Thai Journal of Obstetrics and Gynaecology
September 2002, Vol. 14, pp. 231-236

GYNAECOLOGY

Ultrasonographic Scoring System for Preoperative Discrimination Between Benign and Malignant Ovarian Tumors

Chairak Jivangkul MD,
Paiboon Charoenchainont MD,
Surawute Leelahakorn MD,
Prateep Hanidhikul MD,
Manit Sripramote MD.

Department of Obstetrics and Gynecology, Bangkok Metropolitan Administration Medical College and Vajira Hospital, Bangkok 10300, Thailand

ABSTRACT

Objective To evaluate ultrasonographic scoring system for preoperative discrimination between benign and malignant ovarian tumors.

Design Prospective study.

Setting Department of Obstetrics and Gynecology, Bangkok Metropolitan Administration Medical College and Vajira Hospital.

Material and methods 218 women scheduled for elective surgery for ovarian tumors between May, 1999 and December, 2001 were recruited into the study. Ultrasonographic assessments were performed using Ferrazi's scoring system within 72 hours before surgery by the same gynecologist to evaluate wall, septa, vegetations, and echogenicity of the tumors. The final diagnosis was pathologically confirmed as the gold standard.

Results 173 ovarian tumors were benign and 45 were malignant. The best cut-off value from reciever operating characteristic curve was 9. This value had sensitivity 88.89% (95% CI 76.50-95.20), specificity 91.91% (95% CI 86.90-95.10). The positive and negative predictive values were 74.07% (95% CI 61.10-83.90) and 96.95% (95% CI 93.10-98.70), respectively.

Conclusion Ultrasonographic scoring system shows high diagnostic accuracy in discriminating benign from malignancy ovarian tumors.

Key words: preoperative evaluation, ovarian tumor, ultrasonography, scoring system

The incidence of ovarian cancer increases rapidly after the age of 50. Less than 15% of ovarian cancers occur in women younger than 50 years old.[1] Mean age of women with malignant ovarian tumor was higher than those with benign ovarian tumor[2] as well as menopausal status.[3]

For the preoperative evaluation of ovarian tumors, clinicians have the choices among a wide range of techniques, for example, pelvic examination, the immunoassay of serum tumor markers, transvaginal

ultrasonography with B-mode and color Doppler imaging with pulsed spectral analysis, computed tomography, and magnetic resonance imaging. Accurate preoperative diagnosis would allow referral of patients with questionable malignant tumors to specialized centers for gynecologic malignancy, whereas benign tumors could undergo minimally invasive operation. It could prevent unneccessary invasive operation.

Transvaginal ultrasonography is the most practical modality for assessment of the ovarian tumors because it is a quick and inexpensive imaging technique that can accurately identify masses as either low or high risk.[4] Many investigators have proposed scoring systems based on several gray-scale ultrasonographic features. Ultrasonographic scoring system by Ferrazi E. et al. in 1997,[5] used a composite of five scoring systems. A total of 330 ovarian tumors (261 benign and 69 malignant tumors) were collected in three different centers, which adopted the same diagnostic procedures. The best cut-off value (score ≥ 9) achieved a sensitivity 87%, a specificity 67%, positive predictive value 41%, and the area under the receiver operating characteristic (ROC) curve 0.84, which was significantly better than the areas of the other four scoring systems.[6-9]

The purpose of this study is to evaluate the ability of ultrasonographic scoring system to discriminate benign from malignant ovarian tumors.

Material and methods

Between May 1999 and December 2001, 223 women were admitted to Bangkok Metropolitan Administration Medical College and Vajira Hospital for elective surgery due to the detection of ovarian tumors by pelvic examination and confirmed by ultrasonography. The study protocol was approved by the Ethical Committee. All women had a satisfactory performance status such that surgery could be performed (laparotomy, laparoscopy). All of them gave informed consents.

All ultrasonographic examinations were performed by the same gynecologist within 72 hours before surgery. The equipment used for ultrasonographic evaluation was Aloka SSD-1400 with 7.5-MHz vaginal probe or 3.5-MHz abdominal probe. The inclusion criteria was ultrasonographic diagnosis of ovarian tumor. We excluded masses that were clearly extraovarian by ultrasonography (eg, leiomyoma, hydrosalpinx). Transvaginal ultrasonography with 7.5-MHz transducer was performed unless the mass was judged to be adequately imaged with transabdominal ultrasonography performed with a 3.5-MHz transducer (generally when the mass was relatively large or superiorly located) or the patient declined transvaginal ultrasonography.

The ultrasonographic scoring system was constructed using four basic features: wall, septa, vegetations, and echogenicity. A point scale (1-5) was developed within each category according to specific criteria developed by Ferrazi E. et al. (Table 1). After surgery, the histopathological diagnoses were recorded and classified as benign and malignant group (which included borderline tumor and carcinoma) for data analysis.

Table 1. Ultrasonographic scoring system by Ferrazi E. et al

SCORE	WALL	SEPTA	VEGETATIONS	ECHOGENICITY
1	≤3 mm	none	none	Sonolucent *
2	> 3 mm	≤3 mm		Low echogenicity
3		> 3 mm		
4	Irregular, mostly solid **		≤3 mm	With echogenic areas
5	Irregular, not applicable ***		>3 mm	With heterogeneous echogenic areas, solid

* sonolucent or with fine trabecular and jelly-like hypoechoic content typical of endohemorrhagic corpus luteum
** irregular wall structure, much thicker than 3 mm but capsule identifiable
*** the capsule can not be differentiated from the surrounding structure and the inner echogenicity

The best cut-off value for discriminating the ovarian tumors was determined by receiver operating characteristic curve. The sensitivity, specificity, positive and negative predictive values, and their 95% confidence interval, accuracy, and false positive and negative rates were calculated.

Results

Over the 32 months, we examined 223 women with ovarian tumors. Five women were excluded due to subsequent pathological diagnoses of non-ovarian tumor including 4 leiomyomas and 1 hydrosalpinx. The remaining 218 were available for analysis. Women with benign tumors (n=173) were 14 to 77 years old (mean ± SD, 38.35 ± 11.48 years) and those with malignant tumors (n=45) were 16 to 77 years old (mean ± SD, 46.09 ± 15.14 years). Among patients with benign tumors, 154 (89.02%) were premenopausal and 19 (10.98%) were postmenopausal. In the group of patients with malignant tumors, 26 (57.78%) were premenopausal and 19 (42.22%) were postmenopausal.

The common benign ovarian tumors were endometrioma, mucinous cystadenoma, mature cystic teratoma, and serous cystadenoma. False positive results were found in 14 cases, most of which were mature cystic teratoma (Table 2). There were seven cases of borderline ovarian tumors. Mucinous cystadenocarcinoma was the most common malignant ovarian tumor followed by serous cystadenocarcinoma and clear cell carcinoma. False negative results were found in 5 cases, most of which were borderline ovarian tumors (Table 3).

Table 2. Histopathological diagnoses of benign ovarian tumors and number of women with ultrasonographic scoring system ≥ 9

Histopathological diagnosis	Number	Score ≥ 9	
	N =173	Number	%
Mature cystic teratoma	23	5	21.74
Ovarian fibroma	3	2	66.67
Mucinous cystadenoma	27	2	7.41
Endometrioma	93	2	2.15
Brenner tumor	1	1	100
Tuboovarian abscess	4	1	25
Serous cystadenoma	15	1	6.67
Corpus luteal cyst	5	0	0
Simple ovarian cyst	1	0	0
Struma ovarii	1	0	0

Table 3. Histopathological diagnoses of malignant ovarian tumors and number of women with ultrasonographic scoring system < 9

Histopathological diagnosis	Number	Score < 9	
	N = 45	Number	%
Serous cystadenocarcinoma	6	0	0
Mucinous cystadenocarcinoma	7	1	14.29
Endometrioid adenocarcinoma	4	0	0

Histopathological diagnosis	Number	Score < 9	
	N = 45	Number	%
Clear cell carcinoma	6	1	16.67
Papillary cystadenocarcinoma	2	0	0
Dysgerminoma	2	0	0
Immature teratoma	2	0	0
Squamous cell carcinoma in teratoma	1	1	100
Granulosa cell carcinoma	2	0	0
Metastatic carcinoma	5	0	0
Adenocarcinoma	1	0	0
Borderline serous tumor	2	1	50
Borderline mucinous tumor	5	1	20

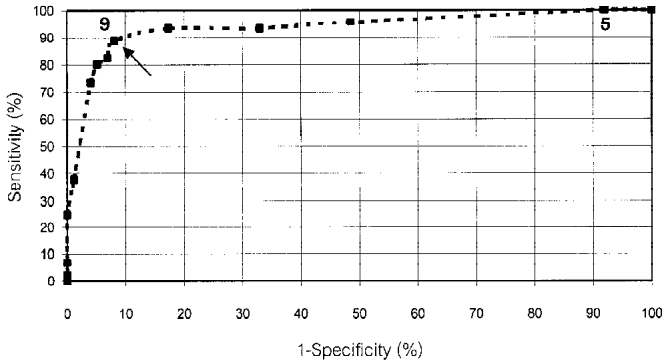

Fig. 1. Receiver operating characteristic curve of ultrasonographic scoring system.

Table 4. Two by two table at cut-off value = 9

Ultrasonographic score	Histopathologic diagnosis	
	Malignancy	Benign
≥ 9	40	14
< 9	5	159

Table 5. Diagnostic values of ultrasonographic scoring system at cut-off value = 9

Diagnostic value		95% CI
Sensitivity	88.89%	76.50-95.20
Specificity	91.91%	86.90-95.10
Positive predictive value	74.07%	61.10-83.90
Negative predictive value	96.95%	93.10-98.70
False positive rate	8.09%	
False negative rate	11.11%	
Accuracy	91.28%	
Prevalence	20.64%	

The best cut-off value of Ferrazi's scoring system that maximized the sum of sensitivity and specificity according to the ROC curves was 9 (Figure 1). The two by two table was shown in Table 4. With a cut-off value of 9 used as the best discriminator, the sensitivity was 88.89% (95% CI 76.50-95.20) and the specificity was 91.91% (95% CI 86.90-95.10). The positive and negative predictive values were 74.07% (95% CI 61.10-83.90) and 96.95% (95% CI 93.10-98.70), respectively. Accuracy was 91.28% and prevalence was 20.64% (Table 5).

Discussion

Most adnexal masses are benign.[10] The ability to accurately discriminate benign from malignant masses before surgery has proved elusive. Bimanual pelvic examination has marked limitation for evaluating the adnexa, because of a lack of predictive value.[1,11,12] Color Doppler ultrasonography helps identifying solid, vascularized components in a mass. Unfortunately, there are considerable overlaps in resistance index and pulsatility index between benign and malignant ovarian tumors. Most studies have been unable to use the resistance index and pulsatility index to distinguish between benign and malignant ovarian lesions.[12,13] Operator dependence and lacking of standard criteria are still the problems.[4] Recently, in the experienced hands, color Doppler imaging and power Doppler imaging used in conjunction with B-mode imaging and combined morphologic assessment by three-dimensional ultrasonography and vascular imaging improve preoperative assessment of ovarian tumors.[14,15]

Although magnetic resonance imaging and computed tomography are superior to Doppler ultrasonography in diagnosis of malignant ovarian masses,[16] they are also more expensive. To date serum CA 125 is the tumor marker with the highest association with ovarian cancer[3] but it can be increased in a variety of other conditions, both benign and malignant.[1] Hence, transvaginal ultrasonography might be the most practical modality for assessment of ovarian tumors. We used the ultrasonographic scoring system proposed by Ferrazi E. et al. because it was better than the others as present earlier. For treatment of borderline ovarian tumor, the physician should strive to complete extirpate the tumor.[17] Thereby, we included borderline ovarian tumors into malignant group. The sensitivity in this study was as sensitive as that reported by Ferrazi E. et al. but our specificity was higher. Inter-observer variation, difference in number and histopathological diagnoses of ovarian tumors, and lower cases of ovarian tumors in this study should be considered.

Alcazar JL, et al.18 studied 268 ovarian tumors in 248 patients using Ferrazi's scoring system. At the best cut-off value from ROC curve, the sensitivity was 84.4% (95% CI 67.2-94.7) and the specificity was 84.5% (95% CI 76.0-90.2). The positive and negative predictive values were 62.8% (95% CI 46.7-77.0) and 94.6% (95% CI 87.8-92.8), respectively.

Ultrasonographic features of mature cystic teratomas include regional or diffuse high echogenicity, hyperechoic lines and dots, fat-fluid level, and a floating mass overlap with ovarian carcinomas. Hence, they were the most common cause of false positive results in our study. At ultrasonography, endometriomas have a wide range of manifestations, from cystic to complex, and may have a solid appearance. Ovarian fibroma and Brenner tumor are also important because they appear as solid masses, thereby mimicking malignant ovarian tumors.[4]

False negative results were found in five cases, two of which were borderline ovarian tumors. Even more important than the high accuracy is the high sensitivity for malignancy, because clinically it is worse to have a false negative test result for patient with ovarian tumor who might need referral to a gynecologic oncologist for appropriate surgical intervention.[1,3,19] If we do not want to miss any case of malignancy, the cut-off value of 5 (sensitivity of 100%) should be used but also the very high false positive rate of 91.91% is unacceptable.

Preoperative assessments of ovarian tumors are helpful in counselling the patients, referral to a gynecologic oncologist, and planning for appropriate

surgery. The reliability of this study were the ultrasonographic assessments were performed by the same gynecologist within 72 hours before surgery and the data was collected in a prospective fashion.

The ultrasonographic scoring system is simple and can easily be applied after a while of training. Hence, our results may be used as a clinical guide before surgery in Thai women with ovarian tumors. Other ultrasonographic findings, including tumor size, ascites, and distant metastases, can also be evaluated to reduce the false positive and negative rates.

In conclusion, the ultrasonographic scoring system developed by Ferrazi E. et al. shows high diagnostic accuracy in discriminating benign from malignant ovarian tumors.

References

1. Rosenthal A, Jacobs I. Ovarian cancer screening. Semin Oncol 1998; 25: 315-25.
2. Okugawa K, Hirakawa T, Fukushima K, Kamura T, Amada S, Nakano H. Relationship between age, histologic type, and size of ovarian tumors. Int J Gynecol Obstet 2001; 74: 45-50.
3. Timmerman D, Bourne TH, Tailor A, Collins WP, Verrelst H, Vandenberghe K, et al. A comparison of methods for preoperative discrimination between malignant and benign adnexal masses: The development of a new logistic regression model. Am J Obstet Gynecol 1999; 181: 57-65.
4. Jeong YY, Outwater EK, Kang HK. Imaging evaluation of ovarian masses. RadioGraphics 2000; 20: 1445-70.
5. Ferrazi E, Zanetta G, Dordoni D, Berlanda N, Mezzopane R, Lissoni G. Transvaginal ultrasonographic characterization of ovarian masses; Comparison of five scoring systems in a multicenter study. Ultrasound Obstet Gynecol 1997; 10: 192-7.
6. Granberg S, Norstrom A, Wikland M. Tumors in the lower pelvis as imaged by vaginal sonography. Gynecol Oncol 1990; 37: 224-9.
7. Sassone AM, Timor-Tritsch IE, Artner A, Carolyn W, Warren WB. Transvaginal sonographic characterization of ovarian disease: evaluation of a new scoring system to predict ovarian malignancy. Obstet Gynecol 1991; 78: 70-6.
8. DePriest PD, Shenson D, Fried A, Hunter JE, Andrews SJ, Gallion HH, et al. A morphology index based on sonographic findings in ovarian cancer. Gynecol Oncol 1993; 51: 7-11.
9. Lerner JP, Timor-Yritsch IE, Federman A, Abramovich G. Transvaginal ultrasonographic characterization of ovarian masses with an improved, weighted scoring system. Am J Obstet Gynecol 1994; 170: 81-5.
10. Brown DL, Doubilet PM, Miller FH, Frates MC, Laing FC, DiSalvo DN, et al. Benign and malignant ovarian masses: Selection of the most discriminating gray-scale and Doppler sonographic features. Radiology 1998; 208: 103-10.
11. Padilla LA, Radosevich DM, Milad MP. Accuracy of the pelvic examination in detecting adnexal masses. Obstet Gynecol 2000; 96: 593-8.
12. Manolitsas TP, Fowler JM. Role of laparoscopy in the management of the adnexal masses and staging of gynecologic cancers. Clin Obstet Gynecol 2001; 44: 495-521.
13. Dubbin PA, Subba B. Screening for gynecological malignancy. Semin Ultrasound CT MR 1999; 20: 231-8.
14. Guerriero S, Alcazar JL, Ajossa S, Lai MP, Errasti T, Mallarini G, et al. Comparison of conventional color Doppler imaging and power Doppler imaging for the diagnosis of ovarian cancer: Results of a European study. Gynecol Oncol 2001; 83: 299-304.
15. Kurjak A, Kupesic S, Sparac V, Bekavac I. Preoperative evaluation of pelvic tumors by Doppler and three-dimensional sonography. J Ultrasound Med 2001; 20: 829-40.
16. Kurtz AB, Tsimikas JV, Tempany CC, Hamper UM, Arger PH, Bree RL, 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.
17. DiSaia PJ, Creasman WT. Clinical gynecologic oncology. St. Louis: Mosby 2002: 259-88.
18. Alcazar JL, Errasti T, Laparte C, Jurado M, Lopez-Garcia G. Assessment of a new logistic model in the preoperative evaluation of adnexal masses. J Ultrasound Med 2001; 20: 841-8.
19. Paley PJ. Screening for the major malignancies affecting woman: Current guidelines. Am J Obstet Gynecol 2001; 184: 1021-30.