**Radiographic Evaluation of Ovarian Tumors**

Ovarian tumors are the leading cause of cancer-related deaths in gynecological malignancies. Additionally, they are the fourth leading cause of death related to cancer. Ovarian tumors can be epithelial, germ cell, sex cord-stromal or metastatic. Germ cell tumors are the most common type of ovarian tumors in children. Young adults with ovarian tumors can have an epithelial, germ cell or a stromal tumor with equal probability. Middle-aged women and the elderly who develop ovarian tumors usually have epithelial ovarian cancer.

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**Introduction**

Ovarian tumors are the leading cause of cancer-related deaths in gynecological malignancies. Additionally, they are the fourth leading cause of death related to cancer. They can be grouped into:

**Benign tumors that can either be:**

1. Cystic enlargements/ functional ovarian cysts.
2. Ovarian cysts/adenomas which include:
   - Epithelial cysts such as serous, mucinous, and endodermal cysts.
- Benign tumors from germ cells such as teratomas and dermoid cysts.
- Benign tumors of sex cord stromal origins such as thecomas and fibromas.

Malignant tumors that are either:

Primary ovarian tumors. These include:

- Epithelial cell tumors such as serous, mucinous, clear cell and transitional cell carcinomas.
- Germ cell tumors such as teratomas, dysgerminomas, endodermal sinus tumor, and embryonal cell carcinomas.
- Sex cord stromal tumors such as thecomas, fibroma and, granulosa cell tumors.

Metastatic tumors:

- They can arise from the endometrium, breast, colon, and cervix.

Germ cell tumors are the most common type of ovarian tumors in children. Young adults with ovarian tumors can have either a germ cell tumor or a sex cord stromal tumor. Middle-aged women and the elderly who develop ovarian tumors usually have epithelial ovarian cancer.

The presentation of ovarian tumors is one characterized by vague symptomatology of abdominal pain or masses and has a protracted clinical course; thus, imaging studies in patients suspected to have ovarian tumors is needed for the initial visualization of the tumor. The imaging method of choice is ultrasonography that is used to determine the risk of malignancy index together with CA 125 levels and postmenopausal status of the patient. A high risk of malignancy index is suspicious for a malignant tumor and indicates a laparotomy for staging, while surgery is still needed as a definitive treatment for benign tumors.

Staging of ovarian cancer is mainly surgical (FIGO system) but computed tomography or magnetic resonance imaging may be done for additional information, or if the TNM staging system is used.

The following table summarizes the main ultrasonographical findings one can use for ovarian tumor staging as per the FIGO system:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ultrasonography Finding</th>
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<tbody>
<tr>
<td>I</td>
<td>Tumor growth is limited to the ovaries.</td>
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<tr>
<td>Ia</td>
<td>Tumor is confined to one ovary.</td>
</tr>
<tr>
<td>Ib</td>
<td>Tumor is bilateral.</td>
</tr>
<tr>
<td>Ic</td>
<td>Ia or Ib but with rupture of the ovarian capsule, or with the presence of a tumor on the ovarian surface.</td>
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<tr>
<td>II</td>
<td>Ovarian tumor with pelvic extension.</td>
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<tr>
<td>Ila</td>
<td>Involvement of the uterus or fallopian tubes.</td>
</tr>
<tr>
<td>Iib</td>
<td>Involvement of other pelvic structures rather than the uterus or fallopian tubes.</td>
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<tr>
<td>Iic</td>
<td>Ila or Iib with ovarian capsule rupture, or tumor on ovarian surface plus malignant ascites.</td>
</tr>
<tr>
<td>III</td>
<td>Unilateral or bilateral ovarian tumor with peritoneal implants, positive retroperitoneal or inguinal lymph nodes, or involvement of the small bowel or omentum.</td>
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### IIIa
Involvement of the small bowel or mesentery is microscopic.

### IIIb
Metastasis to abdominal peritoneal surfaces with lesions smaller than 2 cm.

### IIIc
Extrapelvic metastasis that is larger than 2 cm in diameter.

### IV
Ovarian tumor with distant metastasis, i.e. for example to the lungs.

## Functional Ovarian Cysts

The **most common ovarian mass in women of reproductive age is a functional ovarian cyst**. Follicular cysts that arise from the failure of follicle rupture or regression or from corpus luteum cysts are possible examples of functional ovarian cysts. Functional cysts can be simple, thin-walled and less than 3 cm in diameter or larger more complex cells. A functional cyst that is more than 1 cm in diameter is most likely a corpus luteum cyst.

**On ultrasonography, a functional ovarian cyst usually has the following characteristics:**

- Thin-walled
- Smooth walls
- Anechoic

Posterior acoustic enhancement is usually seen. **Larger cysts with reticular echoes might represent hemorrhage** within a corpus luteum cyst. Such larger and complex cysts should have a follow-up imaging study with magnetic resonance imaging.

On T1-MR images, ovarian cysts show low signal intensity. T2-weighted images typically show very high signal intensity due to the fluid content of the cyst. Magnetic resonance imaging studies usually reveal a thin and featureless wall that enhances the administration of gadolinium. **T2 shortening is not seen with corpus luteum cysts in contrast to endometrial chocolate cysts.**

## Endometriomas

The most common site for **endometriosis is the ovary**. Up to 80% of all cases of endometriosis are found in the ovary. These cysts are known as endometriomas and are usually small. Large endometriomas have been previously described and can reach a diameter of 15 to 20 cm. Endometriomas might have thin, thick or irregular walls.

On ultrasonography, endometriomas typically appear as a cystic mass with low-level echoes. Cysts that show diffuse low-level internal echoes, multilocularity, and hyperechoic wall foci are most likely endometriomas. **Computed tomography scans should not be performed in a patient suspected to have an endometrioma because of the high risk of false-positive malignant diagnosis.**

**Magnetic resonance imaging studies are very useful in the evaluation of the complex endometriomas.** T1-weighted images typically show high signal intensity inside the cyst. The inside of the cyst usually has a low signal intensity on T2-weighted images. The endometriomas’ wall might be of low signal intensity.

## Mature Cystic Teratomas

These tumors arise from ovarian germ cells and are more common in children and
adolescents. They are usually asymptomatic and are discovered incidentally during pelvic physical examinations for other indications. Ectodermal components are more common within these teratomas; hence, the term “dermoid cysts” is occasionally used to describe them.

On ultrasonography, mature cystic teratomas typically show shadowing echogenicity, diffuse echogenicity, hyperechoic lines and dots, and a fluid level within the cyst. In contrast to the previous two cystic ovarian lesions, mature cystic teratomas can be readily confirmed by a computed tomography scan. Computed tomography scans typically show fat and dense calcifications within the teratomas.

Magnetic resonance imaging studies are also useful in the evaluation of a mature cystic teratoma. The fluid part of the teratoma typically has high signal intensity on T1-weighted images and intermediate signal intensity on T2-weighted images. Palm tree-like protrusions and dermoid nipples are common findings on magnetic resonance imaging studies of mature cystic teratomas.

Fibrotic Tumors

Fibromas, thecomas, and fibrothecomas are the most common examples of fibrotic tumors of the ovaries. These tumors are more common in middle-aged women. They are commonly associated with ascites or pleural effusions; however, they are considered as benign ovarian tumors. These tumors arise from the stromal part of the ovaries and do not have any epithelial components.

Ultrasound features of fibrotic tumors include solid masses with hypoechoic nature. The sound attenuation is very strong. Hyperechoic masses can also be seen in fibrotic tumors. Computed tomography scans are useful in the evaluation of solid masses of the ovaries including fibrotic tumors. The fibromas typically are hypoattenuating masses on computed tomography scans with very slow enhancement after contrast administration.

Magnetic resonance imaging studies reveal homogenous low signal intensity masses on T1-weighted images. T2-weighted images of these masses show a well-circumscribed mass again with low signal intensity. Scattered areas of high signal intensity on T2-weighted images can be seen in fibromas and they represent areas of edema or cystic degeneration.

Epithelial Ovarian Tumors

Epithelial ovarian tumors are the most common type of malignant ovarian tumors in women. They include:

- Serous tumors
- Mucinous tumors
- Clear cell tumors
- Endometrioid tumors
- Undifferentiated tumors

Epithelial tumors can be benign, borderline, or malignant. This classification is based on a histological examination, rather than imaging studies. Unilocular thin-walled cysts that do not have papillary projections are more likely to be benign.

Ultrasoundographic features that suggest malignancy include:
- Bilateral tumor
- Multinodular tumor/presence of papillary projections
- Solid areas within the tumor
- Presence of ascites
- Abdominal involvement

The most important radiographic finding suggestive of malignancy is the presence of papillary projections. These papillary projections are better visualized with magnetic resonance imaging studies. The presence of a thin, smooth regular wall makes the possibility of a malignant ovarian cyst very unlikely.

**Magnetic resonance imaging studies and computed tomography scans usually reveal:**

- Heterogenicity
- Faster contrast enhancement
- Calcification on computed tomography
- Multilocular cysts

References

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