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The Diagnostic Accuracy of Abdominal Ultrasound Imaging for Detection of Ovarian Masses

Background/Objective: Detection of the tissue diagnosis of ovarian space occupying lesions (OSOL) has remained a challenging task for sonographers since many adnexal masses have nonspecific sonographic appearances. Our objective was to evaluate the accuracy of the abdominal sonographic diagnosis of adnexal masses in 79 women with a known OSOL undergoing laparotomy for ovarian masses in Tabriz Alzahra's Hospital, northwestern Iran.

Patients and Methods: From March 2004 to February 2005, sonographic reports of each patient were compared with postoperative findings.

Results: Comparison of the preoperative sonographic and final pathologic diagnoses revealed a correct sonographic diagnosis in 77% of patients. The identification of ovarian cystic teratoma was correct in 17/24 cases (sensitivity of 71% and specificity of 98%). The identification of ovarian malignancy was correct in 7/10 patients (sensitivity of 70% and specificity of 98.5%). Sonograms were frankly misread in 14/79 cases, and were missed in 4/79 cases.

Conclusion: In conclusion, our results show high resolution abdominal ultrasonography is an effective method in diagnosis of ovarian tumors and on 70% of patients can differentiate malignant tumors from benign tumors.

Keywords: ultrasonography, ovarian tumors, adnexal masses

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Introduction

Ovarian cancer is now the fourth leading cause of cancer death in the United States, with more than 14,000 deaths being reported each year.[1] adnexal lesion characterization (benign *vs* malignant) is essential for proper patient evaluation and treatment decisions.

Ultrasound is the primary imaging modality to evaluate the ovaries, with a reported accuracy of up to 94% for diagnosis of malignancy.[2] Assessment with ultrasound has been shown to be a sensitive but relatively nonspecific method, leading to unnecessary surgical resection of many benign lesions.[3]

The differential diagnosis of adnexal masses, including their benign or malignant nature, plays a major role in defining the appropriate surgical strategy, which in the case of malignancy allows for a longer disease-free period and even cure. This would also permit the use of laparoscopy in selected cases.

The use of methods such as various types of ultrasound has been reported to attain higher preoperative diagnostic accuracy.[4] Traditionally, sonologists have depended on masses size and morphology as features distinguishing between benign and malignant lesions.[5] Over the last few years, new diagnostic techniques have made a significant contribution to the diagnosis of adnexal masses and in selecting the best surgical treatment.

The majority of ovarian masses are benign (80%), with cystic, solid or mixed characteristics and a favorable prognosis. The other 20% of these masses are malignant tumors.

Considering that the lifetime risk of developing an ovarian tumor is around 5%–7%, diagnostic means are needed which permit accurate classification of these ovarian masses before surgery. Unfortunately, the available diagnostic modalities do not allow distinction between benign ovarian tumors and malignant tumors. In the majority of cases, this is only established by histologic study of the surgical specimen. It is now well established that histopathology is the gold standard for diagnosis of ovarian mass.[6,7]

The objective of the present approach was to assess the sensitivity, specificity, and positive and negative predictive values of abdominal sonographic imaging for discriminating ovarian masses.

Patients and Methods

We reviewed records of 107 patients who were hospitalized for surgical treatment of known ovarian space occupying lesions (OSOL) between March 2004 and February 2005 within the Department of Ultrasound at Alzahra Hospital, Tabriz, northwestern Iran. Patients who had not exact records of sonographic and pathologic reports excluded from the study.

All ultrasound examinations were performed by a dedicated sinologist with 15 years of experience using a General Electric Model X200 ultrasound unit with 3.5 MHz abdominal probe.

Pathologic reports were reviewed by a pathologist with 10 years of experience. Pathologic reports were obtained from laparotomy biopsy specimens for all patients. The excised masses were classified pathologically in two groups of benign and malignant.

Comparison of the preoperative sonographic and final pathologic diagnoses was performed and data was analyzed. The sensitivity, specificity and positive and negative predictive values were determined for abdominal sonographic assessment, for predicting the presence of malignancy and the most common ovarian masses.

Results

Seventy-nine patients had both sonographic and pathologic reports. The mean age of participants was 47 (range: 17–62) years. The pathologic diagnoses of the ovarian masses removed are presented in Table 1.

Pathologically, there were 69 benign and 10 malignant ovarian lesions. The most common diagnosis made by pathology was cystic teratoma followed by serous cystadenoma and mucinous cystadenoma. Findings at pathology showed cystic teratoma (dermoid) in 24 of 79 patients.

The sensitivity of sonography for ovarian cystic teratoma was 71% (CI$_{95\%}$: 53%–89%), the specificity was 98%, the positive predictive value (PPV) was 94%, the negative predictive value (NPV) was 88.5%, the positive likelihood ratio (LR$^+$) was 39.4, and the negative likelihood ratio (LR$^-$) was 0.29.

According to pathologic reports, the rate of a malignant condition was 10 in 79 patients. Seven of 10 ovarian cancers were correctly identified by ultrasound. Malignant ovarian tumors were distinguished from other lesions with a sensitivity of 70% (CI$_{95\%}$: 42%–98%), a specificity of 98.5%, a PPV of 87.5%, a NPV of 96%, an LR$^+$ of 46.7 and an LR$^-$ of 0.3.

Sonographic findings were different from pathologic findings in 18 of 79 patients, including four patients in whom the ovarian mass was missed in sonography while pathology indicated lesions in ovaries; in 14 patients the sonography reports were inconsistence with pathologic findings. A correct sonographic diagnosis was obtained in 61 of 79 patients yielding a sensitivity of 77% (CI$_{95\%}$: 68%–86%).

Discussion

The ovaries are solid, slightly nodular, almond-shaped organs lying deep in the pelvis. Their hidden location, plus the fact that their size, shape, position, and histology change over a woman's lifetime, help explain why ovarian cancer is not readily detected in early stages.[8]

Most ovarian masses detected by ultrasound are benign. It is essential that ultrasound images are interpreted in a manner that decreases inter-observer variations and false-positive results. Patients with clinical findings suggestive for ovarian tumor should undergo transvaginal and/or transabdominal sonography. Sonographic morphology indexing should be performed according to a consensus. The single finding most suggestive for malignancy is a solid or papillary component extending from the inner wall of the tumor.[9]

Table 1. Pathologic findings in patients (n=79)

Benign		Malignant	
Cystic teratoma	24	Mucinous cystadenocarcinoma	3
Serous cystadenoma	22	Serous cystadenocarcinoma	2
Mucinous cystadenoma	11	Papillary serous cystadenocarcinoma	1
Sertoli cell tumor	2	Mullerian mixed tumor	1
Others	10	Others	3

The author's experience is that absence of solid components and absence of irregularities in an adnexal mass at ultrasound examination suggests a benign lesion, whereas any irregularity wehether it is in the outline, the cyst wall, or in the echogenicity of a tumor suggests malignancy.[10] Ultrasound images representative of benign and malignant extra-uterine pelvic tumors are shown in Figure 1.

A correct diagnosis of adnexal masses is relevant to making a suitable pre- and intra-operative therapeutic decision, which decreases the risk of finding undiagnosed carcinomas in laparoscopic and conventional surgeries.[4]

Sonography (transvaginal and transabdominal) is a sensitive method for detecting ovarian cancer, although it lacks the accuracy required to prevent surgery in those who raise no suspicion. In spite of providing low levels of false negative results, hence good degree of diagnosing benign lesions, the false positive rate is high.[11-14]

Campbell et al. first used transabdominal ultrasonography for evaluation of ovarian cancer in asymptomatic patients. In their study, transabdominal ultrasound had a sensitivity of 100%, a specificity of 97.7%, and a positive predictive value of 1.5%. They concluded that transabdominal ultrasound is not effective in discriminating benign from malignant cystic tumors, and hence, is less suitable for evaluation of ovarian tumors than transvaginal ultrasonography.[15]

The introduction of transvaginal ultrasound has significantly improved the ability to look in detail at pelvic structures.[16] Recent studies have indicated that transvaginal ultrasound has a positive predictive value of only 10% in postmenopausal women. This means that for every ovarian cancer identified, at least 10 benign ovarian tumors will be detected.[12, 17]

Ultrasound pelvic examination is a harmless and non-invasive procedure and is the most commonly-used procedure to determine the origin, contents (solid or liquid) and volume of the neoplasm. When possible, transvaginal ultrasound is preferable; its sensitivity of around 100% and specificity of around 83% is higher than the transabdominal ultrasound which has a specificity and sensitivity of over 80%.[18, 19]

Our study showed that abdominal sonography had a sensitivity of 70% and a specificity of 98.55% for predicting ovarian cancer. Sassone et al. indicated that the sensitivity of transvaginal ultrasound is around 100; its specificity is around 83% which is higher than the transabdominal ultrasound which has a sensitivity and specificity of over 80%.[12, 19] An initial report by Kurjak et al. found a sensitivity and specificity about 100% and 99%, respectively, in predicting ovarian cancer.[20] Bourne et al. and Finkler et al. indicated combining advanced ultrasound and measurement of serum CA 125 significantly can effectively detect early ovarian cancer and decrease mortality rate for ovarian cancer.[21, 22]

Most dermoid cysts are easily recognized at grey-scale imaging owing to their fat and hair content. However, as many as 9% or even 18% of dermoid cysts, may manifest a predominately cystic echo pattern indistinguishable from that of other cystic masses. The most characteristic ultrasound features of a dermoid cyst are the presence of (1) a "white ball" (corresponding to hair and sebum) in the corner of a cysts, or filling up the whole tumor, (2) long, echogenic (white) lines and prominent echogenic dots in cyst fluid (corresponding to hair floating freely in

Table 2. Comparison of results as assessed by pathology and sonography

Pathology Sonography	Positive	Negative	Total
Positive	17	1	18
Negative	7	54	61
Total	24	55	79

Note. Sensitivity (TP/TP+FN) =71%. Specificity (TN/TN+FP) =98%. Positive predictive value (TP/TP+FP) = 94%. Negative predictive value (TN/TN+FN) =88.5%. Positive likelihood ratio (sensitivity/1-specificity) =39.4. Negative likelihood ratio (1-sensitivity/specificity) = o.29

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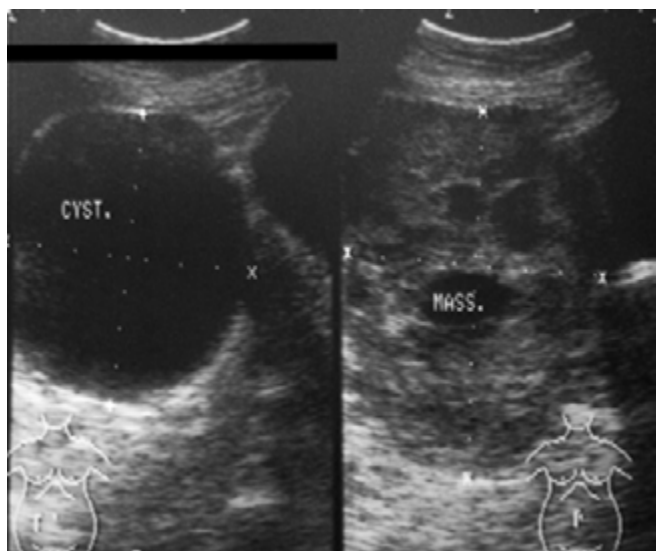
Fig 1. Left: Benign tumor characterized by absence of solid components and absence of irregularities. Right: Malignant tumor characterized by presence of solid components and presence of irregularities.
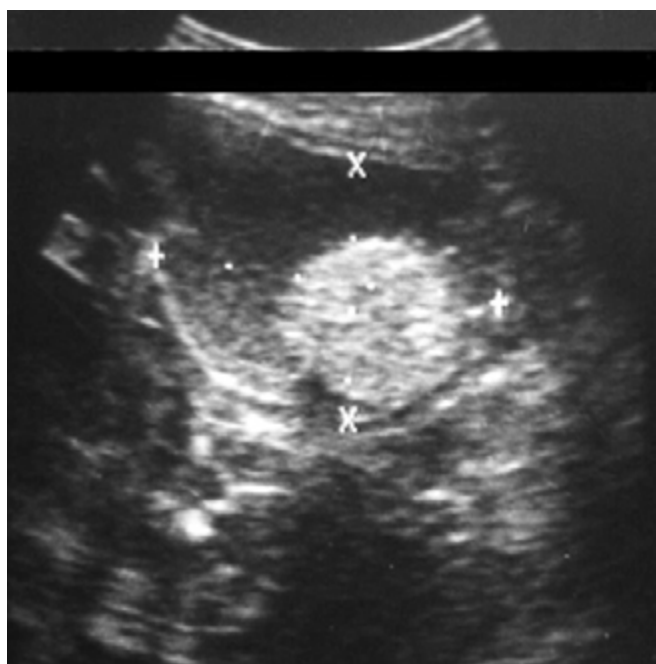
Fig 2. Teratoma cyst with (A) typical "white ball", (B) typical long echogenic lines and bright prominent spots representing hair in fluid and, (C) typical shadowing.

non-fatty fluid), and (3) shadowing. Typical ultrasound images of cystic teratoma are shown in Figure 2.

Confusion of dermoid cysts with mucinous cystadenoma and serous cystadenoma has been reported.[10] In this approach cystic teratoma was the most common diagnosed lesion by ultrasonography. Sensitivity and specificity obtained were 71%, 98%, respectively.

Marret indicated that transvaginal sonography has

demonstrated considerable advantage over conventional transabdominal sonography. However, transabdominal sonography is still useful in large tumors. Also Marret showed that the ultrasound and morphologic parameters have a sensitivity of 80% and a specificity of 93% which make this examination the gold standard for ovarian cysts diagnosis.[23]

At present, several parameters are available for distinguishing benign from malignant masses. The grayscale two-dimensional sonographic parameters that are used most frequently are tumor diameter or volume, septation and presence of papillary projections, echogenicity, and the presence of free fluid. The blood flow of ovarian tumor can be evaluated by B-mode color Doppler ultrasonography and waveform analysis. The resistance to flow is lower in malignant than in benign tumors. Frequently used Doppler parameters are resistance index, pulsatility index, and peak systolic velocity. To improve the preoperative assessment of adnexal masses, most of these parameters have been combined with patient characteristics in diagnostic models. Although the initial publication reported an almost perfect performance of these models, external validation showed their diagnostic performance to be less than good.[24]

Color flow Doppler technique combined with ultrasound are useful for more precise classification of the mass by studying its vascularity. In the benign tumors, vascularization is normal and in malignant tumors, neovascularization is evident.[7]

The authors concluded that sonography could not differentiate follicular cysts, serous cysts and mucinous cysts very well, however, because benign cysts could form or resolve within 24 hours, sonography is immediately suggested before operation. This prevents unnecessary laparotomy and its complications. Improved ovarian visualization via diagnostic imaging technologies is critical for the early detection of asymptomatic lesions of the ovary which should decrease the number of inappropriate operative interventions.

In conclusion, our results show high resolution abdominal ultrasonography is an effective method in diagnosis of ovarian tumors and on 70% of patients can differentiate malignant tumors from benign tumors.

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