# Sonographic Morphology Scores (SMS) for Differentiation Between Benign and Malignant Ovarian Tumor

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**Abstract**

The objectives of this cross-sectional descriptive analysis are to determine the sensitivity and specificity of sonographic morphology scores (SMS) in distinguishing between benign and malignant ovarian tumors and to determine the best cut-off score. The study was conducted at the Department of Obstetrics and Gynecology, Faculty of Medicine, Chiang Mai University. Two hundred and forty eight nonpregnant patients scheduled for elective surgery for ovarian tumors between July, 1996 and March, 1998 were recruited into the study and were sonographically examined in 24 hours of surgery by the same sonographer to evaluate inner wall structure, wall thickness, septum, echogenicity and score of the tumors. The final diagnosis was pathologically confirmed as the gold standard. It was found that the score of 9 from reciever operating characteristic curve was the best cut-off score, giving the sensitivity of 93.1 per cent and specificity of 75.6 per cent. In conclusion, the SMS system is probably useful in distinguishing ovarian malignancy from benign ovarian tumor.

**Key word :** Ovarian Tumor, Sonographic Morphology Scores, Ultrasound, Tumor Differentiation

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Ovarian carcinoma is the most common cause of mortality due to cancer in Thai women, accounting for 47 per cent of deaths from female genital cancer(1). The patient in the early stage of ovarian cancer usually has no symptoms, therefore, most cases are often diagnosed in the advanced stage, resulting in poor outcome of therapy. The 5-year-survival rate of stage 3 and 4 is only 10 per cent, compared to 60-70 per cent for stage 1 and 2(2). Early detection is the main strategy for sur-

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vival rate. One problem encountered which may delay proper early management is the differentiation of benign from malignant adnexal masses. This differentiation is of great value, because the therapeutic approach is markedly different between the two entities. Benign ovarian masses, functional or neoplasm, need more conservative, either close observation or laparoscopic surgery, whereas, the malignant tumors require urgent laparotomy in most cases with planned systematic consultation of available oncologists. Several attempts have been made to distinguish both conditions, especially the use of pelvic ultrasound based on either morphological appearance or Doppler waveforms. Some Western studies have shown that sonographic features of the masses can effectively differentiate the benign from malignant tumors with various accuracy[3-6]. Sassone and et al[6] found that sonographic morphology scores (SMS) system was effective in the differentiation with sensitivity of 100 per cent and specificity of 83 per cent. In our country, although ultrasound is widely available and ovarian cancer is an important problem, the effectiveness of pelvic ultrasound in this aspect has never been evaluated. Therefore, we conducted this study to determine the sensitivity and specificity of sonographic morphology scores (SMS) in distinguishing between benign and malignant ovarian tumors and to determine the best cut-off score.

## PATIENTS AND METHOD

Between July, 1996 and March, 1998, 262 nonpregnant patients were admitted to Maharaj Nakorn Chiang Mai Hospital for elective surgery due to the detection of adnexal mass either by pelvic examination or ultrasonography elsewhere or both.

All sonographic examinations were performed on the day before surgery by the same examiner who had no any clinical information of the patients. The women were examined with either real time sector 5 MHz transvaginal probe or 3.5 MHz transabdominal probe connected to an Aloka model SSD 680EX. After thorough conventional examination, the SMS system was prospectively recorded for subsequent analysis.

The ultrasound parameters for defining the nature of the masses were those proposed by Sassone et al[6]. The variables for scoring included inner wall structure (score of 1, 2, 3, and 4 for smooth, irregular $\leq$ 3 mm., papillary > 3 mm., and not applicable, respectively), wall thickness (score of 1, 2, and 3 for thin; $\leq$ 3 mm., thick; > 3 mm., and not applicable, respectively), septa (score of 1, 2, and 3 for no septa, thin; $\leq$ 3 mm., and thick; > 3 mm, respectively) and echogenicity (score of 1, 2, 3, 4, and 5 for sonolucent, low echo, low echo with echo core, mixed echo, and high echo, respectively). The total scores for each patient were determined by the summation of the score of each variable. After surgery, the histopathological diagnoses were recorded and classified as benign and malignant group (which included borderline tumor and carcinoma) for data analysis.

Based on the study of Botta et al[7] who found that the SMS gave a sensitivity of 89 per cent and specificity of 73 per cent, this study needed the sample size of at least 47 malignant cases to gain the confidence interval of 95 per cent.

The sensitivity and specificity of various cut-off values of SMS were calculated and the best cut-off value for differentiating the tumors was determined by receiver operating characteristic (ROC) curve.

## RESULTS

Between July, 1996 and March 1998, 262 nonpregnant patients initially diagnosed with ovarian tumors and scheduled for elective surgery were recruited into the study and were sonographically examined within 24 hours of surgery. Fourteen were excluded due to the subsequent pathlological diagnoses of non-ovarian tumor including subserous myoma, hydrosalpinx, parovarian cyst, etc. The remaining 248 were available for analysis.

Mean age ($\pm$ SD) of the malignant group was significantly higher than that of the benign group ($44.38\pm14.97$ *vs* $38.59\pm11.97$, Student's *t* test; $P<0.05$)

Histopathological examinations revealed 172 benign tumors and 72 malignant tumors, consisting of 51 cancers and 21 boderline tumors. The types of ovarian tumors according to pathological findings and SMS for each type of tumors are summarized in Table 1. The mean ($\pm$ SD) SMS of the malignant group ($10.99\pm1.85$; range 6.0-15) was significantly higher than that of the benign group ($7.18\pm2.38$, range 1.0-15.0) (Student's *t* test; $P<0.05$).

The sensitivity, specificity, positive predictive values, and negative predictive values in predicting malignancy were calculated for each cut-off

**Table 1. Histopathological diagnoses of the ovarian tumors, means of SMS, and number of patients with SMS ≥ 9.**

| Histopathological diagnosis | | Number | SMS Means | SMS ≥ 9 Number | % |
|---|---|---|---|---|---|
| *Malignant* | Serous cystadenocarcinoma | 15 | 12.00 | 14 | 93.3 |
| | Endometrioid carcinoma | 13 | 12.00 | 12 | 92.3 |
| | Mucinous cystadenocarcinoma | 11 | 11.00 | 10 | 90.9 |
| | Endodermal sinus tumor | 1 | 14.00 | 1 | 100.0 |
| | Mixed germ cell carcinoma | 2 | 12.50 | 2 | 100.0 |
| | Immature teratoma | 2 | 11.00 | 2 | 100.0 |
| | Metastatic carcinoma | 6 | 12.50 | 6 | 100.0 |
| | Clear cell carcinoma | 1 | 11.00 | 1 | 100.0 |
| | Mucinous type (borderline) | 17 | 10.00 | 17 | 100.0 |
| | Serous type (borderline) | 4 | 9.50 | 2 | 50.0 |
| *Benign* | Endometrioma | 49 | 6.63 | 8 | 16.3 |
| | Mature teratoma | 40 | 8.85 | 19 | 47.5 |
| | Mucinous cystadenoma | 34 | 6.97 | 9 | 26.5 |
| | Serous cystadenoma | 14 | 5.43 | 0 | 0.0 |
| | Follicular cyst | 9 | 6.22 | 1 | 11.1 |
| | Corpus luteam cyst | 12 | 6.58 | 1 | 8.3 |
| | Adenofibroma | 4 | 7.25 | 1 | 25.0 |
| | Tubo-ovarian abscess | 3 | 9.33 | 1 | 33.3 |
| | Parovarian cyst | 6 | 5.67 | 0 | 0.0 |
| | Thecofibroma | 1 | 10.00 | 1 | 100.0 |
| | Struma ovarii | 2 | 5.50 | 0 | 0.0 |
| | Sclerosing stromal tumor | 1 | 13.00 | 1 | 100.0 |
| | Brenner tumor | 1 | 11.00 | 1 | 100.0 |
| | Total | 248 | 9.48 | | |

**Table 2 Sensitivity, specificity, positive predictive value, negative predictive value for each cut-off score of SMS system.**

| SMS | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) |
|---|---|---|---|---|
| 5 | 100.00 | 6.25 | 30.38 | 100.00 |
| 6 | 100.00 | 25.57 | 35.47 | 100.00 |
| 7 | 97.22 | 49.43 | 44.03 | 97.75 |
| 8 | 95.83 | 65.34 | 53.08 | 97.46 |
| 9 | 93.06 | 75.57 | 60.91 | 96.38 |
| 10 | 77.78 | 84.66 | 67.47 | 90.30 |
| 11 | 61.11 | 88.64 | 68.75 | 84.78 |
| 12 | 41.67 | 94.89 | 76.92 | 79.90 |
| 13 | 15.28 | 95.45 | 57.89 | 73.36 |
| 14 | 12.50 | 97.73 | 69.23 | 73.19 |
| 15 | 4.17 | 98.86 | 60.00 | 71.60 |

(PPV = positive predictive value, NPV = negative predictive value)

value of SMS as presented in Table 2. The receiver operating characteristic (ROC) curve was constructed from a sensitivity and false positive rate for each cut-off score, as shown in Fig. 1. Based on this ROC curve, the SMS of 9 was the most appropriate cut-off score for detecting a malignant ovarian tumor, giving a sensitivity of 93.5 per cent and specificity of 75.6 per cent. When the cut-off score of 9 was used, the sensitivity of SMS in detecting the malignant cases was calculated for each patho-

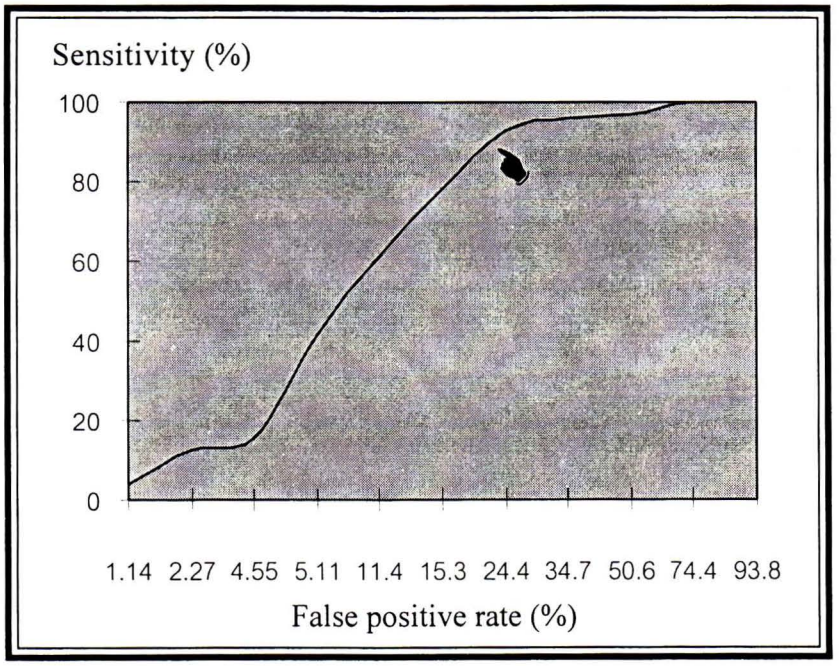


**Fig. 1. Receiver operating characteristic curve of SMS.**

logical diagnosis and also shown in Table 1. The false positive rate was rather high in cases of mature teratoma, endometrioma, and mucinous cystadenoma.

## DISCUSSION

Differentiation of benign from malignant tumors represents one of the most challenging problems. Knowledge of the tumor nature can lead to more proper management. For example, consultation of the oncologist and pathologist in advance or patient counseling regarding the extent of operation can provide better management. Several techniques have been used for this purpose such as CA 125 tumor marker[8], clinical course[9], and various types of imaging technology. Currently, most attention has been paid to ultrasound. Several attempts have been made in order to objectively define the sonographic criteria in predicting malignancy and benignity[3-6].

For practical purposes, we used the variables based on SMS system proposed by Sassone et al[6] because it is simple and easy to learn and can widely be applied without Doppler equipment. The variables including inner wall structure, wall thickness, septum, and echogenicity, can be clearly visualized in most cases.

The efficacy of SMS system in this study is not as sensitive as that reported by Sassone et al[6] who found a sensitivity of 100 per cent; however, it was comparable with that of other Western reports[10-14], which demonstrated that SMS had the sensitivity of 83-89 per cent and sepecificity of 73-97 per cent.

Interestingly, our results indicate that the false positive rate was high in cases of mature teratoma, endometrioma, and mucinous cystadenoma. These tumors were benign but give high scores because of their high echogenicity. This finding was consistent with that observed by Sassone et al[6]. However, in practical use this pitfall may be overcome by other characteristics of these tumors which are not included in the SMS system, such as fried egg appearance or hair speckles of mature teratoma, highly homogeneous echogenicity of endometrioma. In reality, an experienced sonographer can diagnose mature teratoma or endometrioma without difficulty.

False negative rate (malignant tumor in case of score < 9) may be found in some cases,

most of which are borderline tumors. However, rare cases of serous cystadenocarcinoma, endometrioid carcinoma, and mucinous cystadenocarcinoma can have low scores.

Overall, SMS can distinguish the nature of ovarian tumors with high sensitivity. Nearly all malignant tumors were detected with an acceptable false positive rate. The score is helpful in planning for management and counselling of patients as well as their relatives. Furthermore, ultrasound also provides other useful information such as the assessement of uterus, other pelvic structures as a non-invasive procedure. In reality, other sonographic information other than SMS, including the characteristics of Doppler flow, the presence of ascites, or the tumor size, can also be evaluated to reduce the false positive and negative rate. Moreover, although the cut-off score of 9 is the best based on ROC curve, for clinical use, it is not neccessary to choose this cut-off score. If we do not want to miss any case of malignancy at all, the cut-off score of 6 (sensitivity of 100%) should be used but we must accept the higher false positive rate.

To date, other studies regarding sonographic accuracy in differentiating the benign and malignant tumor in the Thai population have never been reported, therefore, our results may be used as a clinical guide before surgery for ovarian tumors or basic data for further studies. The scoring system is simple and can easily be applied after a short training.

The reliability of this study is based on the fact that ultrasound examinations were done by only one examiner who had no clinical information of the patient resulting in no interobserver variability, the examinations were done with the same high quality equipment, and finally the sample size was adequate.

In conclusion, SMS system can effectively differentiate the benign from malignant ovarian tumor with high sensitivity and specificity when the cut-off score is 9. However, the false positive rate was relatively high in mature teratoma, endometrioma and mucinous cystadenoma due to their high echogenicity, therefore, extreme caution should be taken in these conditions.

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# การใช้คะแนนจากลักษณะทางคลื่นเสียงความถี่สูงในการแยกเนื้องอกรังไข่ชนิดธรรมดากับชนิดร้ายแรง

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เป็นการศึกษาเชิงพรรณาแบบตัดขวางเพื่อหาความไว และความจำเพาะของคะแนนจากภาพคลื่นเสียงความถี่สูงในการทำนายแยกเนื้องอกรังไข่ชนิดธรรมดากับชนิดร้ายแรง และเพื่อหาคะแนนที่เหมาะสมในการใช้แยกชนิดเนื้องอกดังกล่าว ทำการศึกษาที่ภาควิชาสูติศาสตร์และนรีเวชวิทยา คณะแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ ศึกษาโดยคัดเลือกตัวอย่างจากผู้ป่วยที่ได้รับการวินิจฉัยเบื้องต้นว่าเป็นเนื้องอกรังไข่ ที่มารับการผ่าตัดแบบไม่ฉุกเฉิน ระหว่างกรกฎาคม 2539 ถึงมีนาคม 2541 จำนวน 248 คน โดยผู้ป่วยทั้งหมดได้รับการตรวจคลื่นเสียงความถี่สูงภายใน 24 ชั่วโมง ก่อนการผ่าตัดโดยแพทย์ผู้ตรวจเพียงท่านเดียว และให้คะแนนตามองค์ประกอบของเนื้องอก ได้แก่ โครงสร้างของผนังด้านในของเนื้องอก ความหนาของผนังเนื้องอก แผ่นกั้นแบ่งช่องภายในเนื้องอก และความเข้มเสียงของเนื้องอก ซึ่งจะประเมินความถูกต้องในการแยกเนื้องอกรังไข่ชนิดธรรมดากับชนิดร้ายแรงโดยเทียบกับผลการตรวจทางพยาธิวิทยาหลังผ่าตัด ผลการศึกษาพบว่าค่าคะแนนที่เหมาะสมในการใช้แยกเนื้องอกชนิดธรรมดากับชนิดร้ายแรงคือ 9 (โดยได้จาก receiver operating characteristic curve) ซึ่งให้ความไวร้อยละ 93.1 และความจำเพาะ 75.6 โดยสรุป ค่าคะแนนจากระบบการให้คะแนนโดยใช้คลื่นเสียงความถี่สูงมีความไว และความจำเพาะสูง ในการทำนายแยกเนื้องอกรังไข่ชนิดร้ายแรงออกจากชนิดธรรมดา

**คำสำคัญ** : เนื้องอกรังไข่, คลื่นเสียงความถี่สูง, ระบบคะแนนจากภาพคลื่นเสียงความถี่สูง, การแยกชนิดของเนื้องอก

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