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Imaging features of complex solid and multicystic ovarian lesions: proposed algorithm for differential diagnosis

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ABSTRACT

Complex solid and multicystic ovarian lesions are broad-spectrum diseases, ranging from benign to malignant. This article describes the broad-spectrum and imaging features of complex solid and multicystic ovarian lesions and illustrates an algorithmic approach to such lesions, focusing on the ultrasonography and magnetic resonance imaging features that allow one to hone the differential diagnosis. Multimodality imaging workup plays an important role in the characterization and differential diagnosis of these diseases. Also, knowledge of the clinical setting and imaging features for the spectrum of complex solid and multicystic ovarian lesions can lead to appropriate management.

Imaging features of ovarian masses vary from cystic to solid in appearance. Purely cystic masses are usually considered to be benign. In general, the possibility of malignancy increases as the percentage of solid components increases. Predicting the nature of an ovarian mass is important for choosing an appropriate treatment as well as clinically relevant information [1]. To be able to offer women with ovarian masses optimal treatment, one needs to know whether the mass is likely to be benign or malignant. If surgery is required, the method of surgery will depend on the benign or malignant nature of the mass [2]. Most benign cysts can be treated with minimally invasive surgery in a general gynecology unit [3], whereas patients with a malignant tumor need to undergo extensive staging procedures and laparotomy in a specialized unit [4].

Ultrasonography (US) is the most common primary imaging modality of choice for ovarian masses, which can evaluate presence of the lesion, determinate its origin, and characterize internal structure and related abnormalities. Transabdominal US, transvaginal US, or both should be performed [5]. While transabdominal US is good for evaluation of large masses and additionally looking for secondary changes like peritoneal involvement, ascites, and hydronephrosis, the large mass itself poses significant difficulty in determining its origin. Transvaginal US provides better detail than transabdominal US and can detect very small lesions [5]. Doppler US helps characterization of ovarian masses by providing information regarding vascular compliance, vessel density, and distribution of vessels within the mass [6]. Findings on Doppler US which have been associated with malignancy include very strong intratumoral blood flow, vascular flow in the center of mass ("central flow"), blood flow within septations and excrescences, and a complex appearance of the vascular architecture. Tumor neovascularity in malignancy has vessels that lack muscular layers and typically have low resistance flow patterns with high diastolic flow relative to systolic flow. Initial pulsed or spectral Doppler studies showed high sensitivity and specificity for detection of ovarian malignancy, but subsequent studies have shown considerable overlap between benign and malignant masses [6].

Computed tomography (CT) has a limited role in characterization of the ovarian lesions. However, it is the imaging modality of choice in patient with ovarian malignancies to allow the comprehensive evaluation of all potential sites of peritoneal implants or lymphadenopathy as well as primary tumor sites [5,6].

Identification and tissue characterization based on magnetic resonance (MR) imaging properties improve the diagnostic accuracy. It can be a valuable problem-solving tool for indeterminate ovarian masses to characterize, with special functional sequences such as diffusion- and perfusion-weighted images as well as conventional T1- and T2-weighted sequences [5,7].

One of the best methods for discriminating between benign and malignant ovarian masses is the subjective assessment (i.e., a subjective evaluation of gray-scale and Doppler US findings by an experienced examiner; also called the pattern recognition approach) [2,8–10]. With the use of this method, high sensitivity (88-100%) and specificity (62-

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98%) have been reported in determining malignant adnexal masses [1,2,8]. There are five categories in the pattern recognition approach (Table 1): unilocular cystic, unilocular solid, multilocular cystic, multilocular solid, and solid [11,12]. The assessment of solid component in the mass is important to discriminate between benign and malignant masses; malignant lesions are well represented (52.5%–62%) in the unilocular solid, multilocular solid, and solid categories [11]. However, some ovarian lesions have characteristic complex solid and multicystic appearances, so-called "sponge-like or spongiform appearance," which are classified into the multilocular solid and solid categories [12].

1. Malignant lesions

1.1. Serous and mucinous carcinoma

Serous and mucinous tumors are the two most common subtypes of epithelial tumors which are the most common histopathologic type of ovarian tumors. They are primarily cystic, and if malignant, are associated with solid tissue or components [5].

Serous tumor is the most common epithelial tumor, and serous cystadenocarcinomas account for 40% to 50% of all malignant ovarian neoplasms [5,13]. Serous tumors are mainly cystic and usually are unilocular or bilocular. Sometimes, serous cystadenocarcinomas may present as solid mass and manifest complex solid and multicystic appearance as well.

Mucinous tumors are the second most common epithelial tumors, and mucinous cystadenocarcinomas account for 5% to 10% of all malignant ovarian neoplasms [14]. Mucinous tumors tend to be larger than serous tumors at presentation. Mucinous tumors are also mainly cystic, but unlike serous tumors they tend to be multiloculated [5]. Loculi are often small, arranged back-to-back, and variable in number [15].

Features suggestive of a malignancy are usually multilocular with a high proportion of solid tissue and are frequently associated with ascites as well as metastatic disease to the peritoneum, omentum, and elsewhere in the abdomen and pelvis. Serous and mucinous carcinomas are also significantly vascular with high color scores [16].

1.2. Endometrioid carcinoma

Endometrioid carcinomas are a subgroup of the primary epithelial ovarian tumors and represent approximately 10%–15% of ovarian cancers [13]. About 15%–30% are associated with synchronous endometrial carcinoma or endometrial hyperplasia [13,17]. Bilateral involvement is seen in 30%–50% of cases [17]. Although rare, endometrial carcinomas may develop in patients with endometriosis. Endometriomas larger than 10 cm, enlarging rapidly, and with solid or solid-cystic areas or papillary outgrowths on their surfaces are to be considered malignant [18]. The most common malignant tumor arising from endometriosis is endometrioid carcinoma, followed by clear cell carcinoma and carcinosarcoma [5,18].

MR imaging revealed two types: a solid type and a cystic type. The cystic type includes unilocular cyst with a monomural nodule, unilocular cyst with multimural nodules, and multilocular cyst with multimural nodules. The lesions arising from endometrioma tended to be of the cystic type and have a good prognosis [19]. Endometrial thickening can also be seen on imaging studies [13].

Table 1
Five categories in the pattern recognition approach of US

Category	Characteristics and Including diseases
Unilocular cystic	Cyst without septa and without solid parts or papillary structures Follicular cyst, serous cystadenoma, borderline malignancy
Unilocular solid	Unilocular cyst with a measurable solid component or at least one papillary structure Serous cystadenocarcinoma, endometrioid carcinoma, clear cell carcinoma, borderline malignancy, cystadenofibroma
Multilocular cystic	Cyst with at least one septum but no measurable solid components or papillary projections Mucinous cystadenoma, theca lutein cyst, tuboovarian abscess, polycystic ovarian disease, ovarian hyperstimulation syndrome, borderline malignancy
Multilocular solid	Multilocular cyst with a measurable solid component or at least one papillary structure Mucinous cystadenocarcinoma, endometrioid carcinoma, clear cell carcinoma, borderline malignancy, cystadenofibroma, struma ovarii, granulosa cell tumor
Solid	Solid components comprise 80% or more Fibrothecoma, granulosa cell tumor, sclerosing stromal tumor, Brenner tumor, serous cystadenocarcinoma, dysgerminoma, metastasis, lymphoma

1.3. Clear cell carcinoma

Clear cell carcinomas are a subgroup of the primary epithelial ovarian tumors and represent approximately 5% of ovarian cancers [13]. They are always malignant, but the prognosis appears to be better than with other ovarian cancers. The majority (75%) of patients presents with stage I, which has a 5-year survival rate of 80%–90% [20,21]. Clear cell carcinomas may develop in patients with endometriosis [5].

Typical imaging findings commonly include a unilocular or large cyst with solid protrusions, but are often revealed to be of a multilocular or multicystic type (Fig. 1) [20,22]. On CT, the attenuation of cystic portion could be high (mean 24 HU) due to hemorrhage or necrosis [22]. The margin of the cyst is almost always smooth, and its signal intensity is variable on T1-weighted images and high on T2-weighted images. The solid protrusions are often round and few in number. On T2-weighted images, solid components typically have intermediate to high signal intensities and are enhanced with contrast administration. Multilocular and multicystic types (Fig. 1) also have mural nodules projected over the outer surface of the cysts and have a similar signal intensity to cysts [20].

1.4. Dysgerminoma

Dysgerminomas are the most common malignant germ cell tumors and account for 3%–5% of all ovarian malignancies [13]. They have predilection for children, adolescents, and young women under 30 years old [23].

Imaging features of dysgerminomas show a multilobulated solid mass with septations. The internal blood flow on US correlates with prominent fibrovascular septa that are hypointense on T2-weighted images but show marked enhancement on contrast-enhanced T1-weighted images (Fig. 2) [13,23,24]. Calcification can be present in a speckled pattern. Anechoic or low signal intensity without an enhancement area represents necrosis and hemorrhage. The tumor becomes a mixed pattern of solid and cystic mass due to marked necrosis and can be completely cystic on rare occasions [23].

1.5. Granulosa cell tumor

Granulosa cell tumors are the most common malignant sex cord–stromal ovarian tumor and estrogen-secreting tumor, although they account for less than 5% of all ovarian malignancies [13,25]. Two subtypes are distinguished by histopathologic findings: adult type and juvenile type [25].

Adult granulosa cell tumors are more common than the juvenile type, accounting for 95% of all granulosa cell tumors and 5%–10% of solid ovarian tumors. They usually occur in peri- and postmenopausal women, with peak prevalence in 50–55-year-olds. Clinical manifestations are associated with an estrogenic effect and present as irregular bleeding, endometrial hyperplasia, polyps, or carcinoma (3%–25%