Magnetic resonance (MR) imaging provides useful information for characterization of various ovarian masses as neoplastic or nonneoplastic and, when neoplastic, on a spectrum from benign to malignant. The use of MR imaging for diagnosis of ovarian masses includes consideration of morphologic characteristics and signal intensity characteristics on T1- and T2-weighted images. The morphologic characteristics of cystic masses, cystic and solid masses, and predominantly solid masses provide important information. In general, cystic masses represent benign tumors, whereas cystic and solid masses are strongly associated with malignancy. Predominantly solid masses include benign, borderline malignant, and malignant tumors. T1-weighted images provide useful information for characterization because hemorrhagic adnexal masses (e.g., endometriotic cyst) and cystic teratomas can be correctly diagnosed when the mass has high signal intensity. Significant low signal intensity in solid masses on T2-weighted images is indicative of fibrothecomas and Brenner tumors because extensive fibrous tissue produces significant low signal intensity on T2-weighted images. A strategy for diagnosis of ovarian masses with MR imaging incorporates signal intensity characteristics into morphologic characteristics.

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Introduction

Ovarian masses can be categorized into various pathologic groups from nonneoplasm to neoplasm and from benign to malignant. The nomenclature of ovarian tumors in the World Health Organization classification is summarized in Table 1. Most of the tumors fall into the first three categories: (a) surface epithelial–stromal tumors, (b) sex cord–stromal tumors, and (c) germ cell tumors. In addition, secondary (metastatic) tumors are an important group of ovarian tumors because treatment options differ from that of primary ovarian malignancies.

Transvaginal ultrasonography (US) and computed tomography (CT) are useful imaging techniques currently used to evaluate ovarian tumors. Transvaginal US has been the foremost modality for detection and characterization of ovarian tumors. CT is commonly performed in preoperative evaluation of a suspected ovarian malignancy. Magnetic resonance (MR) imaging has also proved useful for characterizing benign and malignant ovarian tumors; moreover, it enables a specific diagnosis to be made for certain pathologic types. For example, MR imaging is well known to provide accurate information about hemorrhage, fat, and collagen.

In this article, we present a strategy for diagnosing ovarian masses by using MR imaging. Morphologic characteristics (eg, unilocular, multilocular, cystic and solid, or predominantly solid) and signal intensity characteristics on T1- and T2-weighted images (eg, hemorrhagic, fatty, or collagenous) are specifically described.

MR Imaging Techniques

We recommend administering an antiperistaltic (eg, 1 USP [U.S. Pharmacopeia] unit of glucagon or 20 mg of scopolamine butylbromide) intramuscularly or intravenously prior to the examination.

We performed MR imaging on a 1.5-T unit (Vision and Symphony; Siemens Medical Systems, Erlangen, Germany). Although a phased-array coil was used in most cases, we used a body coil in selected cases when appropriate for tumor size. T2-weighted fast spin-echo images (repetition time msec/echo time [effective] msec = 3000–5000/80–120, echo train length of nine, two signals acquired) were obtained in the sagittal plane. The use of intravenous contrast material (gadolinium chelates, 0.1 mmol/kg) is essential to differentiate malignant from benign ovarian tumors. Although contrast-enhanced studies are not routine for endometriotic cysts or cystic teratomas, administration of gadolinium contrast material is useful in selected cases for detecting carcinoma associated with an endometriotic cyst (eg, clear cell carcinoma, endometrioid carcinoma) or cystic teratoma with malignant transformation.

Other parameters included matrix size of 192–256 X 256–512, field of view appropriate to body habitus (22–26 cm for the phased-array coil and 30–40 cm for the body coil), and 5–7-mm section thickness with an intersection gap of 20%.

Ovarian Tumors by Morphologic Characteristics

Morphologic characteristics provide important information for determining the pathologic group of a tumor. Although MR imaging findings are not specific for any particular pathologic group, some imaging features are more characteristic of one pathologic group than others. For this reason, ovarian tumors are classified into three groups in this article: cystic masses (unilocular or multilocular), cystic and solid masses, and predominantly solid masses.

One of the most important roles of MR imaging is in differentiating malignant from benign tumors. MR imaging criteria for malignant ovarian tumors have been established (1). A contrast-enhanced study is essential because it improves the diagnostic accuracy for ovarian malignancy (1,2). The primary criteria are (a) a solid mass or large solid component, (b) wall thickness greater than 3 mm, (c) septal thickness greater than 3
mm and/or vegetations or nodularity, and (d) necrosis. The ancillary criteria were also formulated as (a) involvement of pelvic organs or the sidewall; (b) peritoneal, mesenteric, or omental disease; (c) ascites; and (d) adenopathy. When these criteria are used, the sensitivity for classifying malignancy is 91%–100% and the specificity is 91%–92% (1,2).

Cystic Masses

Cystic masses include nonneoplastic cysts, benign neoplasms, and borderline neoplasms. Functional cysts, paraovarian cysts, hydrosalpinx, endometriotic cysts, serous cystadenomas, mucinous cystadenomas, and mucinous cystic tumors of borderline malignancy are specifically described in this section.

Unilocular Cystic Masses.—Functional cysts, paraovarian cysts, hydrosalpinx, and serous cystadenomas usually appear as unilocular cystic masses. They are well-circumscribed cystic masses. In uncomplicated cases, they have low signal intensity on T1-weighted images and high signal intensity on T2-weighted images.

Solitary follicle cysts and corpus luteum cysts, so-called functional cysts, are most common in women of reproductive age. They are unilocular cysts with smooth linings that contain serous or bloody fluid (Figs 1, 2) and range from 3 to 8 cm in diameter (3). Functional cysts almost always

Figure 1. Hemorrhagic functional cyst in a 33-year-old woman. Axial T1-weighted (a) and T2-weighted (b) images show a solitary cyst (arrows) in the right ovary. The cyst has a high-signal-intensity rim on both images, which is suggestive of a subacute hematoma. M = uterine leiomyoma.

Figure 2. Functional cyst in an 18-year-old woman. U = uterus, curved arrow = left ovary. (a) Axial T2-weighted image shows a unilocular cystic mass (straight arrows) in the right ovary. (b) On a contrast-enhanced fat-suppressed T1-weighted image, the cyst wall appears smooth without vegetations or nodularity (straight arrows). Transvaginal US was performed 2 weeks after MR imaging, and the mass was definitely diagnosed as a functional cyst because of its regression.
regress within 2 months. Therefore, the cysts require follow-ups over several months. Sometimes these cysts are complicated by rupture and cause abdominal pain and hemoperitoneum.

Paraovarian cysts are not ovarian masses but arise from mesothelial, paramesonephric (müllerian), or mesonephric (wolffian) structures. They usually occur in the mesosalpinx between the ovary and fallopian tube, so that cystic masses close to the ipsilateral round ligament can be demonstrated at MR imaging (4). The cysts contain serous fluid with a thin wall. A normal ipsilateral ovary abuts but is separate from the cyst (Fig 3). Paraovarian cysts may mimic ovarian cysts when MR imaging demonstrates splaying of the ovarian stroma to the cyst (4).

Hydrosalpinx—when large enough—may also mimic a cystic ovarian tumor (Fig 4). Typically, dilated fallopian tubes appear as fluid-filled structures that are sausage-shaped and/or C- or S-shaped when viewed in multiple planes. Salpingitis and pelvic endometriosis are common causes of hydrosalpinx because they often obliterate the fimbriated end of the fallopian tube.

Serous tumors are common and account for approximately 25% of benign ovarian neoplasms (6). Bilaterality is frequent, occurring in 12%–23% of cases (6). Serous cystadenomas are composed of unilocular or multilocular cysts filled with clear watery fluid. The lining of the cyst is flat or may have small papillary projections. The typical MR imaging appearance of serous cystadenoma is a unilocular cyst with a thin wall (Fig 5) (7).

**Multilocular Cystic Masses.**—Endometriotic cysts, mucinous cystadenomas, and mucinous cystic tumors of borderline malignancy are specifically described in this section.

Endometriosis is characterized by the presence of tissue resembling endometrium outside the uterus. The ovaries are the most commonly involved site, and endometriotic cysts usually have a thick fibrotic wall with chocolate-colored hemorrhagic material.

The diagnostic MR imaging findings for ovarian endometriotic cysts are (a) adnexal cysts of high signal intensity on both T1- and T2-weighted images or (b) high signal intensity on T1-weighted images and low signal intensity on
Figure 4. Hydrosalpinx in a 48-year-old woman. Sagittal T2-weighted (a) and contrast-enhanced fat-suppressed T1-weighted (b) images show a large unilocular cystic mass (arrows). The preoperative diagnosis was a serous cystadenoma of the ovary; however, a huge left hydrosalpinx was found at surgery. U = uterus.

Figure 5. Serous cystadenoma in a 27-year-old woman. U = uterus. (a) Sagittal T2-weighted image shows a hyperintense mass that is cystic and unilocular (arrows). (b) On a contrast-enhanced fat-suppressed T1-weighted image, the cyst wall appears smooth without vegetations, nodularity, or a solid component (arrows).
T2-weighted images (shading) (Fig 6). Methemoglobin causes T1 shortening. Chronic cyclic hemorrhage and high viscosity of the contents in the endometriotic cysts cause T2 shortening and produce shading. The cysts show a tendency for multicentric growth (multiplicity) (Fig 6) and are often associated with fibrous adhesions. When these findings are present, MR imaging has a sensitivity of 82%–90% and a specificity of 91%–98% in the diagnosis of ovarian endometriotic cysts (8,9).

T1-weighted images with a selective chemical fat-suppression technique improve the diagnostic accuracy for endometriotic cysts and small peritoneal implants (9,10) and should be obtained in the work-up of patients with clinically suspected endometriosis.

Besides endometriotic cysts, however, hemorrhagic adnexal processes includes functional cysts, abscess, hematosalpinx, and ovarian neoplasms. Outwater et al (11) reported that MR imaging has only modest success in distinguishing endometriotic cysts from other hemorrhagic lesions, with a sensitivity of 68% and a specificity of 83%. Clinical data may provide additional information to distinguish these various differential entities. Specifically, hemorrhagic functional cysts are solitary and usually regress within 2 months. They contain less concentrated hemoglobin so that shading is an uncommon finding on T2-weighted images. Furthermore, acute hematoma (deoxyhemoglobin) is oxidized peripherally during the next subacute stage (methemoglobin), which results in a high-signal-intensity rim on T1-weighted images (Fig 1).

Patients with tubo-ovarian abscess present with fever and abdominal pain, and the diagnosis is usually made clinically or with transvaginal US. MR imaging may demonstrate the abscess as a high-signal-intensity mass on T1-weighted images when its contents are complicated. Strong perilesion enhancement of a thick wall is consistent with a tubo-ovarian abscess (12). Hematosalpinx appears as a tortuous enlarged tube filled with hemorrhagic fluid (13). Both endometrioid and clear cell tumors are common neoplasms associated with endometriosis. Multilocularity and mural foci or nodules in the hemorrhagic cyst are features associated with malignancy, and contrast material should be given in these cases. That is, a hyperintense cystic tumor on both T1- and T2-weighted images with enhancing mural nodules is often seen in cases of endometriosis complicated by ovarian carcinoma (Fig 7) (14,15). The details are discussed later in the “Cystic and Solid Masses” section.

Mucinous tumors are common and account for approximately 41% of benign ovarian neoplasms (6). In contrast to serous tumors, only 2%–5% of cases are bilateral (6). Mucinous cystadenomas are large multilocular cysts containing gelatinous material or fluid of various viscosity. Therefore, the loculi of the tumors often show various signal intensities on both T1- and T2-weighted images and a so-called “stained glass” appearance (Fig 8) (16). They rarely appear as unilocular cysts.
Figure 7. Clear cell carcinoma in a 59-year-old woman. (a, b) Sagittal T2-weighted (a) and fat-suppressed T1-weighted (b) images show a large hyperintense cystic mass (short arrows) with a nodular solid component (arrowhead). Note that an endometriotic cyst (long arrow) abuts the tumor, despite the postmenopausal age of the patient. (c) Contrast-enhanced fat-suppressed T1-weighted image shows strong enhancement of the mural nodule (arrowhead). Short arrows = large mass, long arrow = endometriotic cyst. At surgery, a clear cell carcinoma of the left ovary and an endometriotic cyst of the right ovary that contained chocolate-colored hemorrhagic material were found.

Figure 8. Mucinous cystadenoma in an 18-year-old woman. U = uterus. (a, b) Sagittal T2-weighted (a) and fat-suppressed T1-weighted (b) images show a large multilocular cystic mass (arrows). The loculi show various signal intensities on both images (stained glass appearance). The examination was performed with a body coil because the tumor extended to just below the liver. (c) Contrast-enhanced fat-suppressed T1-weighted image shows no solid component within the tumor (arrows). Note that some loculi show high signal intensity on both the pre- and post-contrast images (arrowheads in b and c); these may mimic an enhancing solid component.
Mucinous cystic tumors of borderline malignancy are noninvasive tumors, and survival rates of patients with these tumors have been reported as 98%–99% (6). These tumors are microscopically characterized by cytologic atypia and epithelial stratification, but stromal invasion is absent. They show identical gross features to those of mucinous cystadenomas. Hence, both borderline mucinous tumors and mucinous cystadenomas have a multilocular appearance at MR imaging and are indistinguishable from each other (Fig 9). Loculi are often small, arranged back-to-back, and variable in number. Contrast-enhanced images are essential to distinguish septal wall thickness from back-to-back small cysts. Furthermore, “true” enhancement should be carefully assessed, as a high-signal-intensity locule on precontrast images may mimic enhancement on postcontrast images (Fig 8). Subtraction postprocessing may aid in identifying true enhancement.

Cystic and Solid Masses
In general, a cystic and solid mass strongly supports the diagnosis of ovarian malignancy. Primary epithelial carcinomas and metastatic tumors often show a cystic and solid appearance and are described in this section. Mature cystic teratoma is the important exception to this appearance and is also described in this section.

Surface epithelial–stromal tumors account for 90% of all ovarian cancers in the Western world (17). In contrast, the relative frequency is lower in Japan, with 76%–79% of all ovarian malignancies being surface epithelial–stromal tumors (17–19). The annual incidence rate also differs, and a 2000 estimate indicated that it was 6.6 per 100,000 in Japan versus 10.6 per 100,000 in the United States (20).

Surface epithelial–stromal tumors include serous, mucinous, endometrioid, clear cell, and transitional cell (Brenner) tumors. Serous carcinomas are the most common and account for up to 50% of all ovarian malignancies (6). Serum CA-125 levels are elevated in 90% of patients with serous carcinoma (6). Unfortunately, most patients present with advanced disease with dissemination throughout the abdominal and pelvic cavities. Intracystic or exophytic papillae are sometimes seen at both gross examination and MR imaging of serous papillary carcinomas (Fig 10). Mucinous carcinomas are less common and represent approximately 11% of ovarian carcinomas (6). More than half of patients with mucinous carcinoma have stage I disease (Fig 11). In fact, mucinous carcinomas can mimic metastases.
to the ovary from the colon or appendix. Metastatic tumors are discussed later in this section.

Endometrioid carcinomas represent 17.5% of ovarian carcinomas, and more than half of these patients have stage I or II disease (6). Clear cell carcinomas account for 7.4% of ovarian carcinomas, and more than half of these patients present with stage I disease (6). Both endometrioid and clear cell tumors are common neoplasms associated with endometriosis. Jimbo et al (21) reported that 23.1% of endometrioid carcinomas and 40.6% of clear cell carcinomas are associated with endometriosis. In contrast, 4.1%–17.1% of endometriosis cases are associated with epithelial ovarian carcinoma (22–24). For these reasons, chocolate cysts with multilocularity, mural foci, or nodules should be considered neoplastic imaging features. Specifically, hyperintense cystic tumors on both T1- and T2-weighted images with enhancing mural nodules are typically seen in patients with ovarian carcinoma associated with endometriosis (Fig 7) (14,15).

Metastases to the ovaries are another important group of ovarian carcinomas. Extragenital tumors of the intestines, stomach, and breast commonly metastasize to the ovaries. They spread via blood vessels and lymphatics. The gross and imaging appearances of metastatic...
tumors are cystic and solid masses (Fig 12), but a large, thin-walled, cystic mass has been rarely described. Since primary mucinous carcinomas can mimic metastases to the ovaries from the bowel, it is important to note that metastases to the ovaries are much more common than primary ovarian mucinous carcinomas. Metastatic carcinomas are often bilateral, whereas primary mucinous carcinomas are usually unilateral. However, a multi-institutional MR imaging study reported that it was difficult to accurately distinguish between primary and secondary ovarian carcinomas (25).

Mature cystic teratoma is the most common ovarian tumor, accounting for 20% of all ovarian neoplasms (26). Mesodermal, endodermal, and ectodermal derivatives are present in the tumor. This benign tumor includes ectodermal derivatives predominantly in most cases, and the cyst is...
lined with keratinized squamous epithelium and skin appendages. Therefore, sebaceous contents are quite common within mature cystic teratomas.

MR imaging demonstrates the fatty material as a high-signal-intensity component paralleling that of subcutaneous fatty tissue on T1-weighted and fast spin-echo T2-weighted images. The cyst shows chemical shift artifact in 62%–87% of cases (27–29) (Fig 13). A selective chemical fat-suppression technique enables differentiation of cystic teratomas from hemorrhagic adnexal processes with a reported sensitivity of 92%–95% (28,29) (Fig 14). Other MR imaging findings for cystic teratomas include layering or floating debris, soft-tissue protuberances (Rokitansky nodules or dermoid plugs), and low-signal-intensity teeth.

Malignant transformation is rare and occurs in approximately 2% of mature cystic teratomas (26). Invasive squamous carcinomas are the most common malignancy arising in cystic teratomas.

The age of patients has a wide range; however, postmenopausal women are most predominantly affected. The tumor tends to spread by direct invasion. Kido et al (30) reported MR imaging findings as fat-containing tumors with a solid component that extends transmurally and invades the adjacent pelvic organs. The use of intravenous contrast material may be helpful in assessing the malignant solid components.

**Solid Masses**

Predominantly solid ovarian masses include benign, borderline, and malignant tumors. Fibrothecomas, Brenner tumors, granulosa cell tumors, and dysgerminomas are specifically considered in this section. In addition, epithelial ovarian carcinomas and metastatic carcinomas are again described.

Although one of the MR imaging criteria for malignant ovarian tumors is a “solid mass or large...
solid component,” fibromas and thecomas are the exception. The term *fibrothecoma* is sometimes applied to these tumors because of their histologic overlap. They are the most common solid benign tumors of the ovary. Fibrothe-comes are categorized as sex cord–stromal tumors and are rarely malignant. They are composed of spindle, oval, or round cells forming variable amounts of collagen. Because of these intersecting bundles of spindle cells, collagen, and hyalinized tissue, fibromas show predominantly low signal intensity on T2-weighted images and intermediate signal intensity on T1-weighted images (31) (Fig 15). On the other hand, edema and cyst formation are relatively common pathologic findings in the tumor. Therefore, fibrothecomas can show mixed low to high signal intensity on T2-weighted images (Fig 16) (31). Fibrothecomas are sometimes estrogenic, and associated uterine enlargement may be demonstrated.

The differential diagnosis includes nondegenerated subserosal uterine leiomyomas. Splaying of the uterine myometrium to the mass and vascular signal voids between the uterus and the mass (flow void sign) indicate uterine leiomyoma (Fig 17) (32). The flow void sign is seen in 85% of uterine leiomyoma cases when the diameter is more than 7 cm (32).

**Figure 15.** Fibroma in a 52-year-old woman. 
(a) Sagittal T2-weighted image shows a hypointense solid mass (arrows). *U* = uterus. (b, c) Unenhanced (b) and contrast-enhanced (c) fat-suppressed T1-weighted images show weak enhancement of the mass (arrows) compared with that of the uterine myometrium (*U*). No vascular signal void is seen between the uterus and the mass.

**Figure 16.** Fibrothecoma in a 72-year-old woman. Axial T2-weighted image shows a heterogeneous solid mass (arrows) with intermediate to high signal intensity. Ascites is seen in the cul-de-sac. The uterus (*U*) is enlarged, an abnormal finding in a postmenopausal woman.
Most Brenner tumors are benign, accounting for 4%-5% of benign surface epithelial–stromal tumors (33). The tumors are sharply circumscribed and are firm at gross examination; at microscopic analysis, they are characterized by a nest of transitional cells scattered throughout a stromal component. The abundant fibrous content and calcification in the tumor result in extensive low signal intensity on T2-weighted images (Fig 18) (34,35). Brenner tumors are reported to

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**Figure 17.** Subserosal leiomyoma in a 44-year-old woman. Sagittal fat-suppressed T1-weighted (a) and T2-weighted (b) images show a well-defined mass (arrows) at the posterior aspect of the uterus (U). The mass has intermediate signal intensity on the T1-weighted image and low signal intensity on the T2-weighted image. There are extensive vascular flow voids (arrowheads) between the mass and the myometrium (the flow void sign). This finding is a reliable indicator of a subserosal uterine leiomyoma.

**Figure 18.** Brenner tumor in a 79-year-old woman. Axial T1-weighted (a) and T2-weighted (b) images show a low-signal-intensity solid mass (arrows) that is sharply demarcated. In addition, a multicystic mass (arrowheads) is seen beside the solid mass. At surgery, a Brenner tumor (solid mass) and an associated mucinous cystadenoma (multicystic mass) were found.
show lower signal intensity on T2-weighted images than other solid tumors (34,35).

Brenner tumors have a frequent association with mucinous cystic tumors in the same ovary (Fig 18). In these cases, gross and imaging examinations show a cystic and solid appearance. The cystic component represents mucinous cystic tumor, and the solid component represents Brenner tumor.

Malignant Brenner tumors (transitional cell carcinomas) are extremely rare. In contrast to benign Brenner tumors, borderline or malignant Brenner tumors have cystic and solid appearances at gross examination. A few MR imaging studies have demonstrated borderline Brenner tumors as cystic masses with papillary and solid elements (36) and malignant Brenner tumors as multilocular cystic masses with large solid components (37).

Intravenous administration of gadolinium contrast material is not essential for characterization of fibromas or Brenner tumors when the signal intensity of the tumor is typical. However, contrast-enhanced studies may be useful for determining the extrauterine origin of the solid mass (38,39).

Granulosa cell tumors are categorized as sex cord–stromal tumors. Ninety percent of granulosa cell tumors are stage I tumors; however, they have malignant potential and can extend beyond the ovary (40). There are two subtypes: adult and juvenile granulosa cell tumors. The adult type accounts for 95% of cases and often occurs in postmenopausal women. Granulosa cell tumors show a variable spectrum of multilocular cystic or solid and cystic appearances at both gross and imaging examinations (41,42) and may be diagnosed by using the criteria in the “Cystic Masses” or “Cystic and Solid Masses” section. Some of these tumors have a predominantly solid appearance and can be diagnosed by following the indicators in this section (Fig 19). Extensive intratumoral hemorrhage is often identified with MR imaging (Fig 19). In addition, granulosa cell tumors are the most common estrogenic ovarian tumors, and associated uterine enlargement with endometrial hyperplasia may be demonstrated on T2-weighted images (41,42).

Dysgerminomas account for 3%–5% of all ovarian malignancies. It is the most common malignant ovarian tumor among children, adolescents, and young adults, with 80% of patients being under 30 years of age (26). Pure dysgerminomas are round, oval, or lobulated solid masses with a fibrous capsule. Reported MR imaging
findings of dysgerminoma are a lobulated hyperintense mass with hypointense septa on T2-weighted images (Fig 20). The septa show strong enhancement because of the presence of vascular structures and connective tissue (43). Epithelial ovarian carcinomas may appear predominantly solid. Specifically, serous carcinomas are sometimes solid (Fig 21), but mucinous carcinomas are rarely solid (6). As these tumors usually show intermediate to high signal intensity on T2-weighted images, specific diagnosis is impossible. Ancillary findings of ovarian carcinoma (ie,
pelvic organ involvement, disseminated nodules, and adenopathy) can indicate a correct diagnosis of malignancy.

Metastatic ovarian carcinomas, especially Krukenberg tumors, may have a predominantly solid appearance (44,45). The great majority of Krukenberg tumors are signet-ring cell carcinomas arising in the stomach. Signet-ring cells scatter in the ovarian stroma with abundant collagen formation or marked edema. Therefore, Krukenberg tumors occasionally show low or high signal intensity on T2-weighted images (44,45). Strong contrast enhancement is usually seen in the solid component or the wall of the intratumoral cyst (45).

### MR Imaging Strategy

Table 2 represents a decision-making diagram. Both morphologic and signal intensity characteristics of the mass should be considered to distinguish benign from malignant ovarian tumors.

Cystic and unilocular masses include nonneoplastic cysts and benign neoplasms (eg, serous cystadenoma). Hyperintense hemorrhagic adnexal processes are seen on T1-weighted images, including hemorrhagic functional cysts, tubo-ovarian abscess, and hematosalpinx. A solitary endometriotic cyst can also be seen as a cystic and unilocular mass. Tubo-ovarian abscess and hematosalpinx appear as a tortuous enlarged tube, so their cystic-unilocular appearance may overlap with the cystic-multilocular category.

Cystic and multilocular masses include endometriotic cysts and benign and borderline tumors
Endometriotic cysts typically show multiplicity and high signal intensity on T1-weighted images because of cyclic hemorrhage. Cystic and solid masses usually indicate primary and secondary ovarian malignancy. Cystic teratomas are an important exception to this criterion, and the presence of hyperintense fatty material on non–fat-suppressed T1-weighted images is diagnostic. Solid masses include benign, borderline, and malignant tumors. Both primary and secondary ovarian malignancies (eg, Krukenberg tumor) are included. In the solid mass group, low signal intensity on T2-weighted images can indicate fibromas and Brenner tumors.

Contrast-enhanced studies are not necessary when masses show typical findings of endometriotic cysts, cystic teratomas, fibromas, or Brenner tumors. The use of intravenous contrast material is essential when differentiation of malignant from benign ovarian tumors is required. As in the established MR imaging criteria for ovarian malignancy, large solid components, vegetations, or nodularity usually show contrast enhancement in the cystic and solid mass group, whereas peripheral, cyst wall, or septal enhancement can be simply seen in the cystic-unilocular or cystic-multilocular mass group. Degeneration, necrosis, or intratumoral hemorrhage in the solid mass group causes a heterogeneous enhancement pattern.

Finally, the ancillary criteria of involvement of pelvic organs or the sidewall, peritoneal disease, ascites, and lymphadenopathy should be carefully evaluated to distinguish benign from malignant disease.

Conclusions
MR imaging is a useful modality for differentiating benign and malignant ovarian tumors, and a specific diagnosis can be made for certain pathologic entities. Morphologic appearance, signal intensity characteristics, and adequate use of intravenous contrast material provide information for arriving at the correct diagnosis.

References


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