Clinical and Experimental Obstetrics & Gynecology

Clin. Exp. Obstet. Gynecol. **2025**; 52(10): 41382
https://doi.org/10.31083/CEOG41382

Original Research

Risk of Borderline and Malignant Tumours in Laparoscopic Surgery for Serous and Mucinous Ovarian Cysts: A Retrospective Study

Kanae Tozaki[1], Wataru Isono[1,2,*], Yoshitomo Machida[1], Junya Tanaka[1], Mayo Nishikawa[1], Ryosuke Arakaki[1], Sumika Matsui[1], Shiko Hayashi[1]

[1]Department of Obstetrics and Gynaecology, Kinan Hospital, 646-8588 Wakayama, Japan
[2]Department of Obstetrics and Gynaecology, Wakayama Medical University, 641-0012 Wakayama, Japan
*Correspondence: tetuken2010@gmail.com (Wataru Isono)
Academic Editor: Michael H. Dahan
Submitted: 16 May 2025 Revised: 13 July 2025 Accepted: 23 July 2025 Published: 20 October 2025

Abstract

Background: When considering laparoscopic surgery for ovarian cysts (OCs), physicians must preoperatively differentiate benign ovarian tumours (Be-OTs) from other tumours, primarily based on magnetic resonance imaging (MRI) findings. Ovarian endometriotic cysts (OECs) and ovarian mature cystic teratomas (OMCTs) can typically be identified with high accuracy using MRI. However, OCs other than OECs and OMCTs may show borderline/malignant OT (Bo/Ma-OT) features on postoperative pathology, even when no suspicious solid components are detected preoperatively. Therefore, the aim of this study was to retrospectively analyse the data of 239 patients over a 15-year period at our institution to explore the potential for preoperative prediction of Bo/Ma-OT. **Methods**: From July 1, 2010 and December 31, 2024, 239 patients who underwent laparoscopic surgery for preoperatively diagnosed serous/mucinous OCs (Se/Mu-OCs) were retrospectively analysed. Among them, 26 cases, including 23 borderline and 3 malignant tumours identified on postoperative pathological examination, were the primary focus of this study. To evaluate the influence of 16 factors, including MRI findings, tumour markers, and basic patient characteristics, both univariate and multivariate analyses were performed. **Results**: According to the results of the chi-square test and multivariate analysis, none of the factors was significantly associated with an increased likelihood of Bo/Ma-OT. **Conclusions**: Preoperative prediction of Bo/Ma-OT in patients undergoing laparoscopic surgery for Se/Mu-OCs remains challenging. Further accumulation of cases and continued analysis will be necessary.

Keywords: borderline/malignant ovarian tumour; laparoscopic surgery; magnetic resonance imaging; serous/mucinous ovarian tumour; multivariate analysis; retrospective study

1. Introduction

As minimally invasive approaches have gained importance in gynecological surgery, laparoscopic surgery is generally performed for ovarian cysts (OCs) following careful preoperative assessment to determine that the lesion is benign [1]. Furthermore, when feasible, laparoscopic ovarian cystectomy is performed as an ovarian-sparing surgery in premenopausal patients requiring fertility preservation or hormonal support [2]. However, when a borderline/malignant ovarian tumour (Bo/Ma-OT) is identified, the primary treatment is converted to total hysterectomy with bilateral salpingo-oophorectomy, and the treatment strategy becomes more complex depending on the tumour stage, as the objective transitions to preventing tumour progression and recurrence [3–5]. Therefore, preoperative differentiation between Bo/Ma-OTs and benign OTs (Be-OTs), primarily based on magnetic resonance imaging (MRI) findings, must be as accurate as possible [6–8]. However, although MRI is considered highly accurate in identifying ovarian endometriotic cysts (OECs) and ovarian mature cystic teratomas (OMCTs) as benign lesions, Bo/Ma-OT, especially in serous/mucinous OCs (Se/Mu-OCs), are sometimes identified postoperatively [9,10]. Therefore, we conducted a retrospective analysis of clinical data from our institution, excluding OECs and OMCTs, to investigate whether Bo/Ma-OT could be predicted preoperatively among other types of OCs, particularly Se/Mu-OCs, by assessing the accuracy of these predictions against postoperative pathological findings.

2. Materials and Methods

2.1 Data Collection

This retrospective study was reviewed and approved by the Human Ethics Committee of Kinan Hospital (Approval No. 283: Clinical outcomes of endoscopic surgery: retrospective analyses, 2024/4/23).

The deidentified medical records of 298 patients who underwent laparoscopic surgery for OCs between July 1, 2010 and December 31, 2024 were retrospectively reviewed. Patients who underwent laparoscopic surgery based on an almost definitive preoperative diagnosis of OECs or OMCTs—these diagnoses being the primary indications for surgical intervention—were excluded. Additionally, patients whose MRI findings suggested only the possibility of these conditions, specifically, 14 patients with

OECs, 16 patients with OMCTs, 16 patients with ovarian fibromas, 2 patients with ovarian haemorrhage, and 5 patients with pelvic masses of unknown origin, were also excluded. Furthermore, 6 patients whose MRI suggested the presence of solid components were excluded, resulting in a total of 59 excluded patients. All 239 cases were subsequently classified as Bo/Ma-OT or Be-OT, with any patient having even a small portion of Bo/Ma-OT in the pathological diagnosis categorized as Bo/Ma-OT. In this study, Bo-OT and Ma-OT were grouped together as Bo/Ma-OT, as the likelihood of a Ma-OT being identified postoperatively was extremely low, occurring in 3 of 239 patients. This classification allowed for a meaningful comparison with Be-OT. Data from the 239 patients included in the analysis were collected, and the following variables were extracted: (1) basic patient characteristics, such as age, body mass index (BMI), parity, gynaecological surgical history, smoking history, and dysmenorrhea; and (2) OC-related data, such as tumour size (defined as the maximal diameter measured on MRI), carbohydrate antigen 19-9 (CA19-9) expression, carbohydrate antigen 125 (CA125) expression, and coexistent leiomyoma. Additionally, data on 5 MRI-related features were extracted from the radiologists' interpretation reports: bilateral cysts, multilocular cysts, septal enhancement, suspected mucinous tumours, and suspected adnexal torsion. Comparisons of operation time and blood loss were conducted for reference only, as this study included data from patients treated with various surgical methods, including salpingo-oophorectomy (187 patients), cystectomy (38 patients), unilateral salpingo-oophorectomy with contralateral cystectomy (7 patients), salpingectomy (4 patients), salpingectomy with cystectomy (1 patient), and adhesiolysis (2 patients). This comparison included patients with coexistent hysterectomy (1 patient) or myomectomy (1 patient), as well as 3 patients who underwent laparoscopically-assisted surgery, which was considered equivalent to laparoscopic surgery in the analysis.

2.2 Analysis Methods

First, we compared the basic characteristics, including age, BMI, parity, tumour size, operation time, and blood loss, between patients undergoing Bo/Ma-OT and those undergoing Be-OT. We then performed the Shapiro-Wilk test for these six variables: in the Bo/Ma-OT group (n = 26), age (W = 0.94, $p = 0.11$) and BMI (W = 0.95, $p = 0.30$) showed normal distributions, while parity (W = 0.89, $p < 0.05$), tumour size (W = 0.85, $p < 0.01$), operation time (W = 0.88, $p < 0.01$), and blood loss (W = 0.32, $p < 0.01$) did not. In the Be-OT group (n = 213), all six variables showed non-normal distributions (age: W = 0.97, $p < 0.01$; BMI: W = 0.96, $p < 0.01$; parity: W = 0.89, $p < 0.01$; tumour size: W = 0.87, $p < 0.01$; operation time: W = 0.92, $p < 0.01$; blood loss: W = 0.38, $p < 0.01$). Therefore, we compared the two groups using medians and the Wilcoxon rank-sum test. Next, after selecting 16 factors from variables realistically available in the medical records, with reference to previous reports [9], the 239 patients were divided into two groups based on the presence or absence of each factor. The proportions of patients undergoing Bo/Ma-OT (n = 26) were subsequently compared between the two groups. In particular, multiple features of tumour were compared. Tumour diameters of 10 cm and 15 cm were used as reference thresholds; however, a 20-cm cut-off was not feasible, as only 12 of the 239 tumours exceeded this size. In addition, as the descriptions of menstruation were sometimes unclear, "menopause" was defined as "age 50 years or older", and complaints such as "irregular menstruation", "heavy menstrual bleeding", and "severe menstrual pain" were collectively categorized as "menstrual disorders".

Finally, candidates for multivariate analysis were selected based on a p-value < 0.05 in the univariate comparisons. As including all 16 factors in the multivariate analysis would result in an excessive number of variables, the p-value threshold was set to identify the factors most likely to be relevant. We then extracted data regarding the following 3 factors: (1) multilocular cyst; (2) septal enhancement; and (3) suspected mucinous tumour. In addition, the 15-cm threshold, which had the smaller p-value, was selected as the criterion for the ninth factor of "large tumour". Multivariate logistic regression analysis was then performed via JMP version 18 for Windows (SAS Institute, Inc., Tokyo, Japan), based on binary data (0 or 1) collected for each factor for each patient in an Excel sheet, to estimate the likelihood of Bo/Ma-OT.

Statistical analyses were performed using Microsoft Excel 365 (Microsoft Corporation, Redmond, WA, USA) and JMP version 18 for Windows. Associations between patient characteristics and the likelihood of Bo/Ma-OT diagnosis were assessed using the Wilcoxon rank-sum test, the Pearson chi-square test, and multivariable logistic regression analysis. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated to quantify the strength of these associations. A p-value < 0.05 was considered statistically significant.

3. Results

3.1 Simple Comparison of Patient Characteristics Between Bo/Ma-OT and Be-OT Groups

The final diagnoses determined by pathological examination are summarized in Table 1. Among the 239 cases, 26 were classified as Bo/Ma-OT, and their patient characteristics were compared with those of the 213 patients with Be-OT.

In the simple comparison of patient characteristics, no significant differences were found between the Bo/Ma-OT and Be-OT groups (Table 2). Operation time was used for reference only, as the surgical approaches varied across cases. However, a trend toward a difference in operation time was observed. As shown in Table 3, simple analysis of the associations between each factor and the likelihood

Table 1. List of pathological diagnoses.

Pathological diagnosis	Number
Ovarian serous cystadenoma	92
Ovarian mucinous cystadenoma	53
Ovarian seromucinous cystadenoma	1
OEC	10
OMCT	7
Paraovarian/paratubal cyst	23
Ovarian haemorrhage	3
Ovarian/tubal tissue	7
Corpus luteum cyst	8
Ovarian struma	2
Ovarian fibroma	3
Ovarian adenofibroma	1
Brenner tumour	1
Retroperitoneal cyst	1
Hydrosalpinx	1
Serous borderline tumour	4
Mucinous borderline tumour	18
Clear cell borderline tumour	1
Granulosa cell tumour	1
Mucinous adenocarcinoma	1
Endometrioid adenocarcinoma	1
Total	239

The final pathological diagnoses of all 239 patients are shown. 11 patients had more than one diagnosis. For these patients, the diagnosis of the primary lesion was used.
OEC, ovarian endometriotic cyst; OMCT, ovarian mature cystic teratoma.

of Bo/Ma-OT identified 4 significant factors: multilocular cyst, septal enhancement, suspected mucinous tumour, and tumour size $\geq$15 cm.

Table 2. Basic characteristics of patient.

Index	Bo/Ma-OT	Be-OT	*p*-value
Age (years)	53 (22–76)	54 (13–92)	0.50
BMI (kg/m^2)	22.3 (16.1–32.5)	21.8 (14.7–36.4)	0.53
Parity	2 (0–5)	2 (0–6)	0.70
Tumour size (mm)	98.5 (43–300)	80.0 (27–300)	0.21
Operation time (minute)	89.5 (42–224)	77.0 (28–228)	0.05
Blood loss amount (mL)	1 (0–489)	0 (0–300)	0.58

The basic characteristics obtained from the patients' medical records are summarized. For each factor, the median and the minimum and maximum values for both patients with Bo/Ma-OT and those with Be-OT are shown. Be-OT, benign ovarian tumour; BMI, body mass index; Bo/Ma-OT, borderline/malignant ovarian tumour.

Table 3. Simple comparison of patient information.

Factor	Presence vs. Absence	*p*-value
Advanced age	n = 17/132 vs. 9/107	0.27
High BMI	n = 9/53 vs. 17/186	0.11
Nulliparity	n = 7/64 vs. 19/175	0.99
Smoking history	n = 3/25 vs. 23/214	0.85
Gynaecological surgical history	n = 7/53 vs. 19/186	0.54
Menstrual disorders	n = 12/86 vs. 14/153	0.25
Bilateral cyst	n = 18/136 vs. 8/103	0.18
Multilocular cyst	n = 12/67 vs. 14/172	$<$0.05
Septal enhancement	n = 11/47 vs. 15/192	$<$0.01
Suspected mucinous tumour	n = 5/19 vs. 21/220	$<$0.05
Suspected adnexal torsion	n = 2/24 vs. 24/215	0.67
Coexistent leiomyoma	n = 4/33 vs. 22/206	0.81
CA19-9 positivity	n = 1/12 vs. 25/227	0.77
CA125 positivity	n = 4/21 vs. 22/218	0.21
Tumour size 10 cm or larger	n = 13/84 vs. 13/155	0.09
Tumour size 15 cm or larger	n = 6/25 vs. 20/214	$<$0.05

Based on the presence or absence of 16 factors extracted from patient medical records, the 239 patients were divided into two groups, with 26 patients in the Bo/Ma-OT group and 213 patients in the Be-OT group, and between-group comparisons were performed. Among these 16 factors, 2 were related to tumour size. The *p*-values were calculated using Pearson's chi-square test. Advanced age was defined as 50 years or older, and high BMI was defined as 25 kg/m^2 or above. CA125, carbohydrate antigen 125; CA19-9, carbohydrate antigen 19-9.

3.2 Factors Predicting Bo/Ma-OT

Among the candidate factors selected based on the simple analyses, none differed significantly between the groups (Table 4). Only septal enhancement had *p*-value $<$ 0.1.

Table 4. Factors influencing Bo/Ma-OT diagnosis.

Factor	OR (95% CI)	*p*-value
Multilocular cyst	1.4 (0.5–3.8)	0.56
Septal enhancement	2.7 (1.0–7.1)	0.06
Suspected mucinous tumour	1.5 (0.4–5.5)	0.57
Large tumour	2.4 (0.7–6.9)	0.14

Multivariate analyses of 239 patients were performed to examine the effects of the 4 factors for which data were collected from the medical records. The ORs and 95% CIs for the incidence of these factors and the *p*-values are shown in this table. CI, confidence interval; OR, odds ratio.

4. Discussion

With the recent trend towards minimally invasive laparoscopic surgery for OTs [1,11], the criteria for preoperative diagnosis Bo/Ma-OT may become increasingly important. This study focused on cystic lesions, primarily Se/Mu-

OCs, which are considered relatively difficult to distinguish on MRI [9]. The aim of this study was to identify factors associated with the likelihood of a postoperative Bo/Ma-OT diagnosis to improve the accuracy of preoperative prediction [12,13].

First, chi-square tests were conducted to compare the effect of each factor on predicting a Bo/Ma-OT diagnosis. Four factors, including multilocular cyst, septal enhancement, suspected mucinous tumour, and tumour size $\geq$15 cm, were significantly associated with an increased likelihood of Bo/Ma-OT (Table 3). These findings appear to reflect clinical impressions in real-world practice and are consistent with previous reports [6–8]. Although the sample size was limited to 239 patients, this study employed an approach in which multivariate analysis was performed on factors with p-values ≤ 0.05 in the initial simple comparisons. However, none of the factors were significant in the multivariate analysis (Table 4), and no-MRI-related findings were significantly associated with a postoperative Bo/Ma-OT diagnosis. Among factors with a p-value < 0.1, only septal enhancement showed an association. These results highlight the difficulty of identifying Bo/Ma-OT preoperatively and suggest that Bo/Ma-OT can be diagnosed postoperatively with a certain probability, regardless of preoperative findings. Therefore, the finding that such occurrences might be nearly random could be considered a meaningful contribution of this study. Although one limitation of the present study is that imaging findings other than MRI, such as transvaginal ultrasonography or contrast-enhanced computed tomography, were not included, they may still provide a foundation for future research.

However, the study is limited by its retrospective design, reliance on data from a single local institution, and relatively small sample size. As all potential risk factors shown in Table 3 were collected from available medical records, there is a possibility for bias. However, although the selection of factors may be limited, it can also be considered an advantage that we performed multivariate analysis after first conducting a simple comparison and narrowing the target factors. In fact, as shown in Table 4, some MRI findings, such as septal enhancement, had relatively small p-values. Therefore, further case accumulation and multicenter studies may enable more accurate analyses in the future.

5. Conclusions

In conclusion, no factors were identified that significantly increased the risk of Bo/Ma-OT diagnosis after laparoscopic surgery. As some MRI findings showed relatively small p-values, future large-scale studies are needed to improve diagnostic accuracy.

Availability of Data and Materials

The datasets analysed in this study are not publicly available due to privacy concerns. However, anonymized and processed data are available from the corresponding author on reasonable request.

Author Contributions

KT and WI collected and processed the clinical data in detail and drafted the manuscript. SH supervised the overall study. SH, SM, RA, WI, KT, YM, JT, and MN were all involved in the initial data collection from patient records and contributed substantially to discussions throughout multiple departmental conferences, where the study design, data interpretation, and manuscript revisions were repeatedly reviewed and improved. SH and RA determined the surgical methods and supervised all medical procedures. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki. This study was reviewed and approved by the Human Ethical Committee of Kinan Hospital (Approval No. 283). Informed consent was obtained from all patients.

Acknowledgment

This research was supported by Kinan Hospital with respect to the provision of medical information.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

[1] Medeiros LRF, Rosa DD, Bozzetti MC, Fachel JMG, Furness S, Garry R, *et al*. Laparoscopy versus laparotomy for benign ovarian tumour. The Cochrane Database of Systematic Reviews. 2009; CD004751. https://doi.org/10.1002/14651858.CD004751.pub3.

[2] Alammari R, Lightfoot M, Hur HC. Impact of Cystectomy on Ovarian Reserve: Review of the Literature. Journal of Minimally Invasive Gynecology. 2017; 24: 247–257. https://doi.org/10.1016/j.jmig.2016.12.010.

[3] Faluyi O, Mackean M, Gourley C, Bryant A, Dickinson HO. Interventions for the treatment of borderline ovarian tumours. The Cochrane Database of Systematic Reviews. 2010; 2010: CD007696. https://doi.org/10.1002/14651858.CD007696.pub2.

[4] Wetterwald L, Sarivalasis A, Liapi A, Mathevet P, Achtari C. Lymph Node Involvement in Recurrent Serous Borderline Ovarian Tumors: Current Evidence, Controversies, and a Review of the Literature. Cancers. 2023; 15: 890. https://doi.org/10.3390/cancers15030890.

[5] Tokunaga H, Mikami M, Nagase S, Kobayashi Y, Tabata T, Kaneuchi M, *et al*. The 2020 Japan Society of Gynecologic Oncology guidelines for the treatment of ovarian cancer, fallopian tube

cancer, and primary peritoneal cancer. Journal of Gynecologic Oncology. 2021; 32: e49. https://doi.org/10.3802/jgo.2021.32.e49.

[6] Ohya A, Fujinaga Y. Magnetic resonance imaging findings of cystic ovarian tumors: major differential diagnoses in five types frequently encountered in daily clinical practice. Japanese Journal of Radiology. 2022; 40: 1213–1234. https://doi.org/10.1007/s11604-022-01321-x.

[7] Shin KH, Kim HH, Yoon HJ, Kim ET, Suh DS, Kim KH. The Discrepancy between Preoperative Tumor Markers and Imaging Outcomes in Predicting Ovarian Malignancy. Cancers. 2022; 14: 5821. https://doi.org/10.3390/cancers14235821.

[8] Wang WH, Zheng CB, Gao JN, Ren SS, Nie GY, Li ZQ. Systematic review and meta-analysis of imaging differential diagnosis of benign and malignant ovarian tumors. Gland Surgery. 2022; 11: 330–340. https://doi.org/10.21037/gs-21-889.

[9] Isono W, Tsuchiya H, Matsuyama R, Fujimoto A, Nishii O. An algorithm for the pre-operative differentiation of benign ovarian tumours based on magnetic resonance imaging interpretation in a regional core hospital: A retrospective study. European Journal of Obstetrics & Gynecology and Reproductive Biology: X. 2023; 20: 100260. https://doi.org/10.1016/j.eurox.2023.100260.

[10] Fischerova D, Zikan M, Dundr P, Cibula D. Diagnosis, treatment, and follow-up of borderline ovarian tumors. The Oncologist. 2012; 17: 1515–1533. https://doi.org/10.1634/theoncologist.2012-0139.

[11] Yokoi A, Machida H, Shimada M, Matsuo K, Shigeta S, Furukawa S, *et al*. Efficacy and safety of minimally invasive surgery versus open laparotomy for epithelial ovarian cancer: A systematic review and meta-analysis. Gynecologic Oncology. 2024; 190: 42–52. https://doi.org/10.1016/j.ygyno.2024.08.011.

[12] Ye Q, Qi Y, Liu J, Hu Y, Li X, Guo Q, *et al*. A predictive model for recurrence in patients with borderline ovarian tumor based on neural multi-task logistic regression. BMC Cancer. 2025; 25: 281. https://doi.org/10.1186/s12885-025-13636-9.

[13] Xie Y, Wang D, Zhang N, Yang Q. Correlation analysis of recurrent factors in borderline ovarian tumors undergoing fertility preservation surgery. Frontiers in Oncology. 2025; 15: 1488247. https://doi.org/10.3389/fonc.2025.1488247.