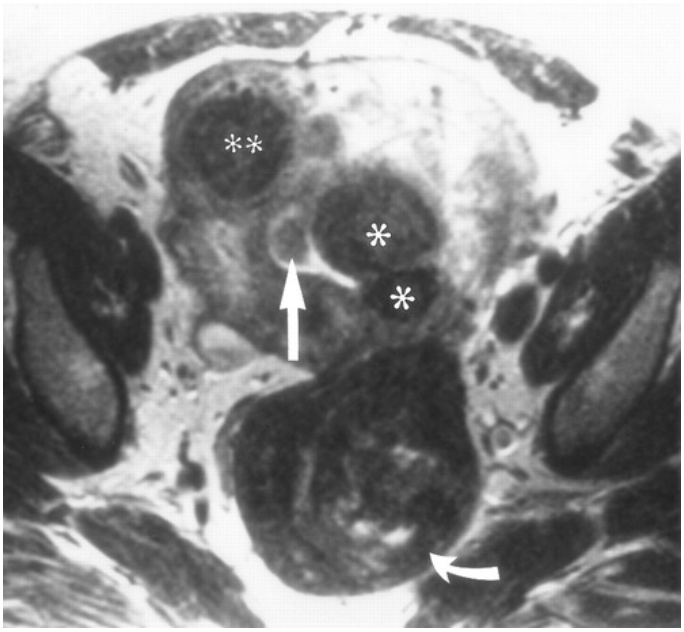

Figure 5. Submucosal, intramural, and subserosal leiomyomas in a 43-year-old woman. Axial T2-weighted fast spin-echo (SE) MR image shows submucosal (large *), intramural (small *), intracavitary (straight arrow), and subserosal (curved arrow) leiomyomas. The latter manifested as a suspected adnexal mass at both rectal examination and an outside ultrasonographic (US) examination. MR imaging was requested to exclude an ovarian neoplasm

Hysterosalpingography

Hysterosalpingography (HSG) is usually performed to assess tubal patency in patients with infertility. However, it is also useful for evaluating the contour of the endometrial cavity, and submucous fibroids can be demonstrated as filling defects. Occasionally a submucosal fibroid may cause tubal obstruction. Intramural or subserosal fibroids will not be seen with this technique (Christine *et al.,* 1988; David Sutton, 1998).

Unusual fibroid variants

Diffuse leiomyomatosis: Diffuse leiomyomatosis [Figure 6] is a rare condition that consists of diffuse involvement of the myometrium by innumerable small fibroids, which results in symmetrical enlargement of the uterus. Although histologically benign, there may be dissemination through the peritoneal cavity or occasionally metastases to distant organs (Ueda *et al.,* 1999).

Lipoleiomyomas: Lipoleiomyomas are rare fat-containing fibroids, with a reported prevalence of between 0.005 and 0.2% (Maebayashi *et al.,* 2003). They are benign and present with the same symptoms as uterine fibroids. The most likely cause is thought to be fatty metamorphosis of the smooth muscle cells of a leiomyoma (Avritscher *et al.,* 2001). If pedunculated, they can be mistaken on imaging for ovarian dermoids. At USG, they are typically echogenic masses, in contrast to the usually hypoechoic fibroids. On MRI, these tumors typically show high signal on both T1W and T2W images; often, they have a hypoechoic rim, which is thought to be due to a surrounding layer of myometrium (Avritscher *et al.,* 2001). A fat-suppression technique is useful to confirm the presence of fat. A 47-year-old woman with a pelvic mass. Sagittal T2W MRI image shows an enlarged heterogeneous uterus containing multiple nodules (arrows). Hysterectomy and histology showed that this was diffuse leiomyomatosis. There was no evidence of extra-uterine spread

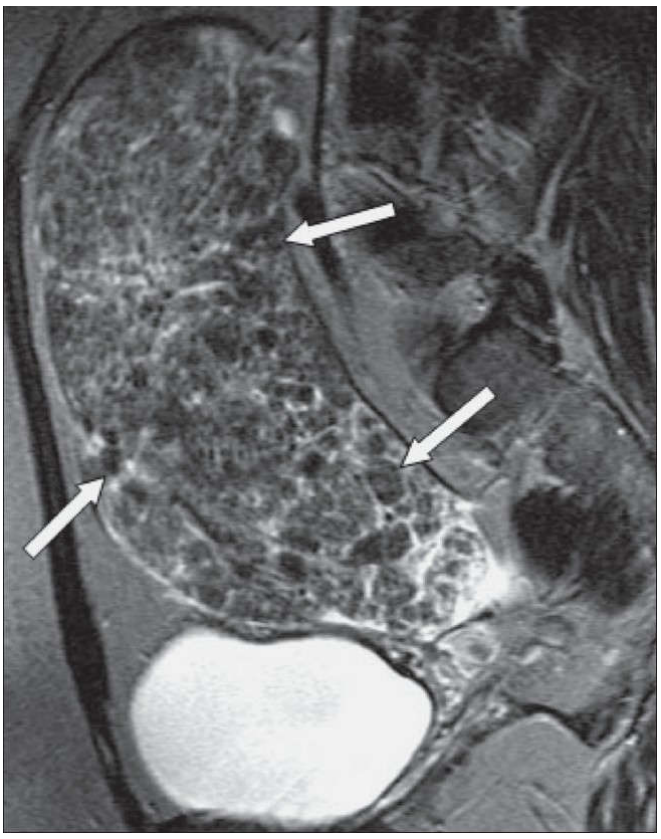

Figure 6. A 47-year-old woman with a pelvic mass. Sagittal T2W MRI image shows an enlarged heterogeneous uterus containing multiple nodules (arrows). Hysterectomy and histology showed that this was diffuse leiomyomatosis. There was no evidence of extra-uterine spread

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