REVIEW

CME CREDIT

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Which ovarian masses need intervention?

ABSTRACT

Ovarian cancer is deadly if not detected early, but it is only one of many causes of pelvic masses, which are common. The physician's job is to determine if a mass is likely to be malignant and needing surgical evaluation. The best predictors of malignancy are a combination of factors that include the patient's age, family history, menopausal status, symptoms, findings on physical examination and imaging studies, and blood level of the cancer biomarker CA125.

KEY POINTS

One should try to determine the origin of a pelvic mass, ie, whether it is in the uterus, fallopian tube, or ovary.

Ovarian masses are more likely to be malignant in older, postmenopausal women, and in those with a family history of breast or ovarian cancer.

Malignant masses tend to be large, firm, irregular in shape, and fixed. Some are bilateral.

Transvaginal two-dimensional ultrasonography is the most widely used imaging study. Computed tomography and magnetic resonance imaging may help if results are inconclusive.

Although CA125 is not completely reliable in detecting ovarian cancer, it is still the most useful biomarker.

MOST PELVIC MASSES are benign, but the consequences of not detecting ovarian cancer early are dire. When a primary care physician encounters a pelvic mass, the challenge is to determine if it needs further evaluation (and by whom—the primary care physician or a specialist?) or whether it can simply be observed.

Pelvic masses are common in women of all ages, although their exact prevalence is uncertain, as most masses are never diagnosed, much less surgically treated.

This article classifies pelvic masses by their origin, provides characteristics of benign and malignant masses, and offers guidelines for management.

FIRST, IDENTIFY THE ORIGIN OF THE MASS

The first step in evaluating a pelvic mass is to identify its origin.

Uterus

Benign uterine fibroids (leiomyomas) are found in at least 20% of women of reproductive age. Many women with uterine fibroids present with menorrhagia (heavy, long menstrual periods) and pelvic pressure or pain. However, fibroids often cause no symptoms and are found incidentally on physical examination or imaging.

Fibroids can arise in various locations. They may occur within the uterus or be attached to the serosa, where they may be mistaken for an adnexal mass.

Fallopian tubes

Hydrosalpinx (fallopian tubes that are dilated from a previous infection or adhesions) can

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give rise to a pelvic mass. Paratubal cysts are common. Ectopic pregnancies are fairly common and can be life-threatening.[1] A mass associated with bowel and bowel adhesions can also be mistaken for an adnexal mass.

Ovaries

Most pelvic masses are in the ovaries. Ovarian cysts are common in both premenopausal and postmenopausal women; two thirds of ovarian masses arise during the reproductive years.

About 6% to 7% of women are estimated to have adnexal masses that cause no symptoms.[2–4] Most masses produce either no symptoms or only mild ones such as abdominal distention, pain, or pressure, or other gastrointestinal or urinary symptoms.

BENIGN OR MALIGNANT?

Most ovarian masses (80% to 85%) are benign. Factors that help predict whether a mass is benign or malignant include:

Patient age—the most important predictor of whether a mass is likely to be malignant or benign. More than one third of cases of ovarian cancer occur in women older than 65 years; in a woman younger than 45 years, the chance of an ovarian mass being a primary malignancy is only 1 in 15.

6% to 7% of women have asymptomatic adnexal masses

Family history. Women who have one first-degree relative with epithelial ovarian cancer are more than three times as likely to develop ovarian cancer compared with women at average risk.[5]

Characteristics of the mass. Most benign masses are unilateral, cystic, mobile, and smooth. Malignant masses are usually solid, fixed, and irregular. Bilateral masses are more likely to be malignant. Malignant masses grow rapidly and may be accompanied by ascites and cul-de-sac nodularity.

MOST OVARIAN MASSES ARE BENIGN

Functional ovarian cysts

The most common benign ovarian masses are functional ovarian cysts: they usually cause no symptoms and are often found incidentally on physical examination or imaging studies.[6–8]

Follicular cysts are the most common type of functional ovarian cyst. They are classified as a cyst if larger than 3 cm, and they rarely grow larger than 8 cm. Follicular cysts can rupture, causing bleeding or pain. Most resolve spontaneously after 4 to 8 weeks.

Corpus luteum cysts can also rupture and bleed, usually between days 20 and 26 of a 28-day menstrual cycle.

Theca lutein cysts are the least common. They occur with pregnancy, may be large and multicystic, and regress spontaneously.

Other benign ovarian masses

There are other types of ovarian masses that are usually benign:

Endometriomas are often as large as 6 cm to 8 cm.

Polycystic ovaries are found in up to 22% of women.

Fibromas.

Benign cystic teratomas (dermoid cysts) are the most common ovarian neoplasm in women younger than 40 years. They are rarely malignant.

MASSES THAT MAY BE MALIGNANT

Epithelial ovarian tumors are more common in older women. Serous epithelial ovarian tumors are often multilocular and sometimes have papillary components. About one in four are malignant, and another 10% have borderline malignant characteristics. Mucinous epithelial ovarian tumors are often lobulated, smooth, and multilocular. About 10% are bilateral on presentation, and up to 10% are malignant. Less common epithelial ovarian tumors include clear cell, Brenner, and mixed forms.

The lifetime incidence of ovarian carcinoma has increased from 1.4% to 1.8% in recent years in the United States. In 2006, an estimated 20,180 women were newly diagnosed with ovarian carcinoma and another 15,310 died of it.[9]

Ovarian cancer has a poor prognosis because 70% to 75% of cases are diagnosed at a late stage. If the disease is caught while in stage 1, it has a 90% to 95% cure rate.[10,11]

EVALUATION OF A PELVIC MASS

The initial workup for a pelvic mass includes a thorough history, physical examination, and

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laboratory tests: beta human chorionic gonadotropin level, Papanicolaou test, cervical and vaginal cultures, and a complete blood count. Further laboratory testing and imaging studies may be needed to identify the origin of the mass and to help determine whether it is likely to be benign or malignant.

Physical examination

Physical examination can help ascertain a pelvic mass's location, consistency, and contour, and whether ascites and upper abdominal masses are present, providing important clues to whether it is likely to be malignant (TABLE 1).[12] However, pregnancy or patient discomfort can limit an examiner's ability to perform an adequate physical examination. Endometriosis, pelvic inflammatory disease, bladder distention, or stool in the rectum frequently causes false-positive results.[13,14]

Padilla et al[14] asked gynecologists, gynecology residents, and medical students to examine 140 patients who were under general anesthesia for surgery. (The examiners were not told why the patients were undergoing surgery.) Physical examination was only 15% to 36% sensitive in detecting adnexal masses.

Balbi et al[15] evaluated 92 patients with an ovarian mass by physical examination, serum CA125 assay, serum CA72.4 assay, and either transvaginal ultrasonography or transabdominal ultrasonography with Doppler and color flow. Physical examination was the most sensitive method (90%) and serum CA72.4 assay was the most specific (88%). The specificity was 100% and the sensitivity was 40% when all four methods were positive.

Ultrasound imaging

Although rapid advances have been made in diagnostic imaging, including the development of three-dimensional transvaginal gray-scale volume and power Doppler imaging, the evaluation of adnexal masses is still a challenge. Imaging studies rely on pattern recognition, scoring systems, and mathematical models for helping to make a diagnosis (TABLE 1).[16–21]

B-mode ultrasonography is often used to evaluate adnexal masses.

Color Doppler ultrasonography has been used since the 1990s. Its spectral display reflects flow toward and away from a transducer and is angle-dependent. Results are calculated based on measures of downstream vascular resistance, such as impedance (eg, resistive index and pulsatility index) and velocity (eg, timed average maximum velocity). Lower values are believed to correlate with tumor neovascularization.

Noor et al[22] studied 97 women, most of whom were premenopausal, who presented with gynecologic symptoms and were found to have a pelvic mass, in most cases of uterine origin. Transabdominal ultrasonography had an 87.6% accuracy rate in diagnosing the mass, with only 3.1% false positives and 9.3% false negatives.

Guerriero et al[23] compared gray scale sonography to color Doppler imaging to preoperatively evaluate 826 pelvic masses in patients at three institutions. For diagnosing malignancy, color Doppler was 82% accurate and 94% specific; gray-scale sonography was only 65% accurate and 84% specific. Sensitivity was similar by color Doppler and gray-scale sonography (95% vs 99%, respec-

TABLE 1

Clues that suggest malignancy in a patient with a pelvic mass

From the history
- Abdominal pain or bloating
- Abnormal vaginal bleeding or discharge
- Change in caliber of stool
- Constipation
- Decreased appetite
- Family history of breast or ovarian cancer
- Frequent urination
- Increased abdominal girth
- Nausea or vomiting
- Significant weight change

From the physical examination
- Ascites or upper abdominal mass
- Mass that is large, firm, irregular, or fixed
- Nodularity on rectal examination

On ultrasonography
- Ascites
- Blood flow to solid components
- Ovarian cyst larger than 5 cm
- Septa, papillae (internal excrescences), or solid components within the ovary

Up to 3/4 of cases of ovarian cancer are diagnosed at a late stage

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A young woman with chronic pelvic pain and a small ovarian cyst

A 24-year-old woman presents to the clinic reporting chronic pelvic pain on her left side. The pain is worse during menses but is always present to some degree. She reports no urinary symptoms or abnormal vaginal bleeding or discharge, and has no history of significant illness or surgery.

She had a full-term, uncomplicated vaginal delivery 2 years ago with the birth of one child. She is sexually active and complains of moderate pain with deep penetration only. She relies on condoms for birth control and takes no medications.

Physical and pelvic examinations are normal.

Ultrasonography reveals a normal-sized uterus without masses. The left ovary is normal, and a simple cyst measuring 3 cm in diameter is found on the right ovary. There is minimal free fluid in the pelvis. A beta human chorionic gonadotropin test is negative.

Q: What is the next step?

- ❑ Reassure the patient that her findings are normal
- ❑ Start combination oral contraceptive pills
- ❑ Repeat ultrasonography in 4 to 6 weeks
- ❑ Refer for surgical evaluation

DISCUSSION

The patient probably has a physiologic ovarian cyst, which is a common incidental finding and is completely normal in a premenopausal woman. The cyst is unlikely to be the source of her pain. Although many physicians prescribe oral contraceptive pills to prevent the formation of new follicular cysts, studies have shown that they are of only limited benefit.

The patient should be reassured that the cyst is normal and unlikely to be the cause of her pain. Further workup for the cyst is not needed at this time. Other sources of her pain should be considered, such as dysmenorrhea, endometriosis, adhesions, psychological factors, gastrointestinal disorders, and many others. The differential diagnosis for chronic abdominal and pelvic pain is very long.

tively). Evaluation of CA125 plasma concentration did not increase the accuracy of either method.

Czekierdowski[24] reviewed the use of gray-scale criteria and pulsed and semiquantitative color Doppler blood flow assessment to evaluate pelvic masses and found that only the resistive index and subjective color assessment helped to diagnose ovarian tumors preoperatively.

Kurjak et al[25] evaluated 14,317 women with few or no symptoms of ovarian carcinoma using transvaginal color Doppler ultrasonography and found that a resistive index of 0.4 or less was 100% sensitive and 99% specific in detecting ovarian malignancy. Subsequently however, multiple investigators disputed these findings.[26–29] Moreover, Tekay and Jouppila[30] evaluated benign ovarian tumors with transvaginal color Doppler ultrasonography and found that 43% had a resistive index of less than 0.4.

Tekay and Jouppila[31] also evaluated pulsatility and resistance measurements with transvaginal color Doppler ultrasonography and found that a cutoff resistance value of 0.6 was 82% sensitive and 72% specific for detecting malignant and potentially malignant tumors. They concluded that a practical cutoff level for either pulsatility or resistance indices for differentiating between malignant and benign ovarian lesions apparently does not exist.

In 1995, the National Institutes of Health issued a consensus statement noting that although color Doppler ultrasonography may improve the specificity of predicting ovarian cancer, its use should be considered investigational.[32]

Three-dimensional imaging. Initial studies indicate that three-dimensional transvaginal gray-scale volume and power Doppler imaging are better than two-dimensional transvaginal gray-scale imaging for differentiating between benign and malignant adnexal masses.[33–35]

Cohen et al[36] evaluated 71 women who had a known pelvic mass using both two-dimensional and three-dimensional gray-scale

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A postmenopausal woman with sharp flank pain and an ovarian cyst

A 54-year-old woman presents to the office reporting sporadic right flank pain that is sharp and colicky. She reports no vaginal bleeding, discharge, or urinary symptoms. She is sexually active without complaints.

The patient had three pregnancies resulting in three live births, and went through menopause 3 years ago. She has no medical or surgical history but has a family history of ovarian cancer: her maternal grandmother was diagnosed with it at age 68.

Physical examination elicits mild right-sided flank pain and minimal right lower quadrant pain. No masses are palpated on pelvic examination, and the uterus is normal in size and shape.

Urinalysis reveals a small amount of blood but is otherwise normal.

Ultrasonography shows a normal uterus and left ovary. The right ovary contains a 4-cm cyst with a single septum and no papillae or solid components.

Q: What is the next step for managing this patient?

- ❑ Repeat ultrasonography in 4 to 6 weeks
- ❑ Reassure the patient that her findings are insignificant
- ❑ Obtain a blood tumor marker (CA125) level
- ❑ Refer for surgical evaluation

DISCUSSION

This patient most likely has a benign ovarian cyst. However, given her age, family history, the size of the cyst, and the mildly suspicious finding of a single septum on ultrasonography, obtaining a CA125 level is recommended.

If her CA125 level is elevated she should be referred to a gynecologist for surgical exploration. The optimum cutoff value is not defined and probably depends on other factors such as personal and family history; however, a value of 35 U/mL is often used.

If the CA125 level is normal, ultrasonography should be repeated in 4 to 6 weeks. If the cyst is enlarged, a referral should be made. If the cyst is stable, the patient should help decide whether surgical removal or repeat ultrasonography should be the next step.

ultrasonography and found that three-dimensional imaging better defines the morphologic and vascular characteristics of ovarian lesions.

Ultrasonography combined with tumor markers

Piccioni et al[37] reviewed 78 patients with ovarian masses and found that gray scale and color transabdominal and transvaginal ultrasonography was 91% sensitive and 88% specific in detecting malignancy. Tumor markers (CA125, CA19.9, and carcinoembryonic antigen) were 95% sensitive and 71% specific. The use of ultrasonography and tumor markers combined had a sensitivity of 92% and a specificity of 90%.

Guerriero et al[38] used clinical factors, CA125 levels, and color and power Doppler to investigate the role of transvaginal ultrasonography combined with the other factors in differentiating functional cysts and other adenexal masses. They concluded that the addition of a biologic marker and clinical factors to ultrasonography might help to differentiate functional cysts from other adnexal masses.

Schelling et al[39] preoperatively evaluated 63 patients who had adnexal lesions with transvaginal B-mode and Doppler sonography and found that the most important criteria for determining malignancy were solid areas within the mass and vascular flow within the region.

Roman et al[40] preoperatively evaluated 226 women with a pelvic mass using a pelvic examination, tumor marker assessment, and transvaginal ultrasonography with selected use of Doppler ultrasonography. They found that the ultrasonographic impression and tumor size were significant predictors of malignancy in premenopausal women, and that CA125 levels and ultrasonographic impression were significant predictors in postmenopausal women.

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TABLE 2

Efficacy of tumor markers for detecting malignancy

INVESTIGATORS	MARKER AND CUTOFF VALUE	SENSITIVITY	SPECIFICITY	PPV	NPV	ACCURACY
Czekierdowski[24]	CA125 (67.5 U/mL)	59.5%	79.4%	74%	66%	69.4%
	CA19.9 (13.4 U/mL)	97.5%	50.7%	66%	95%	74.1%
	CA72.4 (4.1 U/mL)	85.0%	70.6%	74%	82%	77.8%
	VEGF (731 pg/mL)	32.0%	89.0%	74%	57%	60.5%
Mancuso et al[46]	CA125 (35 U/mL)	100%	78.6%	36.7%	100%	81%
Schutter et al[45]	CA125 (35 U/mL)	60%	76%	77%	59%	
	CA125 (60 U/mL)	50%	84%	81%	56%	
	CA15.3 (30 U/mL)	39%	95%	92%	54%	
	CA72.4 (3.5 U/mL)	52%	84%	81%	57%	

PPV = positive predictive value; NPV = negative predictive value; VEGF = vascular endothelial growth factor.

Computed tomography, magnetic resonance imaging

Kurtz et al[41] prospectively evaluated 280 women suspected of having ovarian cancer using Doppler ultrasonography, computed tomography (CT), and magnetic resonance imaging (MRI). MRI was the most accurate in diagnosing malignancy (91% of cases). CT detected 85% of cases, and ultrasonography detected 78%.

They also compared conventional ultrasonography, CT, and MRI to stage the spread of disease. Conventional ultrasonography was the most specific in differentiating disease confined to the pelvis from abdominal spread (96%), and MRI was the most sensitive (98%) vs CT (92%) and conventional ultrasonography (75%).

Onyeka et al[42] compared the use of transabdominal gray-scale ultrasonography with CT to preoperatively evaluate 31 women with clinically diagnosed pelvic masses. CT was more sensitive (48% vs 29%) in making the presumptive diagnosis of a pelvic mass and in detecting ovarian cancer (83% vs 67%), but transabdominal ultrasonography was more specific. Both methods were equally effective in detecting and staging advanced ovarian cancer. Ultrasonography offered better visualization of the ovaries and more precise assessment of tumor size. The authors concluded that CT did not offer a significant advantage and did not change the management of any of the patients reviewed.

Chang et al[43] evaluated 81 women with masses, the origin of which (uterine or extrauterine) could not be determined by ultrasonography. Limited-sequence MRI helped determine the origin of the mass in 79 cases (98%).

CA125 is still the standard tumor marker used in gynecology

Tumor markers

Tumor markers are substances either produced or released by tumor cells or host cells, which indicate that a tumor is present if detected in serum or other biological fluids. Ideally, a marker should be highly sensitive and specific, and its concentration should be proportional to the tumor burden.[44]

Several studies have looked at the role of various cancer antigens to help detect malignancy. These are detailed below and summarized in TABLE 2.

Czekierdowski[24] retrospectively evaluated 451 women with a persistent adnexal mass to determine the accuracy of tumor markers in preoperatively discriminating between malignant and benign ovarian tumors. The optimal cutoff level for CA125 was 67.5 U/mL, which was 69.4% accurate. The best predictive values were provided by CA19.9 (a threshold of 13.4 U/mL was 74% accurate) and CA72.4 (a threshold of 4.1 U/mL was 77.8% accurate). Vascular endothelial growth factor was not useful.

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TABLE 3

Determining risk of malignancy in a woman with an adnexal mass

Premenopausal women

	LOW RISK	INTERMEDIATE RISK	HIGH RISK
Symptoms	None	Mild	Significant
History	No clues	No significant clues	Significant clues, significant findings on physical examination
Ultrasonographic findings	No suspicious criteria	Thin septa or size 5–10 cm only; no other suspicious criteria	Multiple suspicious criteria
Action	Follow with ultrasound in 6–8 weeks	Follow with ultrasound in 6–8 weeks Refer for surgery if findings persist	Order tumor markers Refer for surgical evaluation

Postmenopausal women

	LOW RISK	HIGH RISK
History	No clues	Significant clues
Ultrasonographic findings	No suspicious criteria	Significant suspicious criteria
CA125 level	Normal	Elevated
Action	Follow with ultrasound in 3–6 months; If no change, consider surgery vs more follow-up If changed, refer for surgical evaluation[2,8,13,16]	Refer for surgical evaluation

Despite advances in ultrasound, adnexal masses are still challenging to assess

Schutter et al[45] retrospectively evaluated the diagnostic use of CA125, CA15.3, and CA72.4 antigens in 412 patients who had undergone surgery for a pelvic mass, 133 of whom were found to have ovarian carcinoma. CA125 was the most sensitive marker for ovarian carcinoma, and CA15.3 had the highest specificity and positive predictive value. When all three markers were elevated, the positive predictive value was 97%, but this only occurred in 41% of patients with ovarian cancer. A logistic regression model indicated that the markers correctly predicted ovarian cancer in 73% of cases. The authors concluded that this tumor marker panel is not as good at detecting ovarian cancer as are other combinations of tests and factors that include ultrasonography, physical examination, menopausal status, or patient age.

Mancuso et al[46] evaluated 125 women with a pelvic mass using transvaginal or transabdominal ultrasonography and CA125 level before the patients underwent laparoscopy or laparotomy. Either a cutoff for CA125 of 35 U/mL or ultrasonography alone were equally sensitive (100%) and specific (78.6%) for detecting malignancy and had similar positive predictive values (37%) and negative predictive values (100%). When age and menopausal status were factored in, sensitivity ranged from 91% to 100% and the specificity from 91% to 96.6%. CA125 combined with menopausal data was 97% accurate and

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A postmenopausal woman with vague abdominal discomfort

A 56-year-old woman presents to her primary care physician with complaints of vague abdominal discomfort, mild nausea, and fatigue for the past 2 to 3 months. She went through menopause at the age of 51. She reports occasional constipation and denies any urinary or gynecologic symptoms.

She has a history of two full-term vaginal deliveries. She has no history of significant medical, surgical, or social problems. She has no family history of breast, ovarian, or colon cancer. She takes no medications.

Physical examination of her head and neck, heart, lungs, and extremities is normal. On abdominal examination, the patient is noted to have a moderately distended abdomen that is nontender. On pelvic examination, she is noted to have a fullness in the right adnexa that is difficult to characterize. Her uterus, cervix, and vagina are normal. On rectovaginal examination she is noted to have nodularity in the posterior cul-de-sac.

Q: What is the next step?

- ❑ Obtain basic blood work, including a complete blood cell count and basic metabolic panel
- ❑ Order pelvic ultrasonography
- ❑ Obtain CA125 and carcinoembryonic antigen levels
- ❑ Refer her to a gynecologist for further evaluation

DISCUSSION

All of the above are appropriate steps in the evaluation of this patient. Given her history and physical examination, there is a fairly high likelihood that she has an ovarian malignancy.

Initial blood work, including tumor markers, would be helpful.

Ultrasonography is a fairly inexpensive and simple test that can give you more information about the vague findings encountered during her pelvic examination. This should be the initial imaging study before the other imaging tests (computed tomography or magnetic resonance imaging).

Lastly, this patient should see a gynecologist to coordinate the test findings and determine the likelihood of malignancy.

had the highest positive predictive value (78.6%). CA125 was 81% accurate when used alone and 95% accurate when combined with ultrasonography.

The authors concluded that CA125 is a good marker for ovarian cancer in postmenopausal women because the lower incidence of benign diseases makes a high CA125 level more likely to be associated with a malignant mass.

A MULTIMODAL APPROACH IS BEST

A multimodal preoperative evaluation consisting of a thorough history, physical examination, imaging studies, and biomarkers may improve patient care by sorting out benign from malignant masses (TABLE 3).

Transvaginal two-dimensional ultrasonography is the most widely used imaging study. Qualitative evaluation of flow through septa and solid components should be performed as indicated. The clinical value of resistive index, pulsatility index, and three-dimensional ultrasonography is limited because techniques vary widely and because it is difficult to reduce the complex data generated into a simple index. CT and MRI may be helpful when ultrasonography is inconclusive.

Biological tumor markers can help diagnose ovarian cancer in women with other risk factors for malignancy. CA125 is still the standard tumor marker used in gynecology. Many studies have tried to define better panels of markers, all of which have been more sensitive but less specific than single markers. The optimum cutoff level is difficult to say, but 35 U/mL is probably the most commonly used. Higher levels can be used, but sensitivity is decreased in order to gain specificity.

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REFERENCES

1. **Berek JS.** Novak's Gynecology. 13th ed. Philadelphia: Lippincott Williams & Wilkins; 2002.
2. **Simcock B, Anderson N.** Diagnosis and management of simple ovarian cysts: an audit. Australas Radiol 2005; 49:27–31.
3. **Campbell S, Bhan V, Royston P, Whitehead MI, Collins WP.** Transabdominal ultrasound screening for early ovarian cancer. BMJ 1989; 299:1363–1367.
4. **Knudsen UB, Tabor A, Mosgaard B, et al.** Management of ovarian cysts. Acta Obstet Gynecol Scand 2004; 83:1012–1021.
5. **Varras M.** Benefits and limitations of ultrasonographic evaluation of uterine adnexal lesions in early detection of ovarian cancer. Clin Exp Obstet Gynecol 2004; 31:85–98.
6. **Dodson MG.** The ovary. In: Dodson MG, editor. Transvaginal Ultrasound. New York: Churchill Livingstone; 1991:134–137.
7. **Deligeoroglou E, Eleftheriades M, Shiadoes V, et al.** Ovarian masses during adolescence: clinical, ultrasonographic and pathologic findings, serum tumor markers and endocrinological profile. Gynecol Endocrinol 2004; 19:1–8.
8. **Curtin JP.** Management of the adnexal mass. Gynecol Oncol 1994; 55:S42–S46.
9. **American Cancer Society.** Cancer facts and figures 2006. Atlanta, GA: American Cancer Society, 2006.
10. **ACOG Committee on Gynecologic Practice.** The role of the generalist obstetrician-gynecologist in the early detection of ovarian cancer. Int J Gynaecol Obstet 2003; 80:235–238.
11. **Hoskins WJ, Perez CA, Young RC, et al, editors.** Principles and Practice of Gynecologic Oncology. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2005.
12. **Barber HR, Graber EA.** The PMPO syndrome (postmenopausal palpable ovary syndrome). Obstet Gynecol 1971; 38:921–923.
13. **Rangel JN, Escobar PF.** Anatomical and surgical considerations for minimally invasive surgery of adnexal mass lesions. MedUNAB 2005; 8:151–158.
14. **Padilla LA, Radosevich DM, Milad MP.** Accuracy of the pelvic examination in detecting adnexal masses. Obstet Gynecol 2000; 96:593–598.
15. **Balbi GC, Musone R, Menditto A, et al.** Women with a pelvic mass: indicators of malignancy. Eur J Gynaecol Oncol 2001; 22:459–462.
16. **Valentin L.** Pattern recognition of pelvic masses by gray-scale ultrasound imaging: the contribution of Doppler ultrasound. Ultrasound Obstet Gynecol 1999; 14:338–347.
17. **DePriest PD, Shenson D, Fried A, et al.** A morphologic index based on sonographic findings in ovarian cancer. Gynecol Oncol 1993; 51: 7–11.
18. **Alcazar JL, Jurado M.** Using a logistic model to predict malignancy of adnexal masses based on menopausal status, ultrasound morphology, and color Doppler findings. Gynecol Oncol 1998; 69:146–150.
19. **Sutantawibul A, Ruangvutilert P, Sunsaneevithayakul P, Boriboonhirunsarn D.** A model for malignancy probability prediction of adnexal masses. J Med Assoc Thai 2003; 86:742–749.
20. **Valentin L, Hagen B, Tingulstad S, Eik-Nes S.** Comparison of "pattern recognition" and logistic regression models for discrimination between benign and malignant pelvic masses: a prospective cross validation. Ultrasound Obstet Gynecol 2001; 18:357–365.
21. **Testa AC, Ajossa S, Ferrandina G, et al.** Does quantitative analysis of three-dimensional power Doppler angiography have a role in the diagnosis of malignant pelvic solid tumors? A preliminary study. Ultrasound Obstet Gynecol 2005; 26:67–72.
22. **Noor N, Sadeque AS, Kundu SS.** Diagnostic accuracy of transabdominal sonography in the evaluation of pelvic mass of gynecological origin. Bangladesh Med Res Counc Bull 2003; 29:86–91.
23. **Guerriero S, Alcazar JL, Coccia ME, et al.** Complex pelvic mass as a target of evaluation of vessel distribution by color Doppler sonography for the diagnosis of adnexal malignancies: results of a multicenter European study. J Ultrasound Med 2002; 21:1105–1111.
24. **Czekierdowski A.** Studies on angiogenesis in the benign and malignant ovarian neoplasms with the use of color and pulsed Doppler sonography and serum CA-125, CA-19.9, CA-72.4 and vascular endothelial growth factor measurements. Ann Univ Mariae Curie Sklodowska [Med] 2002; 57:113–131.
25. **Kurjak A, Zalud I, Alfirevic Z.** Evaluation of adnexal masses with transvaginal color ultrasound. J Ultrasound Med 1991; 10:295–297.
26. **Fleischer AC, Rodgers WH, Rao BK, et al.** Assessment of ovarian tumor vascularity with transvaginal color Doppler sonography. J Ultrasound 1991; 10:563–568.
27. **Timor-Tritsch LE, Lerner JP, Monteagudo A, Santos R.** Transvaginal ultrasonographic characterization of ovarian masses by means of color flow-directed Doppler measurements and a morphologic scoring system. Am J Obstet Gynecol 1993; 168(3 Pt 1):909–913.
28. **Karlan BY, Platt LD.** The current status of ultrasound and color Doppler imaging in screening for ovarian cancer. Gynecol Oncol 1994; 55:528–533.
29. **Bourne TH.** Should clinical decisions be made about ovarian masses using transvaginal color Doppler? Ultrasound Obstet Gynecol 1994; 4:357–360.
30. **Tekay A, Jouppila P.** Blood flow in benign ovarian tumors and normal ovaries during the follicular phase. Obstet Gynecol 1995; 86:55–59.
31. **Tekay A, Jouppila P.** Validity of pulsatility and resistance indices in classification of adnexal tumors with transvaginal color Doppler ultrasound. Ultrasound Obstet Gynecol 1992; 2:338–344.
32. **NIH Consensus Development Panel on Ovarian Cancer.** NIH consensus conference. Ovarian cancer. Screening, treatment, and follow-up. JAMA 1995; 273:491–497.
33. **Bonilla-Musoles F, Raga F, Osborne NG.** Three-dimensional ultrasound evaluation of ovarian masses. Gynecol Oncol 1995; 59:129–135.
34. **Kurjak A, Kupesic S, Breyer B, Sparac V, Jukic S.** The assessment of ovarian tumor angiogenesis: what does three-dimensional power Doppler add? Ultrasound Obstet Gynecol 1998; 12:136–146.
35. **Chan L, Lin WM, Uerpairojkit B, Hartman D, Reece EA, Helm W.** Evaluation of adnexal masses using three-dimensional ultrasonographic technology: preliminary report. J Ultrasound Med 1997; 16:349–354.
36. **Cohen LS, Escobar PF, Scharm C, Glimco B, Fishman DA.** Three-dimensional power Doppler ultrasound improves the diagnostic accuracy for ovarian cancer prediction. Gynecol Oncol 2001; 82:40–48.
37. **Piccioni MG, Fabiani C, Fattouche V, Furano S, Melluso J, Sabelli V.** Preoperative evaluation of ovarian masses: ultrasound and biochemical screening. Clin Exp Obstet Gynecol 2003; 30:217–219.
38. **Guerriero S, Ajossa S, Lai MP, et al.** The diagnosis of functional ovarian cysts using transvaginal ultrasound combined with clinical parameters, CA125 determinations, and color Doppler. Eur J Obstet Gynecol Reprod Biol 2003; 110:83–88.
39. **Schelling M, Braum M, Kuhn W, et al.** Combined transvaginal B-mode and color Doppler sonography for differential diagnosis of ovarian tumors: results of a multivariate logistic regression analysis. Gynecol Oncol 2000; 77:78–86.
40. **Roman LD, Felix JC, Muderspach LI, Agahjanian A, Qian D, Morrow CP.** Risk of residual invasive disease in women with microinvasive squamous cancer in a conization specimen. Obstet Gynecol 1997; 90:759–764.
41. **Kurtz AB, Tsimikas JV, Tempany CM, et al.** Diagnosis and staging of ovarian cancer: comparative values of Doppler and conventional US, CT, and MR imaging correlated with surgery and histopathologic analysis—report of the Radiology Diagnostic Oncology Group. Radiology 1999; 212:19–27.
42. **Onyeka BA, Atalla A, Deemer H.** Comparative diagnostic values of grey-scale USS versus CT scan in the primary management of gynaecological pelvic mass with emphasis on ovarian cancer detection and staging. J Obstet Gynaecol 2001; 21:516–519.
43. **Chang SD, Cooperberg PL, Wong AD, Llewellyn PA, Bilbey JH.** Limited-sequence magnetic resonance imaging in the evaluation of the ultrasonographically indeterminate pelvic mass. Can Assoc Radiol J 2004; 55:87–95.
44. **Gadducci A, Cosio S, Carpi A, Nicolini A, Genazzani AR.** Serum tumor markers in the management of ovarian, endometrial and cervical cancer. Biomed Pharmacother 2004; 58:24–38.
45. **Schutter EM, Davelaar EM, van Kamp GJ, Verstraeten RA, Kenemans P, Verheijen RH.** The differential diagnostic potential of a panel of tumor markers (CA 125, CA 15-3, and CA 72-4 antigens) in patients with a pelvic mass. Am J Obstet Gynecol 2002; 187:385–392.
46. **Mancuso A, De Vivo A, Triolo O, Irato S.** The role of transvaginal ultrasonography and serum CA 125 assay combined with age and hormonal state in the differential diagnosis of pelvic masses. Eur J Gynaecol Oncol 2004; 25:207–210.

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