Simple ultrasound examination as a diagnostic tool for malignant ovarian tumors

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Abstract. Ovarian cancer is ranked as the third most common cancer among Indonesian women. Simple ultrasound examinations that can be used as a screening tool for the detection of ovarian malignancies may prove useful in primary health care. This study aimed to determine the diagnostic values of a simple ultrasound examination for the detection of ovarian malignancy and compare them with the postoperative histopathological findings of the tumor. This cross-sectional study conducted at the Cipto Mangunkusumo Hospital evaluated gynecologic outpatients with ovarian tumors who had undergone surgery during the period of March 2015 to July 2015. Samples were obtained by consecutive sampling. Analysis was performed using the chi-squared test and logistic regression to ascertain the relationship between the ultrasound morphologic patterns and the histopathologic findings. Furthermore, a model derived from the logistic regression was used to calculate the probability of developing ovarian malignancy. Among the 80 subjects with ovarian cancer, 72.5% presented with benign tumors and 27.5% with malignant tumors. Using a cutoff of ≥2 morphologic patterns in the ultrasound examination, 53.8% subjects presented with malignancy, and the diagnostic values of sensitivity, specificity, positive predictive value, and negative predictive value were 100%, 82.8%, 68.8%, and 100%, respectively. The probability of a subject having an ovarian malignancy if ≥3 morphologic patterns were present was above 88.9%. Simple ultrasound examinations may thus prove beneficial for the detection of ovarian malignancy.

1. Introduction

Ovarian malignancy is the fourth most common malignancy in developed countries [1], and the third most common malignancy in women after cervical and breast malignancy in Indonesia [2]. Approximately 204,449 new cases of ovarian malignancy are reported each year, resulting in nearly 124,860 deaths worldwide [3].

Ovarian malignancy is considered as a silent killer in women. The 5-year survival rate of patients with ovarian malignancy is highly dependent on the stage of cancer [4,5]. In Indonesia alone, the mortality rate due to ovarian cancer is 22.6% of all gynecological cancers. Approximately 42.5% of the cancer patients seek treatment during stages II–IV; at these late stages, the cancer is estimated to spread and metastasize in nearly 70%–80% of cases. The five-year-survival-rate for ovarian cancer
has been reported as 72.8% at stage I, 46.3% at stage II, 17.2% at stage III, and only 4.8% at stage IV [5].

The high rates of mortality may be attributed to the difficulty in detecting ovarian malignancies during the early stages. Nearly 50% of patients report to the physicians during the advanced stage, which has a poor prognosis [5]. Therefore, a holistic diagnosis approach is needed to reduce the mortality associated with this cancer. Diagnosis of the ovaries can be initiated during anamnesis, paying specific attention to the potential risk factors and family history of the malignancy [6]. According to Olson et al (2001) [7], the symptoms of ovarian malignancy are not specific, and it is often mis-diagnosed as dyspepsia syndrome.

The use of ultrasound scans is a good option during early examination of ovarian malignancy (80%–100% sensitivity) [8]. In Indonesia, ultrasonographic examination has not been used as a standard procedure in primary health care. In the Pedoman Penyelenggaraan Puskesmas Mampu PONED 2013 (Indonesia’s guidelines for obstetri neonatal basic emergency in Puskesmas) [9], it was concluded that ultrasound examination by general practitioners in primary health care is only required for the screening of obstetric problems, not gynecological problems. However, we believe that, in order to suppress cancer-related mortality, it is necessary to screen for ovarian malignancy in the primary care.

This study aimed at evaluating the benefits of a simple ultrasound examination for the assessment of ovarian tumors among women in Indonesia. In the future, it is hoped that ultrasound examination can be used as an accurate and routine diagnostic screening tool for ovarian malignancies and be performed routinely by health personnel in primary care.

2. Methods
This descriptive cross-sectional study compared the results of ultrasound examinations with that of the histopathologic gold standard examination among tumor patients in Indonesia. Data were collected according to the consecutive sampling of ovarian tumor patients who underwent surgery from March 2015 until July 2015 at Dr. Cipto Mangunkusumo (RSCM) hospital in Jakarta, Indonesia. Medical records were reviewed and data regarding transvaginal and transabdominal ultrasound examinations (bilaterality, wall surface, wall thickness, number of loci, papillary protrusion, presence of solid part, and ascites) and histopathological examinations were collected. Patients with incomplete histopathological data and ultrasound data, and those diagnosed with advanced post-chemotherapy malignant ovarian tumors, solid ovarian neoplasms, and dermoid cysts were excluded from the study.

The collected data was processed using SPSS version 21 and analyzed by chi-squared test after entering the amounts into a dummy table. An alternative test was used if the requirements were not fulfilled. Specificity, sensitivity, positive and negative predictive value, positive and negative likelihood ratio, and accuracy were reported. Furthermore, multivariate analysis (logistic regression) was conducted to identify simultaneous morphological patterns and equation models that may indicate the probability of developing a malignant ovarian tumor in the subjects. The study was approved by the Health Research Ethics Commite, Faculty of Medicine Universtas Indonesia-Cipto Mangunkusumo Hospital (No. 711/UN2.F1/ETIK/2015).

3. Results
Data search was performed by evaluating the records of patients with ovarian tumor admitted at the hospital from March 2015 to July 2015. The data of 101 patients with ovarian tumor was obtained; however, after the application of the exclusion criteria, 21 subjects were excluded, bringing the total number of subjects analyzed in this study to 80.
Table 1. Characteristics of the subjects

| Variable                      | Total (n = 80) | Malignant (n = 22) | Benign (n = 58) |
|-------------------------------|---------------|-------------------|----------------|
| Age [year old; mean ± SD]    | 39.06 ± 12.40 | 44.86 ± 12.16     | 36.86 ± 11.86  |
| Obstetric history [Para; median (min–max); n (%)] | 1 (0–5)       | 1 (0–4)           | 1 (0–5)        |
| 0 time                        | 36 (45)       | 11 (50)           | 25 (43.1)      |
| 1st time                      | 11 (13.75)    | 2 (9.1)           | 10 (17.2)      |
| 2nd time                      | 16 (20)       | 3 (13.6)          | 13 (22.4)      |
| 3rd time                      | 9 (11.25)     | 4 (18.2)          | 5 (8.6)        |
| 4th time                      | 5 (6.25)      | 2 (9.1)           | 3 (5.2)        |
| 5th time                      | 2 (2.5)       | 0 (0)             | 2 (4.3)        |
| Complaints [n (%)]            |               |                   |                |
| Increased abdominal size      | 61 (76.3)     | 21 (95.5)         | 40 (69)        |
| Lump in abdomen               | 46 (57.5)     | 17 (77.3)         | 29 (50)        |
| Abdominal pain                | 43 (53.8)     | 10 (45.5)         | 33 (56.9)      |
| Weight loss                   | 23 (28.8)     | 14 (63.6)         | 9 (15.5)       |
| Bloating                      | 22 (27.5)     | 6 (27.3)          | 16 (27.6)      |
| Losing appetite               | 21 (26.3)     | 15 (68.2)         | 6 (10.3)       |
| Urination complaint           | 1 (1.3)       | 1 (4.5)           | 0 (0)          |
| Bowel complaint               | 0 (0)         | 0 (0)             | 0 (0)          |
| CA-125 [U/mL; median (min–max)] | 153 (11–2529) | 247 (15–2529)     | 127 (11–645)   |
| Risk of Malignancy Index [median (min–x); n (%)] | 323 (11–22761) | 855 (47–22761)   | 200,5 (11–1047) |
| High (>200)                   | 38 (47.5)     | 16 (72.7)         | 26 (44.8)      |
| Moderate (25–200)             | 32 (40.0)     | 6 (27.3)          | 29 (50)        |
| Low (<25)                     | 3 (3.8)       | 0 (0)             | 3 (5.2)        |

*There are no 7 data because CA-125 is not checked; SD, standard deviation

As shown in Table 1, the mean age of the patients was 39.06 ± 12.35 years with the mean age in the malignant tumor group being higher than that in the benign tumor group (44 vs 36 years old). The obstetric history (para) demonstrated a median of 1 childbirth, with the minimum of 0 and a maximum of 5. The majority of the researched subjects had never given birth (45%). The most common complaint was enlarged abdomen (76.3%). The research subjects in the malignant group had a median CA-125 tumor marker level of 247 U/mL with a median RMI of 855, whereas in the benign group, the median CA-125 level was 127 U/mL with a median RMI of 200.5.

Table 2. Characteristics of ultrasonographic morphological patterns

| Variable          | Result (n = 80) |
|-------------------|----------------|
| Morphological Patterns [n (%)] |                  |
| 0                 | 16 (20)        |
| 1                 | 32 (40)        |
| 2                 | 9 (11.3)       |
| 3                 | 13 (16.3)      |
| 4                 | 8 (10)         |
| 5                 | 2 (2.5)        |
| 6                 | 0 (0)          |
Table 2. Continue

| Variable                        | Result (n = 80) |
|---------------------------------|----------------|
| **Bilaterality [n (%)]**        |                |
| Bilateral                       | 33 (41.3)      |
| Unilateral                      | 47 (58.8)      |
| **Surface of the wall [n (%)]** |                |
| Irregular                       | 15 (18.8)      |
| Smooth                          | 65 (81.3)      |
| **Type of locus [n (%)]**       |                |
| Multilocular                    | 29 (36.3)      |
| Unilocular                      | 51 (63.8)      |
| **Papillary protrusion [n (%)]**|                |
| Yes                             | 10 (12.5)      |
| No                              | 70 (87.5)      |
| **Solid part [n (%)]**          |                |
| Present                         | 33 (41.3)      |
| Not Present                     | 47 (58.8)      |
| **Ascites [n (%)]**             |                |
| Yes                             | 11 (13.8)      |
| No                              | 69 (86.3)      |

The morphological pattern data showed unilateral tumors as the most common feature (58.8%), along with smooth wall surface (81.3%), unilocularity (63.8%), no papillary protrusion (87.5%), no solid part (58.8%), and no ascites (86.3%) in the ultrasonographic tests (Table 2).

Table 3. Ovarian tumor histopathology

| Variable                                           | Result (n = 80) |
|----------------------------------------------------|----------------|
| **Histopathologic result [n (%)]**                 |                |
| Malignant                                          | 22 (27.5)      |
| Serous cystadenocarcinoma                          | 3 (3.75)       |
| Mucinous cystadenocarcinoma                        | 8 (10)         |
| Sero-mucinous cystadenocarcinoma                   | 2 (2.5)        |
| Endometrioid cystadenocarcinoma                    | 3 (3.75)       |
| Clear cell cystadenocarcinoma                      | 4 (5)          |
| Mixed epithelial tumor                             | 1 (1.25)       |
| Androblastoma/Sertoli-Leydig-cell tumor            | 1 (1.25)       |
| Benign                                             | 58 (72.5)      |
| Endometriosis                                     | 28 (35)        |
| Kistadenoma serosum                               | 3 (3.75)       |
| Kistadenoma Musinosum                              | 22 (27.5)      |
| Kistadenoma seromusinosum                         | 1 (1.25)       |
| Endometrioid Cystadenoma                           | 0 (0)          |
| Clear cell cystadenoma                             | 1 (1.25)       |
| Mature teratoma                                    | 3 (3.75)       |

The histopathologic results (Table 3) showed malignant results in 27.5% of the cases, with the most common histopathologic type being mucinous cystadenocarcinoma (10%), whereas the most benign tumor was endometriosis cyst (35%).
Table 4. Comparison of morphological patterns in the ultrasound and histopathological tests (a cutoff of two morphological patterns).

| Histopathologic tests | Malignant | Benign | Total | p value | Test          |
|-----------------------|-----------|--------|-------|---------|---------------|
| Morphology ≥2         | 22        | 10     | 32    | <0.001  | Chi-squared   |
| <2                    | 0         | 48     | 48    |         |               |
| Total                 | 22        | 58     | 80    |         |               |
| Sens                  | 100%      | 82.8%  |       |         |               |
| Spec                  | 68.8%     | 48     |       |         |               |
| PPV                   | 100%      | 5.81   |       |         |               |
| NPV                   | 0         | 0      |       |         |               |
| LR+                   | 87.5%     |        |       |         |               |
| LR-                   |           |        |       |         |               |
| Accuracy              |           |        |       |         |               |

Table 5. Comparison of morphological patterns of the ultrasound with the results of the histopathological test (cutoff of three morphological patterns).

| Histopathologic Test | Malignant | Benign | Total | p value | Test          |
|----------------------|-----------|--------|-------|---------|---------------|
| Morphology ≥3        | 17        | 6      | 23    | <0.001  | Chi-squared   |
| <3                   | 5         | 52     | 57    |         |               |
| Total                | 22        | 58     | 80    |         |               |
| Sens                 | 77.3%     | 89.7%  |       |         |               |
| Spec                 | 73.9%     | 91.2%  |       |         |               |
| PPV                  | 91.2%     | 7.50   |       |         |               |
| NPV                  | 0.25      |        |       |         |               |
| LR+                  | 88.8%     |        |       |         |               |
| LR-                  |           |        |       |         |               |
| Accuracy             |           |        |       |         |               |

Comparisons of the morphological patterns of the ultrasound with the results of the histopathological test revealed significant associations between the two (p < 0.001) (Table 4). When the morphological limit of ≥2 patterns was considered, a 100% sensitivity and 82.8% specificity was obtained, with a positive predictive value of only 68.8% but a negative predictive value of 100%. When the morphological limit of ≥3 was used, the sensitivity value was 77.3%, the specificity was 89.7%, the positive predictive value was 73.9%, and the negative predictive value was 91.2% (Table 5).

Table 6. Relations between ultrasonographic morphological patterns and histopathological results.

| Variable            | Histopathology | P value | OR    | 95% CI  | Test         |
|---------------------|----------------|---------|-------|---------|--------------|
|                     | Malignant  | Benign  |       |         |              |
|                     | n   | %    | n   | %    |     | Min  | Max  |     |     |              |
| Bilaterality        | Bilateral | 12     | 36.4 | 21    | 63.6 | 0.137 | 2.11 | 0.78 | 5.72 | Chi-squared |
|                     | Unilateral| 10     | 21.3 | 37    | 78.7 |       |      |      |      |              |
| Wall surface        | Irregular | 12     | 80.0 | 3     | 20.0 | <0.001 | 22.0 | 5.25 | 92.24 | Fisher     |
|                     | Smooth   | 10     | 15.4 | 55    | 84.6 |       |      |      |      |              |
| Locus               | Multilocular | 14     | 48.3 | 15    | 51.7 | 0.002 | 5.02 | 1.76 | 14.32 | Chi-squared |
|                     | Unilocular| 8      | 15.7 | 43    | 84.3 |       |      |      |      |              |
| Papillary protrusion| Yes       | 7      | 70.0 | 3     | 30.0 | 0.004 | 8.56 | 1.97 | 37.14 | Fisher     |
|                     | No        | 15     | 21.4 | 55    | 78.6 |       |      |      |      |              |
| Solid Part          | Yes       | 20     | 60.6 | 13    | 39.4 | <0.001 | 34.62 | 7.14 | 167.91 | Chi-squared |
|                     | No        | 2      | 4.3  | 45    | 95.7 |       |      |      |      |              |
| Ascites             | Yes       | 7      | 63.6 | 4     | 36.4 | 0.008 | 6.30 | 1.63 | 24.43 | Fisher     |
|                     | No        | 15     | 21.7 | 54    | 78.3 |       |      |      |      |              |
| Total               | 22        | 27.5  | 58   | 72.5   |              |
In Table 6, the locus (p = 0.002), presence of papillary protrusion (p = 0.004), presence of solid part (p < 0.001), wall surface (p < 0.001), papillary protrusion (p = 0.004), and presence of ascites (p = 0.008) were found to be significantly associated. Conversely, no significant association between the tissue histopathology findings and bilaterality was noted (p = 0.137).

| Morphologic Pattern | Diagnostic Value |
|---------------------|------------------|
|                     | P value | Sens | Spec | PPV | NPV | LR+  | LR−  | Accuracy |
| Uni/bilateral       | 0.137   | 54.5% | 63.8% | 36.4% | 78.7% | 1.51  | 0.71  | 61.3%    |
| Wall surface        | <0.001  | 54.5% | 94.8% | 80.0% | 84.6% | 10.55 | 0.48  | 83.8%    |
| Locus               | 0.002   | 63.6% | 74.1% | 48.3% | 84.3% | 2.46  | 0.49  | 71.3%    |
| Papillary protrusion | 0.004   | 31.8% | 94.8% | 70.0% | 78.6% | 6.15  | 0.72  | 77.5%    |
| Solid part          | <0.001  | 90.9% | 77.6% | 60.6% | 95.7% | 4.06  | 0.12  | 81.3%    |
| Ascites             | 0.008   | 31.8% | 93.1% | 63.6% | 78.3% | 4.61  | 0.73  | 76.3%    |

The results of the calculation of the diagnostic values of the morphological patterns are presented in Table 7. The highest sensitivity value was observed for tumors with a solid part (90.9%), while an irregular wall surface and presence of papillary protrusion presented with the highest specificity values (94.8%). The best positive and negative predictive values were observed for irregular wall surface (80%) and solid part component (95.7%), respectively. The irregular wall pattern presented with the highest accuracy rate (83.8%). After all the data were collected, the research variables with p values < 0.25 in the bivariate analysis were included in the multivariate analysis (Table 8).

Table 8. Multivariate analysis of ultrasonographic morphological patterns with the histopathological outcomes

| Variable              | P value | OR    | IK 95%  |
|-----------------------|---------|-------|---------|
| Wall Surface          | 0.010   | 18.42 | 2.02–167.93 |
| Locus                 | 0.019   | 10.73 | 1.47–78.37 |
| Papillary protrusion  | 0.011   | 28.37 | 2.14–375.43 |
| Solid part            | 0.009   | 23.64 | 2.19–254.73 |

Based on the results of the multivariate analysis, it was found that the morphological patterns of the ultrasonographic examination that influenced against the malignant of cystic ovarian tumor were irregular wall surface, presence of multilocular septum, papillary protrusion, and presence of a solid part. The probability of a subject experiencing ovarian malignancy is calculated based on the type and number of risk factors in each subject.

Table 9. The probability of a subject experiencing a malignant ovarian tumor based on the type and number of morphological patterns.

| Variable          | y    | P    |
|-------------------|------|------|
| (A) Irregular wall surface | −3.452 | 3.1% |
| (B) Multilocular locus       | −3.993 | 1.8% |
| (C) Papillary protrusion     | −3.021 | 4.6% |
| (D) Solid part              | −3.203 | 3.9% |
| A + B                        | −1.079 | 25.4% |
| A + C                        | −0.107 | 47.3% |
| A + D                        | −0.289 | 42.8% |
Based on the data in Table 9, the morphological pattern that had the greatest chance of leading to malignancy when it appeared alone was papillary protrusion (4.6%), followed by presence of a solid part (3.9%). If two morphological patterns were obtained, the chances of the tumor turning malignant ranged from 25.4% to 53.3%, and if three morphological patterns were observed, the chances were found to increase from 88.9% to 95.5%. Finally, when four morphological patterns were noted, the subject had a 99.6% chance of experiencing a malignant ovarian tumor.

4. Discussion

In the current study, the mean age of the patients was 39.15 ± 12.35 years, and patients in the malignant group were found to be older than those in the benign group (44 vs 36 years). This result is in line with the results of the study by Yazbek et al. which was conducted at the King's College Hospital in London, wherein the mean age of women with malignant adnexa masses was 52 years and that of those with benign and borderline growths was 39 years [10]. In another study, the mean age of women with malignant adnexa mass was reported as 61 years, whereas in the benign and borderline cases the mean ages were 46 and 51 years, respectively [11]. In addition, a study by Aziz MF in Indonesia showed similar results where the incidence of ovarian cancer was highest in the 45–54 year age group (27.7%) followed by the 35–44 age group (26.8%) [2]. These results are consistent with the literature suggesting that the risk of ovarian malignancy increases with age, and a sharp increase occurs at the age of 35–39 years and peaks at the age of 80–84 years. Although the age of the patients in the study conducted in London [10] was higher than that reported in Indonesia, the age range of the patients in both studies fell within the category associated with high risk of ovarian tumor; moreover, the mean age of patients with malignant ovarian tumor was higher than that of those with benign ovarian tumor.

The birth history of the subjects in the current study demonstrated a median of 1 (0–5 times), and nearly 45% of subjects had never given birth. This is similar to the results of the study by Goff et al. where nearly 48% of the 1,709 women examined had never given birth [12]. Women with nulliparity are known to have a higher risk of ovarian malignancy because they experience a greater amount of ovulation, which could invaginate or damage the epithelial cells on the surface, thus increasing the risk of ovarian malignancy.

The chief complaint of the subjects in the current study was increase in abdominal size (76.3%) in both the malignant (95.5%) and benign (69%) tumor groups. This is similar to the results of the study by Goff et al. where the most common complaints in 128 women (84 benign tumors and 44 malignant tumors) were bloating (70%) and increased abdominal size (64%) [12].

The median level of the tumor marker CA-125 in the malignant group was 247 U/mL with a median RMI of 855, whereas in the benign group, the median CA-125 level was 127 U/mL with a median RMI of 200.5. These results were not significantly different from those reported in a retrospective study comprising 182 women, where CA-125 levels were higher in patients with malignant tumors when compared to those with benign tumors [13]. Bouzari et al. found that a CA-125 cutoff value of 88 U/mL would yield 88% sensitivity, 97% specificity, an estimated positive score of 84%, and a negative predictive value of 99% [13]. However, only the diagnostic value, not the RMI value, was provided in that study. The optimal cutoff value for RMI 3 was 265 with a 91%
sensitivity, 96% specificity, a positive predictive value of 78%, and a negative predictive value of 99% [13].

The prominent morphological pattern observed based on the findings of the current study was unilateral tumor (58.8%), smooth wall surface (81.3%), unilocular locus (63.8%), no papillary protrusion (87.5%), no solid part (58.8%), and no ascites (86.3%). The histopathologic results showed malignancy in 27.5% of the cases, with the most common histopathologic type being cystadenocarcinoma mucinosum (10%), whereas the most benign condition observed was endometriosis cyst (35%). These results are similar to those reported by Timmerman et al. where the proportion of malignant ovarian tumors in 1,066 patients was 27% [14]. In another study, the proportion of ovarian malignant tumors in a population of 155 women was 50.32% [15]. However, this study did not exclude patients diagnosed with solid ovarian tumors, which have a higher risk of turning malignant when compared with cystic ovarian tumors.

Comparison of the number of morphological patterns using the limit of ≥2 patterns with the results of the histopathological test revealed a sensitivity value of 100%, a specificity value of 82.8%, a positive predictive value of 68.8%, and a negative predictive value of 100%. When the morphological limit of ≥3 patterns was used, the sensitivity, specificity, positive predictive, and negative predictive values were 77.3%, 89.7%, 73.9%, and 91.2%, respectively. Similar results were obtained in the study by Hafeez et al., where the sensitivity and specificity values of the ultrasound in detecting malignant tumors were 93% and 89%, respectively, while the positive and negative predictions were 91% and 89%, respectively; the accuracy rate was 91% [8]. However, the study by Galvan et al. reported even higher ultrasound diagnostic scores (98.6% sensitivity, 94.9% specificity, 94.7% positive predictive value, 98.7% negative predictive value, and 96.7% accuracy) [16].

The results of the bivariate analysis in the present study revealed significant correlations between the histopathological findings and the following morphological patterns of the ultrasonography: irregular surface (p < 0.001), multilocular locus (p = 0.002), papillary protrusion (p = 0.004), solid part (p < 0.001), and presence of ascites (p = 0.008). No significant associations between the tissue histopathology and bilaterality were noted (p = 0.137). Multivariate analysis showed that the morphological patterns that influenced the potential for malignant transformation were irregular wall surface, presence of a multilocular septum, papillary protrusion, and presence of a solid part in the ovarian cystic tumor. These findings are similar to those reported by Timmerman et al. who found a significant association between ascites, irregular papillary protrusion (≥1), irregular wall, papillary protrusion, bilateral mass, incomplete septum, and acoustic shadow in the histopathologic results (p < 0.01). In addition, significant associations were also found in multilocular tumor types with solid sections (p < 0.01), unilocular tumors with a solid part (p = 0.02), multilocular and unilocular tumors without solid parts (p < 0.01), and tumors with a solid part (p < 0.01) [14]. However, no significant association was found in bilateral tumor properties. This can be due to many benign tumors that appear to be bilateral in this study (63.6%).

Calculations of the diagnostic value of the morphological pattern revealed highest sensitivity values for the solid part of the tumor (90.9%), and the highest specificity values for irregular wall and presence of papillary protrusion (94.8% for both). The highest positive and negative predictive values were observed for the variables irregular wall surface pattern (80%) and presence of solid part (95.7%), respectively. The highest accuracy rate of 83.8% was noted for the irregular wall variable. The diagnostic values of morphological patterns in the study by Timmerman et al. were slightly different from those in the present study. The highest sensitivity and specificity values in their study were observed for the variables solid part (91.8%) and ascites (96.1%), respectively. The specificity values of irregular wall surface and papillary protrusion were 69.2% and 82.2%, respectively, which were lower than the values obtained in the current study. However, the specificity values of ascites were similar in both studies (96.1% in Timmerman et al. vs 93.1% in the present study). The highest positive predictive value for the ascites variable was 83%, and the highest negative predictive value for the surface variable in the irregular cyst wall was 90.3% [14].
Based on the results of the multivariate analysis, it was found that the morphological patterns of the ultrasonographic examination that influenced together against the malignancy potential of the cystic ovarian tumor were irregular wall surface pattern, presence of multilocular septum, papillary protrusion, and presence of a solid part. The morphological pattern that had the greatest chance of leading to malignancy when it appeared alone was papillary protrusion with a probability of 4.6%, followed by presence of a solid section (probability, 3.9%).

In the studies by Timmerman et al., the factors that affected ovarian tumor malignancy in 1,066 women with adnexal tumors, based on logistic regression, were age, family history of ovarian cancer (odd ratio [OR] 4.95), maximum tumor diameter, maximum diameter of the solid component, presence of ascites (OR 4.2), presence of blood flow in the papillary protrusion (OR 3.23), presence of a solid lesion (OR 2.53), presence of irregular cyst internal wall (OR 3.13), and increased color score [14,17]. However, their studies included demographic characteristics and ultrasound results as predictors of malignancy in ovarian tumors, whereas in the current study, only the characteristics of the ultrasound were included [17]. Nevertheless, the presence of solid components and irregular internal wall surface cysts were found to be more likely to lead to malignancy in both studies.

5. Conclusion
The findings of this study indicate that the strong predictive factors for ovarian malignancy based on ultrasound examination were irregular wall pattern, presence of multilocular locus, papillary protrusion, and presence of a solid part of the tumor. The probability of having a malignant ovarian tumor was more than 88.9% when three or more predictive morphological patterns of a simple ultrasound examination were involved.

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