Adnexal masses present a special diagnostic challenge, in part because benign adnexal masses greatly outnumber malignant ones. Determination of a degree of suspicion for malignancy is critical and is based largely on imaging appearance. Endovaginal ultrasonography (US) is the most practical modality for assessment of ovarian tumors because it is readily available and has a high negative predictive value. Morphologic analysis of adnexal masses is accurate for identifying masses as either low risk or high risk. The most important morphologic features are non-fatty solid (vascularized) tissue, thick septations, and papillary projections. Color Doppler US helps identify solid, vascularized components in a mass. Spectral Doppler waveform characteristics (eg, resistive index, pulsatility index) correlate well with malignancy but generally add little information to morphologic considerations. Computed tomography can help assess the extent of disease in patients before and after primary cytoreductive surgery. Magnetic resonance (MR) imaging is better reserved for problem solving when US findings are non-diagnostic or equivocal because, although it is more accurate for diagnosis, it is also more expensive. The signal intensity characteristics of ovarian masses make possible a systematic approach to diagnosis. Mature cystic teratomas, cysts, endometriomas, leiomyomas, fibromas, and other lesions can be accurately diagnosed on the basis of T1-weighted, T2-weighted, and fat-saturated T1-weighted MR imaging findings.
Introduction
Gynecologic malignancies include cervical cancer, endometrial cancer, and ovarian cancer. Ovarian cancer is the second most common gynecologic malignancy (1); however, it remains the leading cause of death among these diseases and is the fourth leading cause of cancer deaths in women in the United States (1). In spite of diagnostic and therapeutic advances in the care of women with ovarian cancer, the overall 5-year survival rate has changed little (1–4).

Ovarian tumors can be categorized as epithelial, germ cell, sex cord–stromal, or metastatic. Epithelial tumors are the most common histopathologic type of malignant ovarian tumor (85% of cases) (Fig 1) (5,6). Subtypes of epithelial tumors include serous, mucinous, endometrioid, clear cell, and Brenner tumors. Epithelial tumors are rare before puberty; their prevalence increases with age and peaks in the 6th and 7th decades of life (5). The most common type of ovarian malignancy is serous carcinoma (approximately 40% of cases) (2,3,5–7). Therefore, it is important to be familiar with the clinical and imaging aspects of ovarian epithelial tumors in particular. In this article, we discuss the relative merits of ultrasonography (US), magnetic resonance (MR) imaging, and computed tomography (CT) in the evaluation of women with adnexal masses. In addition, we discuss the clinical settings in which each modality can be used to greatest advantage and the important criteria for the imaging diagnosis of adnexal masses.

Diagnosis, Staging, and Treatment of Gynecologic Malignancy
Determination of a degree of suspicion for malignancy in an adnexal mass is the most critical step after identification of the mass. An estimated 5%–10% of U.S. women with a suspect adnexal mass will undergo surgery, but in only 13%–21% of these patients will the mass prove to be malignant (8). Thus, the number of suspect benign masses is far greater than the number of malignant masses. This discrepancy becomes even greater if screening with cancer antigen (CA)–125 or US is used to define the population. In these circumstances, 10–20 surgeries will be performed for every cancer detected (8,9). Although general ovarian cancer screening is currently not recommended, screening of high-risk groups such as persons with a family history of cancer is recommended (8). Similar high rates of surgery for benign masses are found in these high-risk groups (10).

Many of the most common causes of lesions that may mimic an adnexal mass (eg, small simple cysts) require no invasive testing. In the interests of efficiency and practicality, patients with suspect adnexal masses initially undergo pelvic US. Although endovaginal US can depict smaller lesions and internal features of masses (eg, papillary projections), it is not clear whether endovaginal US should always be performed in preference to transabdominal US (11–14). The more limited field of view and scanning windows used in endovaginal US may result in failure to identify abnormalities lying higher in the pelvis, particularly in patients with enlarged myomatous uterus (11–14). Endovaginal US may be performed if transabdominal US findings are nondiagnostic; it may also be performed as an initial examination, followed by a brief transabdominal evaluation if the entire uterus and ovaries are not visualized endovaginally. Both conventional and Doppler US are less accurate than MR imaging in diagnosing ovarian malignancy (15–17). However, because it is impractical to perform MR imaging in all patients with abnormalities, this modality is reserved for uncertain or problematic cases.

The degree of suspicion for malignancy in a given mass is based largely on imaging appearance, but other factors such as serum CA-125 level must also be considered. This stratification of risk is becoming particularly important when laparoscopy or noninvasive management is being
considered. Expedited referral of patients with suspect masses to a gynecologic oncologist for definitive staging with laparotomy correlates with better survival rates (18–20).

**Serum CA-125 Assay**
The most extensively studied ovarian cancer–associated marker is CA-125. CA-125 is an antigen determinant on a high-molecular-weight glycoprotein (21). Serum CA-125 assay is a useful preoperative test for prediction of epithelial ovarian cancer and provides additional data to help discriminate between benign and malignant adnexal masses as well as select an adjunct screening modality (21–23). A multimodality approach (ie, clinical examination, imaging, and serum assays) is necessary to detect malignant masses at an early stage. The combination of normal findings at serum CA-125 assay, endovaginal US, and clinical examination of the pelvis virtually excludes the possibility of ovarian cancer (24).

Although elevated serum CA-125 levels (>35 U/mL) have been found at radioimmunoassay in more than 80% of ovarian cancer patients, only 50% of patients with stage I disease have elevated serum CA-125 levels (21,22,25). CA-125 is not a tumor-specific antigen; it is also elevated in approximately 1% of healthy control subjects, in patients with liver cirrhosis, endometriosis, first-trimester pregnancy, pelvic inflammatory disease, and pancreatitis, and in 40% of patients with advanced intraabdominal nonovarian malignancy (21,25,26).

Serial measurements of the serum CA-125 level are routine in the clinical follow-up of ovarian cancer patients (21,27). Increasing serum CA-125 levels in patients with early-stage disease is predictive of recurrence regardless of imaging findings. In 87% of patients, doubling or halving of the serum CA-125 level correlates with tumor progression or regression, respectively (27,28). A combination of serum CA-125 assays and imaging studies may aid in patient treatment. Elevated serum CA-125 levels and negative or equivocal findings at CT or MR imaging may be more suggestive of small lesion size; however, there does not seem to be any direct correlation between tumor size and serum CA-125 level. Negative serum CA-125 assays and negative imaging findings do not exclude recurrent tumor; occult tumor will be detected in up to 50% of affected patients at second-look laparotomy (27,29–32).

**Laparoscopic Evaluation of Adnexal Masses**
Exploratory laparotomy was the standard approach for diagnosis and therapy of adnexal masses until the past decade. The goal of exploratory laparotomy has been the proper staging of ovarian cancer and complete resection should it be found (29,33–35). However, exploratory laparotomy is a more extensive surgical procedure than is necessary in most cases.

Laparoscopic surgery has rapidly evolved and is an important surgical modality for management of adnexal masses. Postoperative discomfort and length of hospital stay are often reduced with laparoscopy compared with laparotomy (29,36–38). Ovarian cystic tumors without signs of malignancy can be treated with laparoscopic surgery (37,39–41). In many young patients with nonmalignant ovarian lesions such as endometriosis, benign cysts, benign cystic proliferations, and fibromas, treatment with laparoscopy can obviate laparotomy (29,37–39,42).

Laparoscopy is frequently used in the diagnostic evaluation of adnexal masses. However, laparoscopic diagnosis raises concerns about the possibility of tumor spillage due to cyst rupture, which correlates with a worse prognosis (43). In addition, laparoscopy may lead to the diagnosis and resection of large numbers of functional cysts and other innocuous lesions that could have been followed up clinically without surgery (28,36,44). Finally, delay in performing definitive staging laparotomy may be associated with a worse prognosis (20). For these reasons, laparoscopy is reserved for patients with masses that are non-suspicious based on imaging findings (45–48).

**Staging Laparotomy**
The prognostic factors for ovarian cancer are variable and include histologic grade, stage of disease, and residual tumor size after surgical staging. The most predictive factor is the stage of the tumor (2,33,34,49). Accurate tumor staging is based on findings at exploratory laparotomy with multiple biopsies (29,34). The staging classification scheme for ovarian cancer is a surgical-pathologic system modified by the International Federation of Gynecology and Obstetrics. In very general terms, stage I disease is limited to the ovaries, stage II disease is limited to the pelvis,
Table 1
Staging System for Ovarian Neoplasms

<table>
<thead>
<tr>
<th>Stage</th>
<th>US Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Growth limited to the ovaries</td>
</tr>
<tr>
<td>Ia</td>
<td>Growth limited to one ovary, no ascites present containing malignant cells, no tumor on the external surface, capsule intact</td>
</tr>
<tr>
<td>Ib</td>
<td>Growth seen in both ovaries, no ascites present containing malignant cells, no tumor on the external surfaces, capsules intact</td>
</tr>
<tr>
<td>Ic</td>
<td>Tumor either stage Ia or Ib but tumor found on surface of one or both ovaries, capsule ruptured, ascites present containing malignant cells, or peritoneal washings positive</td>
</tr>
<tr>
<td>II</td>
<td>Growth involving one or both ovaries with pelvic extension</td>
</tr>
<tr>
<td>IIa</td>
<td>Extension or metastases to the uterus or fallopian tubes</td>
</tr>
<tr>
<td>IIb</td>
<td>Extension to other pelvic tissues</td>
</tr>
<tr>
<td>IIc</td>
<td>Tumor either stage IIa or IIb but tumor found on surface of one or both ovaries, capsule(s) ruptured, ascites present containing malignant cells, or peritoneal washings positive</td>
</tr>
<tr>
<td>III*</td>
<td>Tumor involving one or both ovaries with histologically confirmed peritoneal implants outside the pelvis or positive retroperitoneal or inguinal nodes; tumor limited to the true pelvis but with histologically confirmed malignant extension to small bowel or omentum</td>
</tr>
<tr>
<td>IIIa</td>
<td>Tumor grossly limited to the true pelvis with negative nodes but with histologically confirmed microscopic seeding of abdominal peritoneal surfaces or extension to small bowel or mesentery</td>
</tr>
<tr>
<td>IIIb</td>
<td>Tumor involving one or both ovaries with histologically confirmed implants, metastasis to abdominal peritoneal surfaces (lesions ≤2 cm), negative nodes</td>
</tr>
<tr>
<td>IIIc</td>
<td>Extrapelvic peritoneal metastasis (lesions &gt;2 cm) or positive retroperitoneal or inguinal nodes</td>
</tr>
<tr>
<td>IV†</td>
<td>Growth involving one or both ovaries with distant metastases, positive cytologic findings if pleural effusion is present</td>
</tr>
</tbody>
</table>

Source.—Reference 50.
*Includes superficial liver metastases.
†Includes parenchymal liver metastases.

Stage III disease is limited to the peritoneal cavity, and stage IV disease is hematogenous (liver parenchymal) disease or has spread beyond the abdomen (Table 1) (49,51).

When ovarian cancer spreads beyond the ovaries, it generally does so either by seeding into the peritoneal cavity (including regional invasion) or by way of lymphatic dissemination. Retroperitoneal nodal spread may be present even in cases with little or no apparent intraperitoneal involvement. Most of the lymphatic drainage of the ovary proceeds cephalad along the infundibulopelvic ligaments to the aortic nodal group. The intraperitoneal spread of ovarian cancer is more apparent clinically than is the spread through lymphatic vessels. Hematogenous spread to parenchymal organs or bone occasionally occurs in advanced disease but is not significant in apparent early disease (49,52).

Stage laparotomy includes abdominal hysterectomy, bilateral salpingo-oophorectomy, omentectomy, random peritoneal biopsy, and lymph node biopsy. Approximately 70% of patients have stage III or stage IV disease at the time of diagnosis. Furthermore, 30%–40% of patients who are initially thought to have stage I or stage II disease prove to have intraabdominal spread at surgery. The presence of occult microscopic or overt metastasis that was missed during staging laparotomy indicates that the disease was understaged initially. This leads to an inaccurate prognosis and may have a profound influence on the selection and success of primary treatment (33,49,52,53).

Exploratory laparotomy is necessary in all cases of suspected ovarian cancer to help confirm the diagnosis, determine the extent of the disease by staging, and resect the tumor (7,34,35,52). In the largest prospective multicenter study to date, US, CT, and MR imaging demonstrated a similar accuracy in staging ovarian carcinoma (15). CT and MR imaging are most useful in assessing and planning treatment for more advanced ovarian cancer. MR imaging is particularly useful in evaluating tumor extension into the uterus, bladder, rectum, or pelvic sidewall and in determining whether tumors can be optimally debulked (54). The reported overall staging accuracy of MR imaging is 75%–78%, similar to that of CT. However, if there are motion artifacts from bowel or insufficient orally-administered contrast agent, MR imaging may be less sensitive than CT in detecting small mesenteric and peritoneal implants (55–57).
Treatment

The treatment of women with ovarian cancer has traditionally included initial surgical staging and aggressive cytoreductive surgery followed by cisplatinum-containing adjuvant chemotherapy (29,52,53). Treatment of early-stage (stages I and II) epithelial ovarian cancer consists of total hysterectomy and bilateral salpingo-oophorectomy. For women of childbearing age with stage I unilateral disease who wish to preserve their fertility, the surgery may be limited to a unilateral salpingo-oophorectomy, although this is somewhat controversial (33–35).

Despite decades of effort to improve the early detection and diagnosis of epithelial ovarian carcinoma, the majority of patients present with advanced (stages III and IV) ovarian cancer. Frequently, findings in these patients include a distended abdomen due to ascites, along with large tumor masses in the abdomen and pelvis (35,53,58). At exploration, complete resection of the tumor is usually impossible, and patients cannot be cured with surgery alone. Patients with advanced-stage disease should undergo tumor debulking as indicated (33,58).

Debulking, or cytoreductive surgery, refers to a surgical procedure to reduce the volume of tumor implants in a patient with metastatic ovarian cancer (33,53,58). Debulking in a patient with advanced ovarian cancer is not only believed to make the patient more comfortable; it also reduces potential obstruction in the gastrointestinal tract and reduces the adverse metabolic effects of the tumor while helping the patient maintain her nutritional status (58,59). Numerous studies have evaluated the effects of residual disease following primary cytoreductive surgery on response rate to chemotherapy, progression-free interval, and survival rate. Optimal debulking has come to denote minimal residual disease no greater than 1.5–2.0 cm in diameter, whereas suboptimal debulking denotes bulky residual disease greater than 2.0 cm in diameter (33,58,59). Successful debulking enhances the effect of chemotherapy and results in prolonged survival (53,58,60). Patients with unresectable disease (ie, patients in whom optimal debulking is not possible) benefit from chemotherapy followed by surgical debulking of residual disease (58,60).

Patients with stage Ia or Ib ovarian cancer can be followed up without further therapy after definitive surgery, whereas patients with more advanced disease require postoperative chemotherapy (34,51,59). Among the chemotherapeutic agents, cisplatinum is the single most effective agent in advanced ovarian cancer. Despite primary response rates of 60%–80% with platinum-based regimens, 80%–90% of women with stage III disease and over 97% of women with stage IV disease die from cancer within 5 years of presentation. Because there is little evidence to suggest that current chemotherapeutic regimens will offer dramatic improvements over those of the past decade, it has been suggested that improvements in survival rate for patients with ovarian carcinoma will result from better detection of the disease at an early or preclinical stage (53,59).

Patients who have undergone treatment for ovarian cancer are best followed up with serial measurements of serum CA-125 level and clinical examination. Routine CT is of little value in asymptomatic patients (8,61,62). Second-look laparotomy continues to be the most accurate way to assess response to chemotherapy in protocol settings but is known to have a high false-negative rate (ie, patients later relapse after negative second-look procedures) and has not been shown to improve survival rate (30,31,63). CT can help detect gross disease and obviate extensive repeat biopsy. If imaging studies show residual disease, the patient may be offered additional treatment. However, even if there is no radiologic evidence of recurrent disease, the high false-negative rate of imaging studies for the detection of peritoneal spread precludes assuming that the patient is disease free (32,64,65). Additional clinical trials with newer second-line chemotherapy will be necessary before definitive statements can be made with regard to effects on survival rate in patients who undergo second-look laparotomy (30,31,63).

Imaging Evaluation

US Scoring System

US remains the study of choice in the initial evaluation of suspect adnexal masses because it is relatively inexpensive, noninvasive, and widely available. Transabdominal US, endovaginal US, or both should be performed for the evaluation of adnexal masses (13,66–69). Preliminary studies that were performed in an attempt to screen for or identify early-stage ovarian carcinoma, especially in postmenopausal women, used transabdominal US and were unable to help identify morphologic characteristics that would allow differentiation of benign from malignant masses (66,67,69). The advent of high-frequency endovaginal probes allowed high-resolution imaging of the pelvic organs in general and of the ovaries in particular. Endovaginal US has allowed markedly improved resolution for uterine and adnexal imaging and is essential for imaging adnexal masses whose nature is not apparent at transabdominal US (13,68,70–72).
Numerous studies have examined whether gray-scale criteria can allow differentiation of benign from malignant ovarian masses. US, whether transabdominal or endovaginal, relies on morphologic assessment of the tumor to distinguish between benign and malignant disease. Morphologic features including thick, irregular walls and septa, papillary projections, and solid, moderately echogenic loculi have been described as suggestive of malignant tumor (68,72–74). Many morphologic scoring systems have been proposed and are based on the wall thickness, inner wall structure, septal characteristics, and echogenicity of the lesion (Table 2). In 1991, Sassone et al (68) proposed a morphologic scoring system using endovaginal US to characterize ovarian lesions and demonstrated a sensitivity of 100% and a specificity of 83% in distinguishing benign from malignant ovarian lesions. The sensitivity of morphologic analysis with US in predicting malignancy in ovarian tumors has been shown to be 85%–97%, whereas its specificity ranges from 56% to 95% (13,70,73–76).

**Doppler US Evaluation**

Color Doppler US of ovarian masses helps identify vascularized tissue and can assist in differentiating solid tumor tissue from nonvascularized structures. It is also used in conjunction with pulsed Doppler US to identify vessels for waveform analysis. Most studies have relied on waveform analysis to distinguish benign from malignant ovarian masses, but much if not more information can be obtained with color Doppler US (75,77,78). Benign lesions tend to initiate new tumor blood vessel formation peripherally from preexisting host vessels, whereas malignant tumors tend to initiate new tumor blood vessel formation centrally (71,79,80). Waveform analysis is based on the fact that malignant tumor vessels are morphologically abnormal: They lack smooth muscle in their walls and demonstrate an irregular course and arteriovenous shunt formation (71,73,79–83). In addition, malignant tumor vessels generally have low impedance, which causes high diastolic flow and low systolic-diastolic variation. Some differentiation between benign and malignant masses is achieved by quantifying these differences.

Two indexes have been used in analyzing Doppler waveforms: the pulsatility index and the resistive index. Both increase with increasing distal vascular resistance, and the two indexes have a high correlation. A comparison of different studies shows that no standard has been established concerning which Doppler index to use or what cutoff value is most appropriate. However, resistive indexes less than 0.4–0.8 (84–90) and pulsatility indexes less than 1.0 are generally considered to be suspicious for malignancy (84,85,87–93). Doppler US has yielded variable results in distinguishing benign from malignant masses, with a sensitivity of 50%–100% and a specificity of 46%–100% (70, 73,75,76,86,91,94,95). Differing results are partly due to varying threshold values and corresponding tradeoffs between sensitivity and specificity.

Problems associated with Doppler US include operator dependence and lack of standard criteria in distinguishing benign from malignant waveforms. Moreover, in cases in which septations, papillae, and solid areas of tumor are absent, it is difficult to detect signal for waveform analysis. In addition, certain Doppler indexes can be misleading in premenopausal women and usually have a lower specificity because physiologic alterations in the ovary due to the menstrual cycle cause lowered blood vessel resistance, thereby mimicking malignancy. Finally, acute inflammatory adnexal

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**Table 2**

Morphologic Scoring System for Adnexal Masses Based on US Features

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score 0</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall structure</td>
<td>Smooth</td>
<td>...</td>
<td>Solid</td>
<td>Papillary projections (≥3 mm)</td>
</tr>
<tr>
<td>Shadowing</td>
<td>Yes</td>
<td>No</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Septa</td>
<td>None</td>
<td>Thick</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Echogenicity</td>
<td>Sonolucent, low-level echoes or echogenic core*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Includes echogenic masses such as mature cystic teratoma.
disease and endometriosis are common conditions associated with an increased number of capillaries and dilatation of blood vessels, which causes a low pulsatility index (96). In a study by Reles et al (73), the sensitivity of color Doppler US was 80% and the specificity only 67% in premenopausal patients, whereas in postmenopausal patients, the sensitivity and specificity were 93% and 83%, respectively.

Use of a combination of morphologic analysis with endovaginal US and pulsed Doppler waveform analysis with color Doppler US may help overcome these problems (70,73,77,94). In a study of 82 patients, Timor-Tritsch et al (94) demonstrated that use of a morphologic scoring system in conjunction with color Doppler US affords better differentiation of benign and malignant ovarian masses than would use of either procedure alone. Their morphologic scoring system yielded a sensitivity of 94%, a specificity and 87%, and a disappointing positive predictive value of 60%. When the pulsatility index or resistance index was included, more acceptable levels of sensitivity (94%), specificity (99%), and positive predictive value (94%) were obtained. Brown et al (78) used a scoring system based solely on findings of solid (nonhyperechoic) components, pattern of flow (central or peripheral), ascites, and septations and demonstrated high levels of accuracy. In the largest multicenter study to date, Doppler US was inferior to MR imaging in the identification of malignant ovarian disease (15).

CT Evaluation
Among women with ovarian disorders, CT has been used primarily in patients with ovarian malignancies, either to assess disease extent prior to surgery or as a substitute for second-look laparotomy. Although CT may play a useful role in diagnosing adnexal masses, it is more often of limited value in this setting.

CT, particularly spiral CT, has several advantages: It is widely available and can be performed rapidly and relatively easily. Moreover, CT of the abdomen or pelvis allows comprehensive evaluation of all potential sites of peritoneal implants or lymphadenopathy as well as of the primary tumor site. CT allows use of oral contrast agent to distend and mark the bowel and help differentiate bowel from peritoneal implants, which gives this modality a major advantage over US and MR imaging. For these reasons, CT is a very attractive method for evaluating the extent of disease in women with ovarian malignancy. However, available studies have not demonstrated that CT is significantly superior to other modalities in staging ovarian malignancy (15,54). A few small-scale studies have suggested that MR imaging, particularly with gadolinium-enhanced, fat-saturated breath-hold techniques, may be more accurate than CT in staging ovarian carcinoma (54,57,97). Many studies have shown that CT is neither sensitive enough nor specific enough to replace second-look laparotomy or even percutaneous biopsy for second-look evaluation (32,61,62,64,65,98). The largest study to date comparing US, CT, and MR imaging in the staging of ovarian malignancy showed little difference between the modalities (15).

CT is most useful for evaluating the extent of disease in the abdomen and pelvis. In some studies, CT has demonstrated reasonable accuracy in determining which patients may have tumor implants that can be optimally surgically debulked (ie, all tumor nodules greater than 2 cm can be removed) (54,99). Patients with unresectable disease would undergo percutaneous or laparoscopic biopsy, after which they would undergo chemotherapy and optimal surgical debulking after completion of chemotherapy. Clinical trials have shown that optimal debulking after chemotherapy improves survival rate in these patients.

MR Imaging Evaluation
The principal advantage of MR imaging is that it combines some of the best features of CT and US. The accuracy of MR imaging in the diagnosis of mature cystic teratomas, endometriomas, and leiomyomas is well established and derives from its superb contrast resolution and its usefulness in tissue characterization (100–105). The identification of these types of masses depends on tissue characterization based on magnetic resonance properties. For adequate pelvic MR imaging evaluation, images must be obtained in at least two planes. Acquisition of both T1- and T2-weighted images is fundamental in the delineation of pelvic anatomy and in tissue characterization (100,106,107). Fat-saturated T1-weighted images help distinguish fatty from hemorrhagic masses (103,104,107,108). The use of small fields of view (20 cm), high-resolution matrixes (256 x 256), and thin sections (4 mm) improves the delineation of small structures such as papillary projections. Administration of antiperistaltic drugs prior to MR imaging helps suppress bowel motion and improve visualization of the adnexa and peri toneal surfaces. Gadolinium-enhanced T1-weighted images help characterize the internal architecture of cystic lesions and improve detection of peritoneal and omental implants (109–111). The value of dynamic imaging with gadolinium chelates has not been established, but this modality appears promising (112).
Several types of tissue and fluid can be distinguished at MR imaging on the basis of their signal intensity characteristics (101). Cystic and solid lesions demonstrate low signal intensity on T1-weighted images and relatively high signal intensity on T2-weighted images. In general, benign epithelial ovarian neoplasms are predominantly cystic, whereas malignant epithelial neoplasms contain both cystic and solid components. There are differences in signal intensity between cystic and solid tissue. Cystic lesions containing simple fluid have prolonged T1 and T2 relaxation times and very high signal intensity on T2-weighted images. Although solid lesions contain large amounts of both intracellular and extracellular fluid, resulting in increased T1 and T2 relaxation times, they have a relatively intermediate signal intensity on T2-weighted images that is considerably lower than that of fluid (100,101,106,107). This difference is accentuated with use of a relatively long echo time (90–120 msec).

Fat, hemorrhage, and some high-viscosity, mucin-containing lesions have high signal intensity on T1-weighted MR images. A typical fat-containing lesion is a mature cystic teratoma (103, 104). Hemorrhagic lesions include endometriosis, hemorrhagic cyst, hemorrhagic foci of adenomyosis, and hematosalpinx (102,104,113–117). Fat-suppressed T1-weighted MR images help distinguish between hemorrhage and fat, as for example in a teratoma (103,117). In general, low-viscosity mucin has low signal intensity on T1-weighted MR images and high signal intensity on T2-weighted images. High-viscosity mucin demonstrates variable T1 shortening, resulting in variable signal intensity on both T1- and T2-weighted images (101).

Fibrosis or smooth muscle has low or intermediate signal intensity on T1-weighted MR images and low signal intensity on T2-weighted images compared with other soft tissues because of the T2 shortening effects of intramuscular actin, myosin, and collagen and the decreased extracellular fluid compared with surrounding tissues. Fibrotic lesions include fibroma, fibrothecoma, cystadenofibroma, Brenner tumor, and the walls of chronic pelvic abscesses (113,118–120). Masses that contain smooth muscle include leiomyoma and the stroma of adenomyosis (115,121). Identifying the signal intensity of a mass can help narrow the differential diagnosis. However, there are no MR imaging signal intensity characteristics that are specific for malignant epithelial tumor; such tumors must be distinguished based on morphologic criteria.

Administration of gadolinium chelates allows better depiction of internal architecture and is useful in differentiating cystic from solid lesions.
and malignant from benign lesions (17,109,111,122). Injection of gadolinium-enhanced contrast agent is recommended for accurate characterization of some adnexal lesions, especially for delineation of necrosis, papillary projections, solid components, septations, peritoneal implants, and omental disease (Fig 2) (17,108,111,112). In the evaluation of adnexal masses, the presence of papillary projections is highly specific for malignant epithelial ovarian neoplasms. Endovaginal US lacks specificity for the characterization of adnexal masses because fibrinous debris and adherent clot in the cyst wall may mimic the appearance of papillary projections. With the injection of gadolinium-enhanced contrast agent, the papillary projections enhance but adherent clot and debris do not. In most studies, MR imaging has proved superior to endovaginal US in the differentiation of benign from malignant adnexal masses (16,17,70,123).

Specific Diagnoses

Functional Cysts
The management of adnexal masses in women of reproductive age remains a common clinical gynecologic problem. Most ovarian cysts are functional cysts (ie, follicular cysts that result from a failure of the follicle to rupture or regress or corpus luteum cysts that derive from hemorrhage in a corpus luteum) (124,125). Simple cysts are generally thin-walled (<3 mm), unilocular cysts less than 3 cm in diameter. Corpus luteum cysts may enlarge secondary to internal hemorrhage and cystic transformation. Cysts larger than about 1 cm often represent corpus luteum cysts (124,126). Small simple cysts are common in postmenopausal patients (127). A simple unilocular cyst without solid components is highly unlikely to be malignant (127,128).

At US, a functional ovarian cyst is typically anechoic with thin, smooth walls and posterior acoustic enhancement. Similar US characteristics may be seen in benign ovarian neoplasms such as serous cystadenomas. More complex appearances can be produced by hemorrhage in a corpus luteum cyst. Hemorrhagic cysts have a variety of appearances depending on the stage of evolution of the clot, but lacelike reticular echoes or an intracystic solid clot are most typical (Fig 3) (129,130). Complex cysts with such appearances should lead to follow-up US or further assessment with MR imaging. The most helpful feature in distinguishing functional cysts from ovarian neoplasms is the presence of papillary projections and nodular septa in the latter (16,108,111,131). The reported blood flow detection rate in functional cysts has ranged from 19% to 61%; however, blood flow assessment at initial Doppler US...
Figure 4. Endometrioma in a 40-year-old woman. (a) Sagittal US image shows a cystic mass with diffuse low-level echoes. (b) T1-weighted spin-echo MR image (600/16) reveals a mass in the right ovary with high signal intensity and a discrete wall (arrow). (c) On a T2-weighted MR image (3,617/119), the mass demonstrates very low signal intensity ("shading") (arrow). These findings are typical for endometrioma.

is not useful in distinguishing functional ovarian cysts from ovarian neoplasms (73,91,94,132). Therefore, follow-up US remains the best approach for identifying functional cysts. Follow-up US to assess for cyst resolution is a useful initial study in cysts that are suspicious for hemorrhage and is appropriate in both premenopausal and postmenopausal women (127–129,133).

Most ovarian cysts have intermediate to low signal intensity on T1-weighted MR images and very high signal intensity on T2-weighted images owing to the presence of simple fluid. Cyst walls are thin and featureless on T1-weighted images, are usually clearly depicted on T2-weighted images, and enhance with the administration of gadolinium-enhanced contrast agent. Hemorrhagic corpus luteum cysts have relatively high signal intensity on T1-weighted images and intermediate to high signal intensity on T2-weighted images (126,134,135). Corpus luteum cysts do not demonstrate the profound T2 shortening that is seen with many endometriomas (104,126).

Endometriomas
Endometriosis is the presence of endometrial glands and stroma outside the uterus and is a common disease in women of childbearing age.
Eighty percent of all pelvic endometriosis is found in the ovary (136,137). Endometrioid cysts, or endometriomas, are usually small but can reach 15–20 cm in diameter. Endometriomas contain an obliterated, mostly endometrial gland lining (136,137). The walls of endometriomas are initially thin, but later they become fibrotic and thickened and may have an irregular external border (138).

At US, endometriomas appear as a cystic mass with diffuse, low-level echoes (Fig 4a). They have a wide range of manifestations, from cystic to complex, and may have a solid appearance. Endometriomas may have thick internal septa; however, this finding is not common. Fluid-fluid or debris-fluid levels can be seen (136,137,140). Patel et al (138) found that cysts with diffuse, low-level internal echoes were highly likely to represent endometriomas if multicellularity or hyperechoic wall foci were present and features such as solid components were absent. Hyperechoic foci result from cholesterol clefts in the wall.

CT is not generally useful for evaluating patients with endometriosis. Because of the infiltrative fibrotic wall, endometriomas and implants may mimic malignant disease. One finding that may be helpful in a minority of cases is a hyperattenuating clot floating dependently within the cyst cavity.

The most specific MR imaging findings in endometriomas are multiple cystic masses with high signal intensity on T1-weighted images and low signal intensity on T2-weighted images (Fig 4b, 4c). On the basis of these criteria, the sensitivity and specificity of MR imaging in the diagnosis of endometrioma vary from 90% to 92% and from 91% to 98%, respectively (104,135,140–142). Low signal intensity on T2-weighted images is occasionally seen in functional ovarian cysts or adnexal masses other than endometriomas. Endometriomas acquire an iron concentration in their cyst contents many times higher than even that of whole blood (143–145). This property gives them their characteristic appearance of very high signal intensity on T1-weighted images (similar to fat) and low signal intensity on T2-weighted images, a combination of findings not seen in pelvic hematomas at any stage of evolution (116).

Other possible MR imaging findings in endometriomas include high signal intensity on both T1- and T2-weighted images, adhesion to the surrounding organs, and a thickened, low-signal-intensity wall. However, these are nonspecific findings: The first finding may occur with hemorrhagic functional cysts as well as malignant ovarian lesions, whereas the second and third findings frequently also occur in women with pelvic inflammatory disease or a history of pelvic surgery (102,135).

Noncystic endometrial implants may be especially difficult to define at MR imaging due to their small size, potential obscuration by artifact from bowel peristalsis, and occasional lack of differentiation from adjacent fat on contrast-enhanced images. Small hemorrhagic endometrial implants become more obvious on fat-saturated T1-weighted MR images (102,140,146–148). Implants commonly manifest as solid masses with low signal intensity on T2-weighted images due to fibrosis surrounding the glandular islands (102,146).

**Mature Cystic Teratomas**

Mature cystic teratomas are the most common ovarian neoplasm in some series (5) and derive from ovarian germ cells. Although all three germ cell layers are present, ectodermal components predominate, so that these lesions are often referred to as dermoid cysts. Because they are usually asymptomatic, mature cystic teratomas are often discovered incidentally at routine pelvic examination (149).

US features ascribed to mature cystic teratomas include the presence of a shadowing echogenicity, regional or diffuse high echogenicity, hyperechoic lines and dots, and a fat-fluid level
Mature cystic teratoma in a 31-year-old woman with an elevated serum CA-125 level of 384. (a) Transabdominal US image shows an echoic mass with sound attenuation (arrow). $U =$ uterus. (b) Contrast-enhanced CT scan demonstrates a mass with low attenuation (arrow), a finding that is diagnostic for a fat-containing lesion. $U =$ uterus. (c) T1-weighted spin-echo MR image (600/16) demonstrates a high-signal-intensity mass in the right ovary. (d) Fat-saturated T1-weighted spin-echo MR image (500/16) demonstrates saturation of the lipid component of the mass (arrow).

Some of these US features overlap with the US features of other ovarian neoplasms such as endometriomas or ovarian carcinomas (150–152). Mature cystic teratomas are readily recognized at CT by the presence of fat and dense calcifications (Figs 5b, 6a).

The diagnosis of mature cystic teratoma is straightforward at both CT and MR imaging. Adipose tissue within the Rokitansky nodule as well as the sebum-rich fluid in the cyst cavity demonstrate fat attenuation at CT (Fig 6a) (152–154). Calcifications may or may not be present in the wall. A floating mass with hair or a fat-fluid interface can sometimes be identified. Pitfalls in the diagnosis of dermoid cyst at CT include fat blending in with surrounding retroperitoneal fat, occasional dermoid cysts without a fatty component, and lipoleiomyoma of the uterus, an unusual variant of myoma (155).

MR imaging features reflect the composition of the tumors. The lipid-laden cyst fluid demonstrates high signal intensity on T1-weighted im-
ages and intermediate signal intensity on T2-weighted images (Fig 6). Fat demonstrates high signal intensity on T1- and T2-weighted fast spin-echo images. Internal patterns of mature cystic teratomas such as palm tree–like protrusions or dermoid nipples are typical findings (104,106,150).

Both endometriomas and mature cystic teratomas demonstrate high signal intensity on T1-weighted images and therefore must be distinguished from one other (103,104). The fat in mature cystic teratomas results in chemical shift artifact at the fat-fluid interface. This artifact manifests as bright or dark bands along the frequency-encoding gradient. Use of frequency-selective fat saturation allows differentiation of hemorrhagic lesions from lipid-containing lesions such as endometriomas (Fig 5d) (103,117,156).

Besides mature cystic teratoma, the only ovarian mass to demonstrate fat is immature teratoma. This malignant mass is typically large at

Figure 6. Mature cystic teratoma in a 22-year-old woman. (a) Axial CT scan shows a low-attenuation mass in the right adnexa (arrow). (b) Axial T1-weighted spin-echo MR image (533.3/16) demonstrates a mass with high signal intensity (arrow). (c) T2-weighted fast spin-echo MR image (4,250/119) shows the mass (arrow) arising from the right ovary (arrowheads). Note that ovarian morphology is preserved, with no evidence of destruction or invasion. A septate uterus is incidentally noted. (d) Axial fat-saturated T1-weighted gradient-echo MR image (200/2.9) demonstrates saturation of the cystic contents of the mass (arrow).
Figure 7. Immature teratoma in a 28-year-old woman. (a) Transverse transabdominal US image shows a mass with bright foci posterior to the uterus (arrows). (b) CT scan through the midabdomen shows a large mass (arrows) containing calcifications and foci of fat (arrowheads). (c) Axial T1-weighted spin-echo MR image (550/16) shows a large mass in the left ovary (arrows) with multiple high-signal-intensity foci (arrowheads). (d) Fat-suppressed T1-weighted fast multiplanar spoiled gradient-echo MR image (400/2.6) shows that some of the bright foci in (a) represent fat (arrowheads). The mass is mostly solid (S) but also has a large cystic component (C). The serum α-fetoprotein level was 571.

presentation and has prominent solid components containing small foci of fat and coarse calcifications (Fig 7).

Fibrothecomas are ovarian tumors of gonadal stromal origin and may be variants of a single entity. They are composed of fibrous tissue and theca cells with abundant lipid in the cytoplasm. These theca cells are responsible for the estrogenic effects of these tumors. Pure fibromas consist of intersecting because they appear as solid masses, thereby mimicking malignant neoplasms. They are associated with ascites in 40% of cases, particularly in larger lesions, and with pleural effusions (Meig syndrome) in a small percentage of cases (157,158). Fibromas, thecomas, fibrosed thecomas, and fibrothecomas are ovarian tumors of gonadal stromal origin and may be variants of a single entity.
bundles of spindle cells without theca cells or estrogenic effect (158,159). Fibromas and cystadenofibromas are not related. Fibromas are of stromal derivation and have no epithelial component. In contrast, in cystadenofibromas, the fibrous component is part of the neoplasm, which is believed to be of epithelial and stromal origin similar to cystadenomas and cystadenocarcinomas (6,158).

At US, fibromas most commonly manifest as solid, hypoechoic masses with sound attenuation, which at times may be striking (Fig 8a). However, the US appearance is variable, and hyper-echoic masses with increased through-transmission may be seen (160,161).

At CT, fibromas manifest as diffuse, slightly hypoattenuating masses (Fig 8b). Unlike most other solid masses, fibromas show poor, very slow enhancement with administration of contrast material (162).

Fibromas demonstrate homogeneous, relatively low signal intensity on T1-weighted MR images. On T2-weighted images, fibromas appear as well-circumscribed masses with low signal intensity containing scattered high-signal-intensity areas representing edema or cystic degeneration (Fig 8c, 8d) (113,118). This low signal intensity
Figure 9. Cystadenofibroma with borderline features in a 69-year-old woman. (a) T1-weighted MR image (500/16) shows a large mass containing slightly hyperintense cyst fluid. (b) T2-weighted fast spin-echo MR image (6,000/108) shows papillary projections (arrowheads) consisting of a low-signal-intensity fibrous core and barely visible edematous stroma. A prominent fibrous component with very low signal intensity is seen in the wall (arrow). (c) Fat-suppressed T1-weighted gradient-echo MR image (365/3.2) obtained after the administration of gadopentetate dimeglumine demonstrates marked enhancement of the papillary projections (arrowheads) but less enhancement of the fibrous component (arrow).
results from the abundant collagen content of these tumors and is relatively diagnostic for fibroma (113,118).

The fibrotic component of fibrothecoma, cystadenofibroma, and leiomyoma appears as an area of low signal intensity on T2-weighted images, a finding that is similar to that seen in fibromas (Fig 9) (113,118,163,164). The imaging appearance of thecomas without prominent fibrosis is similar to that of malignant tumors (113,165,166). The prominent lipid component of thecomas could theoretically be depicted at chemical-shift MR imaging, which similarly helps detect lipid in adrenal adenomas and clear cell carcinomas of the kidney. Cystadenofibromas usually appear as multilocular cystic masses with a solid fibrotic component (118). These tumors are less likely to be borderline or malignant compared with other serous or mucinous tumors.

Pedunculated uterine leiomyomas and broad ligament leiomyomas frequently appear as adnexal or ovarian masses at US. These tumors typically demonstrate very low signal intensity on T2-weighted MR images (163,164). Absence of a normal ipsilateral ovary helps distinguish fibromas from pedunculated leiomyomas. The presence of small follicles surrounding the mass helps identify the ovarian origin of fibromas (Fig 8) (101,108).

Epithelial Neoplasms

Epithelial ovarian neoplasms represent 60% of all ovarian neoplasms and 85% of malignant ovarian neoplasms. The two most common types of epithelial neoplasms are serous and mucinous tumors, although clear cell, endometrioid, Brenner, and undifferentiated tumors also fit into this category. All epithelial ovarian neoplasms can be classified as benign, borderline (ie, having a low potential for malignancy), or malignant (carcinomas) on the basis of their histologic characteristics and clinical behavior (167, 168).

Benign forms of serous and mucinous tumor are common, but benign forms of endometrioid and clear carcinoma are rare. Features that are more suggestive of benign cystic neoplasm include unilocularity of cysts, thin walls, minimal septations, and absence of papillary projections. Borderline tumors show more proliferation (papillary projections) than cystadenomas and may metastasize throughout the peritoneum but are not true malignancies (Figs 9, 10). They are often seen in younger patients. The most important histologic feature that helps differentiate borderline tumors from carcinomas is the absence of stromal invasion (167,169). Although borderline tumors have been reported in all the epithelial ovarian tumor subtypes, most are serous or mucinous type tumors (167). Borderline tumors have better prognoses than higher-grade malignancies. The reported 5-year survival rate for women with borderline malignancies varies from 94% to slightly less than 90% (170).

Epithelial neoplasms are typically primarily cystic, may be either unilocular or multilocular, and in malignant varieties are associated with varying proportions of a solid component (6, 56,100). In general, the cell type (eg, serous, mucinous) cannot be determined on the basis of appearance at MR imaging, CT, or US. Profuse
Borderline papillary serous tumor in a 48-year-old woman with an elevated serum CA-125 level. (a) Longitudinal US image of the right adnexa shows a cystic mass (cursors) containing a mural excrescence (arrow). (b) Doppler US image of the cyst wall shows a high-resistance waveform with a pulsatility index of 1.73, a finding that is suggestive of a benign mass. (c) Fat-saturated T1-weighted gradient-echo MR image (160/3.3 [effective]) shows excrescences (arrow) as fronds that have lower signal intensity than the cyst fluid. (d) T2-weighted MR image (4,000/126 [effective]) shows papillary projections (thick arrow) with a low-signal-intensity core (thin arrow). (e) Photomicrograph (original magnification, ×40; hematoxylin-eosin stain) shows the papillary projections with a low-signal-intensity core (Cr) and edematous papillae (P).
Figure 11. Papillary serous carcinoma in a 41-year-old woman. (a) Sagittal T2-weighted MR image (5,833/126) shows a right ovarian mass with irregular solid components (arrow) and florid intracystic papillary projections (arrowheads). Ascites is also present (A), with implants in the cul-de-sac. (b) Sagittal fat-suppressed T1-weighted gradient-echo MR image (310/2.9) obtained after the administration of gadopentetate dimeglumine shows enhancement of the papillary projections (arrowheads) and solid components (thick arrow) as well as implants (thin arrow).

Table 3
Correlation between Macroscopic Appearance and Histologic Findings in the Cyst Wall of Lesions Determined to be Ovarian Neoplasms at Pathologic Analysis

<table>
<thead>
<tr>
<th>Macroscopic Appearance</th>
<th>Histologic Findings</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Benign</td>
<td>Borderline</td>
</tr>
<tr>
<td>Thin wall</td>
<td>234</td>
<td>2</td>
</tr>
<tr>
<td>Thick wall</td>
<td>46</td>
<td>3</td>
</tr>
<tr>
<td>Papillary projections</td>
<td>71</td>
<td>8</td>
</tr>
</tbody>
</table>

Source.—Reference 172.
Note.—Numbers indicate number of lesions.

papillary projections, which are often more clearly seen after contrast material enhancement, are highly suggestive of borderline or malignant tumors (Figs 9, 11) (17,123,131,168,171). Pathologic and MR imaging studies have suggested that large papillary projections with no solid component indicate a borderline or malignant tumor (Table 3) (131,168,172). Granberg et al (172,173) found papillary projections in 20%, 62%, and 92% of benign, borderline, and malignant cystic masses, respectively at pathologic examination (Table 3). In one CT and MR imaging study, papillary projections were found in 9% of benign neoplasms, 67% of borderline neoplasms, and 38% of malignant neoplasms (56). Benign epithelial tumors demonstrate smaller, less numerous papillary projections than borderline or malignant masses (168). Thick walls and septations are less reliable signs of malignancy because they are frequently seen in endometriomas,
Figure 12. Poorly differentiated papillary serous ovarian carcinoma in a 67-year-old woman. (a) Longitudinal endovaginal US image through the right adnexa shows a heterogeneous, moderately echogenic solid mass (m) that is not clearly distinguishable from the uterus (u). (b) Axial T2-weighted fast spin-echo MR image shows the mass (M) as distinct from the uterus (black arrow). The mass invades posteriorly into the perirectal fat and anterior rectal wall (white arrow), a finding that was confirmed at surgery.

Figure 13. Stage IIIc papillary ovarian carcinoma in a 46-year-old woman. Contrast-enhanced CT scans obtained at the level of the Morison pouch (a) and in the pelvis (b) show calcified implants in the Morison pouch, along the spleen, and along both pelvic sidewalls (arrowheads). Note that the calcified implants have an attenuation similar to that of the oral contrast material in the small bowel and could be mistaken for bowel.
Figure 14. Borderline mucinous ovarian tumor in a 59-year-old woman. (a) Axial T1-weighted spin-echo MR image (400/10) shows a large, multiloculated ovarian tumor (t) with variable signal intensities among the loculi. (b) Sagittal T2-weighted fast spin-echo MR image (4,200/85 [effective]) shows the tumor (t) with predominantly high signal intensity similar to that of urine in the bladder (b).

Abscess complexes, peritoneal cysts, and benign neoplasms such as cystadenofibromas and mucinous cystadenomas (102,108). Solid, nonfatty, nonfibrous tissue is the most powerful predictor of malignancy (Fig 12). Ancillary findings of pelvic organ invasion, implants (peritoneal, omental, mesenteric), ascites, and adenopathy are signs that increase diagnostic confidence for malignancy.

Serous tumors are the most common neoplasms in both the benign and malignant category. Because these masses are primarily cystic, the terms serous cystadenoma and serous cystadenocarcinoma are used to describe them. Cystadenomas are usually unilocular, whereas malignancies demonstrate solid components and multilocularity (6,51,168). The signal intensity of the cyst contents of these tumors is variable but is usually low to intermediate on T1-weighted MR images and high on T2-weighted images. At CT, diffuse psammomatous calcifications may cause these tumors or their implants to have very high attenuation (Fig 13) (174).

Mucinous ovarian tumors are less common than serous neoplasms. They represent 20% of all ovarian tumors and approximately 10% of all malignant ovarian tumors (6). Mucinous ovarian tumors are generally cystic but unlike serous tumors may be very large and tend to be multiloculated (Fig 14) (51). They often have variable signal intensity in the loculi owing to proteinaceous or mucinous contents and hemorrhage. Pseudomyxoma peritonei represents implants of mucinous appendiceal or ovarian tumor contents on the peritoneal surfaces and is most commonly seen with borderline or well-differentiated carcinoma (125,175). The MR imaging appearance of pseudomyxoma is similar to that of mucin-containing peritoneal cyst. The signal intensity of mucin on T1-weighted images varies depending on the degree of mucin concentration. On T1-weighted images, loculi with watery mucin have a lower signal intensity than loculi with thicker mucin. On T2-weighted images, the corresponding signal intensities are flipped, so that loculi with watery mucin have high signal intensity and loculi with thicker mucin appear slightly hypointense.
Conclusions

Despite the development of effective surgical and chemotherapeutic approaches, ovarian carcinoma remains a leading cause of death from gynecologic malignancy. The treatment of patients with ovarian masses requires initial stratification of risk based on the imaging appearance of the mass, clinical presentation and findings, and serum CA-125 level. Laparoscopic management of masses is largely restricted to those having a benign imaging appearance. Recommendations based on the US imaging appearance include no further evaluation (eg, simple cysts), follow-up US (eg, hemorrhagic cyst), MR imaging or laparoscopy (eg, suspected endometrioma, mature cystic teratoma, fibroma, leiomyoma), or staging laparotomy (eg, cystic and solid masses). Morphologic analysis at US focuses on the presence of solid tissue, thick septations, ascites, fatty tissue, and papillary projections. Factors such as larger size, small amounts of free fluid, bilaterality, and multifocality are of lesser importance and are commonly seen in benign processes.

Masses such as mature cystic teratomas, cysts, endometriomas, leiomyomas, and fibromas can be accurately diagnosed on the basis of findings at T1-weighted, T2-weighted, and fat-saturated T1-weighted MR imaging. Gadolinium-enhanced fat-saturated T1-weighted MR imaging of the entire abdomen is recommended to assess for peritoneal implants and to confirm the presence of solid components in the tumor. Endometriomas commonly demonstrate low signal intensity on T2-weighted images as well as implants and multiplicity. Fibrotic lesions such as leiomyomas, fibromas, and cystadenofibromas also demonstrate low signal intensity on T2-weighted images.

CT, US, and MR imaging all have a similar accuracy in staging ovarian carcinoma. CT is used to assess the extent of disease in patients before and after primary cytoreductive surgery but has a high false-negative rate for identifying residual disease after chemotherapy.

References


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