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ABOUT COVER

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ORIGINAL ARTICLE

Retrospective Study

Develop a nomogram to predict overall survival of patients with borderline ovarian tumors

Xiao-Qin Gong, Yan Zhang

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Abstract

BACKGROUND

The prognosis of borderline ovarian tumors (BOTs) has been the concern of clinicians and patients. It is urgent to develop a model to predict the survival of patients with BOTs.

AIM

To construct a nomogram to predict the likelihood of overall survival (OS) in patients with BOTs.

METHODS

A total of 192 patients with histologically verified BOTs and 374 patients with epithelial ovarian cancer (EOC) were retrospectively investigated for clinical characteristics and survival outcomes. A 1:1 propensity score matching (PSM) analysis was performed to eliminate selection bias. Survival was analyzed by using the log-rank test and the restricted mean survival time (RMST). Next, univariate and multivariate Cox regression analyses were used to identify meaningful independent prognostic factors. In addition, a nomogram model was developed to predict the 1-, 3-, and 5-year overall survival of patients with BOTs. The predictive performance of the model was assessed by using the concordance index (C-index), calibration curves, and decision curve analysis (DCA).

RESULTS

For clinical data, there was no significant difference in body mass index, preoperative CA199 concentration, or tumor localization between the BOTs group and EOC group. Women with BOTs were significantly younger than those with

EOC. There was a significant difference in menopausal status, parity, preoperative serum CA125 concentration, Federation International of gynecology and obstetrics (FIGO) stage, and whether patients accepted postoperative adjuvant therapy between the BOT and EOC group. After PSM, patients with BOTs had better overall survival than patients with EOC (*P* value = 0.0067); more importantly, the 5-year RMST of BOTs was longer than that of EOC (*P* value = 0.0002, 95%CI -1.137 to -0.263). Multivariate Cox regression analysis showed that diagnosed age and surgical type were independent risk factors for BOT patient OS (*P* value < 0.05). A nomogram was developed based on diagnosed age, preoperative serum CA125 and CA199 Levels, surgical type, FIGO stage, and tumor size. Moreover, the c-index (0.959, 95% confidence interval 0.8708–1.0472), calibration plot of 1-, 3-, and 5-year OS, and decision curve analysis indicated the accurate predictive ability of this model.

CONCLUSION

Patients with BOTs had a better prognosis than patients with EOC. The nomogram we constructed might be helpful for clinicians in personalized treatment planning and patient counseling.

Key Words: Borderline ovarian tumors; Epithelial ovarian cancer; Nomogram; Survival

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Core Tip: The recurrence and overall survival of borderline ovarian tumors (BOTs) after operation have been one of the main concerns of patients and clinicians. In this research, we firstly performed a 1:1 propensity score matching analysis by applying age as a matching variable, then we found that patients with BOTs had a better overall survival as compared to patients with epithelial ovarian cancer (EOC), more importantly, the 5-year restricted mean survival time of BOTs was longer than EOC. What's more, we conducted a nomogram that could accurately predict 1, 3, 5-year overall survival in patients with BOTs.

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INTRODUCTION

Borderline epithelial ovarian tumors (BOTs), a category of low-grade malignant potential carcinoma derived primarily from ovarian epithelial lesions, comprise 10%-20% of epithelial ovarian tumors[1]. BOTs have been classified into serous, mucinous, endometrioid, clear cell, Brenner (transitional cell), and mixed epithelial tumors. The major subtypes of BOTs are mucinous and serous following histological examination, accounting for approximately 30% and 67% of BOTs, respectively[2,3]. BOTs are characterized by cytological evidence of malignancy in which atypical epithelial cell proliferation and nuclear atypia are observed but with no obvious invasion to the stroma, which differs from epithelial ovarian cancer (EOC)[4,5].

Compared to EOC, patients with BOTs are reported to have a better prognosis[6-8]. Age is reported to be a significant risk factor for OS in EOC, and some studies have shown that BOT patients tend to have an earlier age at diagnosis than EOC patients, implying that age may be the reason for the different prognoses of the two groups[9]. Apart from age, the Federation international of gynecology and obstetrics (FIGO) stage of tumors is also demonstrated to be a risk factor that mainly influences prognosis and recurrence rates, and others are peritoneal spread, histology, genetic factors, and vascular invasion[10,11]. The 5-year overall survival rate of BOTs is 80%-95%, and the 20-year survival rate is 80%, but some patients will relapse and die from their disease[5,12,13]. Therefore, the recurrence and prognosis of BOTs after surgery are one of the main concerns of patients and gynecologic researchers.

FIGO classification is applied for BOT staging, as with malignant epithelial ovarian tumors. The diagnosis is primarily based on pathological results, and the main and initial treatment method is surgery. However, "semi malignant ovarian tumors" as BOTs were mentioned as early as 1929[14]. In addition, the diagnosis of BOTs cannot be determined before surgery because patients with BOTs have no specific clinical symptoms. Considering the above particular characteristics of BOTs, a prognostic model is urgently needed for physicians and patients in the course of therapy.

To date, nomograms are regarded as an important prognostic tool that has been applied to numerous types of cancer and nontumor clinical research and can be very valuable to clinicians and patients[15]. The use of nomograms has favorably been compared to traditional staging systems for many cancers, and thus, it has been proposed as an alternative or even as a new standard[16]. Although several studies have used nomograms to study the relapse of BOTs, there is no such model to investigate the survival of patients with BOTs.

In the present study, we retrospectively collected and analyzed single-center data of women diagnosed with BOTs and EOC after surgery. Next, we compared the basic characteristics and survival outcomes between BOTs and EOC. Then, we evaluated the prognostic risk factors for BOTs. Moreover, we established a nomogram based on 6 clinical variables and follow-up information to improve the predictive capacity for the prognosis of BOTs. We believe that the outcome gained from our study will provide more information for patient consultation and oncologists to evaluate the survival of patients with BOTs, ultimately contributing to the development of optimal therapeutic strategies.

MATERIALS AND METHODS

Patients

Patients included in this research had histologically proven BOTs and were treated at the Department of Obstetrics and Gynecology, Tongji Hospital, between January 2012 and August 2020. The patients were staged (I–IV) according to the FIGO 2019 standards. The exclusion criteria were other benign or malignant tumors, especially cervical and ovarian tumors treated by preoperative chemotherapy and gynecological diseases (*e.g.*, endometriosis and pelvic infection). A total of 563 individuals were ultimately enrolled, including 371 EOC patients and 192 BOTs patients. This study was approved by the Ethical Committee of Tongji Hospital of Tongji Medical College at Huazhong University of Science and Technology. Written informed consent was waived.

Outcomes

The clinical indices analyzed included patient age at diagnosis, body mass index, menopausal status and parity, the level of preoperative tumor marker (CA125, CA199) FIGO stage, surgical type, and postoperative adjuvant therapy. Overall survival (OS) was regarded as the time interval (in months) between the date of surgery and the date of death or censoring. Disease-free survival (DFS) was defined as the time interval (in months) between the date of surgery and the date of recurrence or censoring. The restricted mean survival time (RMST) described the average survival time of patients enrolled in the study during the follow-up period of truncation and was simply estimated by the area under the survival curve up to the specific time, which could be used to explain cumulative covariate effects, especially in the presence of nonproportionality.

Propensity score matching analysis

Because this was a retrospective study and the operative approach was not assigned randomly, there were potentially confounding factors and selection biases between groups that could impact the outcomes of comparisons. To overcome the biases produced by disequilibrium between the two groups, PSM was conducted. The propensity score was calculated by the logistical regression model using age as covariates. PSM was performed as one-to-one matching between the BOTs and EOC groups with nearest-neighbor matching and a 0.1 caliper width using R (version 4.0.2).

Construction of the nomogram

We performed univariate and multivariate Cox regression analyses *via* clinical factors. To intensify the prognostic predictive ability of the clinical factors included for OS of BOT patients, a nomogram with the 'rms' R package was constructed. Bootstraps with 1000 resamples were used for these activities. The factors comprising the C-index, calibration plots, and DCA were adopted to measure the predictive effectiveness of the nomogram. The predicted results of the nomogram are displayed in the calibration curve, and the 45° line indicates the ideal prediction. During the internal validation of the nomogram, the total points of each patient in the validation cohort were calculated according to the established nomogram. Then, Cox regression in this cohort was performed using the total points as a factor, and finally, the C-index and calibration curve of validation were derived based on the regression analysis. P value < 0.05 was considered statistically significant.

Statistical analysis

Data were analyzed with SPSS (IBM version 19.0) and R (Version 4.0.2). Continuous variables were calculated as the mean ± standard deviation (SD) or median and range as appropriate and compared with Student's t tests. Categorical variables were calculated as rates (%) and compared using the chi-square test or Fisher's exact test, as appropriate. OS rates were determined using Kaplan–Meier survival curves and compared by the log-rank test. Univariate and multiple Cox regression analyses were used

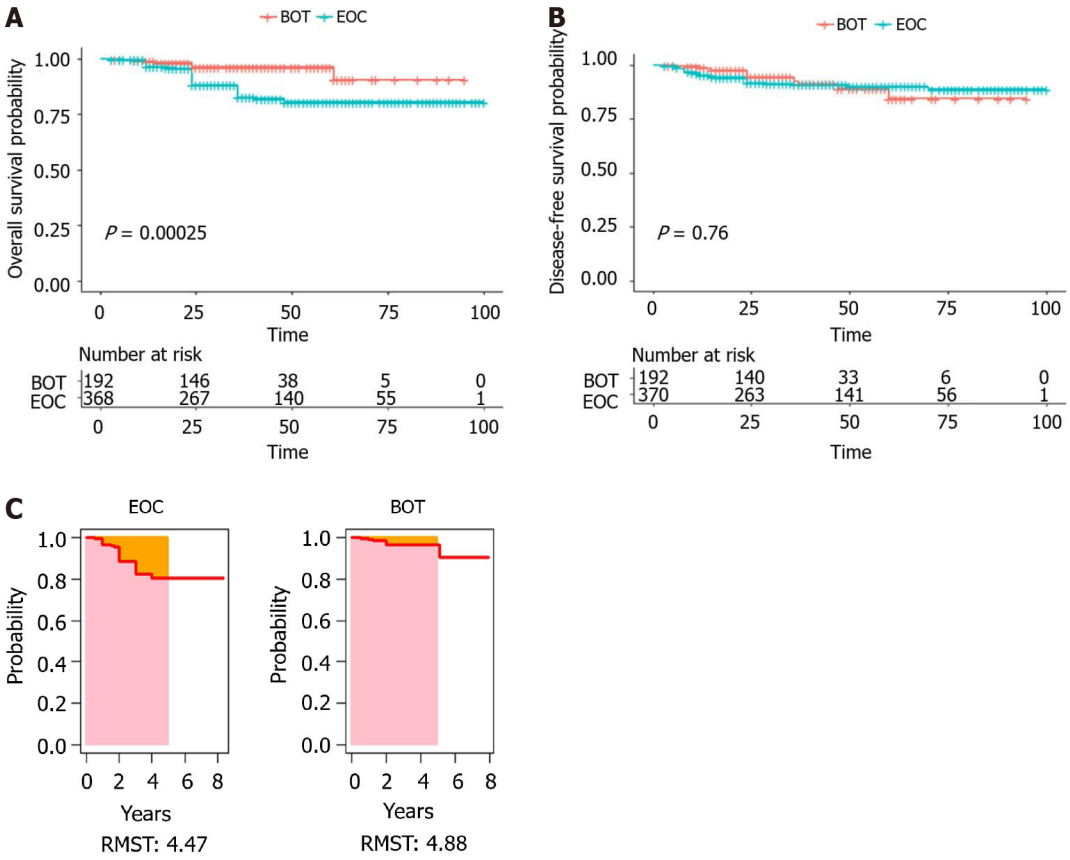

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Figure 1 Survival outcome before propensity score matching for patients with borderline ovarian tumors and epithelial ovarian cancer. A: Kaplan–Meier curves for overall survival; B: Kaplan–Meier curves for disease-free survival; C: Survival curves of restricted mean survival time. EOC: Epithelial ovarian cancer; BOT: Borderline ovarian tumor; RMST: Restricted mean survival time.

to assess independent prognostic factors among our clinical data. *P* value < 0.05 was considered statistically significant.

RESULTS

Characteristics of the population

A total of 192 patients with BOTs and 371 patients with EOC who underwent primary resection were included in this study. Patient baseline characteristics before PSM and after PSM are presented in Table 1. Before PSM, there were no statistically significant differences in body mass index, tumor localizations, or the frequencies of elevated preoperative CA199 concentrations between the two groups. However, the age of diagnosis for BOTs (41 ± 15.2 years) was less than that of EOC (51 ± 11.8 years). The frequencies of postmenopausal status (25.5% *vs* 52.3%, *P* value < 0.0001), parity (74.1% vs. 90%, *P* value < 0.001), elevated preoperative CA125 concentration (55.7% *vs* 86.3%, *P* value < 0.0001), advanced FIGO stage (II-IV) (12.5% *vs* 59.3%, *P* value < 0.0001), and accepted adjuvant therapy (33.3% *vs* 78.7%, *P* value < 0.0001) were significantly lower in patients with BOTs than in patients with EOC. To overcome the effect of potentially confounding factors and selection biases on the comparison outcome, PSM was adopted. After 1:1 PSM analysis, a total of 192 patients with BOTs (mean diagnosed age 41 ± 15.3 years) and 192 patients with EOC (mean diagnosed age 45.8 ± 12.8 years) were matched. Except for menopausal status, the significantly different frequency trends between them were the same as the outcome before PSM.

Clinical outcomes of patients with BOTs and patients with EOC

Before PSM, the median follow-up period for all patients was 41.9 mo (range, 3-100 mo). The 1-, 3- and 5-year OS rates of women with BOTs were 98.9%, 96.4%, and 90.8%, respectively, and the 1-, 3-, and 5-year DFS rates were 98.9%, 92.4%, and 84.6%, respectively. For the EOC group, the 1-, 3-, and 5-year OS rates of patients with BOTs were 96.7%, 82.7%, and 80.6%, respectively, and the 1-, 3-, and 5-year DFS rates were 95.3%, 91.0%, and 88.9%. In addition, the OS and DFS curves for BOTs and EOC patients are shown in Figure 1A and B. The P value of OS and DFS for the two groups were 0.00025 and 0.76,

Table 1 Patient baseline characteristics among borderline ovarian tumors and epithelial ovarian cancer before propensity score matching and after propensity score matching

Variables	Before PSM			After PSM		
	BOTs (*n* = 192)	EOC (*n* = 371)	*P* value	BOTs (*n* = 192)	EOC (*n* = 192)	*P* value
Age at diagnosis (years)	41.0 ± 15.2	51.0 ± 11.8	< 0.0001	41.0 ± 15.2	45.8 ± 12.8	0.0008
Body mass index (kg/m^2)	22.6 ± 3.2	23 ± 8.1	0.5159	22.6 ± 3.2	22.4 ± 3	0.5189
Menopausal status (%)			< 0.0001			0.565
Premenopausal	143 (74.5)	176 (47.4)		143 (74.5)	138 (71.9)	
Postmenopausal	49 (25.5)	194 (52.3)		49 (25.5)	54 (28.1)	
Unknown	0 (0)	1 (0.3)		0 (0)	0 (0)	
Parity (%)			< 0.0001			< 0.0001
Nulliparous	6 (3.1)	0 (0)		6 (3.1)	0 (0)	
Parous	133 (69.3)	334 (90)		133 (69.3)	164 (85.4)	
Unknown	53 (27.6)	37 (10)		53 (27.6)	0 (0)	
Preoperative CA125>35 IU/mL (%)			< 0.0001			< 0.0001
Elevated	107 (55.7)	320 (86.3)		107 (55.7)	163 (84.9)	
Normal	76 (39.6)	37 (10)		76 (39.6)	19 (9.9)	
Unknown	9 (4.7)	14 (3.8)		9 (4.7)	10 (5.2)	
Preoperative CA199>34 IU/mL (%)			0.945			0.827
Elevated	54 (28.1)	104 (28)		54 (28.1)	58 (30.2)	
Normal	110 (57.3)	209 (56.3)		110 (57.3)	104 (54.2)	
Unknown	28 (14.6)	58 (15.6)		28 (14.6)	30 (15.6)	
Tumor localizations			0.153			0.196
LO	44 (22.9)	99 (26.7)		44 (22.9)	54 (28.1)	
RO	86 (44.8)	165 (36.4)		86 (44.8)	69 (35.9)	
Unknown	62 (32.3)	137 (36.9)		62 (32.3)	69 (35.9)	
FIGO stage (%)			< 0.0001			< 0.0001
I	168 (87.5)	151 (40.7)		168 (87.5)	85 (44.3)	
II	7 (3.6)	34 (9.2)		7 (3.6)	16 (8.3)	
III	17 (8.9)	169 (45.6)		17 (8.9)	80 (41.7)	
IV	0 (0)	17 (4.6)		0 (0)	11 (5.7)	
Surgical type (%)			0.0005			0.0005
BSO	7 (3.6)	4 (1.1)		7 (3.6)	1 (0.5)	
HB	13 (6.8)	8 (2.2)		13 (6.8)	4 (2.1)	
HBO	5 (2.6)	31 (8.4)		5 (2.6)	17 (8.9)	
HBOA	8 (4.2)	15 (4)		8 (4.2)	11 (5.7)	
HBOL	77 (40.1)	291 (78.4)		77 (40.1)	146 (76)	
TR	34 (17.7)	6 (1.6)		34 (17.7)	5 (2.6)	
USO	48 (25)	13 (3.5)		48 (25)	7 (3.6)	
CS	0 (0)	3 (0.8)		0 (0)	1 (0.5)	
Postoperative adjuvant therapy (%)			< 0.0001			< 0.0001

Yes	64 (33.3)	292 (78.7)	64 (33.3)	156 (81.3)
No	125 (65.1)	78 (21)	125 (65.1)	36 (18.8)
Unknown	3 (1.6)	1 (0.3)	3 (1.6)	0 (0)

BOT: Borderline ovarian tumor; BSO: Bilateral salpingo-oophorectomy; EOC: Epithelial ovarian cancer; FIGO: Federation international of gynecology and obstetrics; HB: Total hysterectomy with bilateral adnexectomy; HBO: Total hysterectomy with bilateral adnexectomy and omentectomy; HBOA: Total hysterectomy with bilateral adnexectomy, omentectomy, and appendectomy; HBOL: Total hysterectomy with bilateral adnexectomy, omentectomy, and lymph node dissection; LO: Left ovary; RO: Right ovary; TR: Tumor resection; USO: Unilateral salpingo-oophorectomy; CS: Cytoreductive surgery.

respectively. The RMST was used to analyze survival curves to perform comparisons between the BOTs group and the EOC group. Before PSM, for estimating the 5-year RMST, the mortality of EOC exceeded that of BOTs, with a *P* value equal to 0.041 and 95%CI (-0.509 to -0.997) (Figure 1C).

After PSM, the median follow-up period was 41.7 mo (range, 4-100 mo). The 1-, 3-, and 5-year OS rates of women with BOTs were 98.9%, 96.4%, and 90.8%, respectively, and the 1-, 3-, and 5-year DFS rates were 98.9%, 92.4%, and 84.6%, respectively. For the EOC group, the 1-, 3-, and 5-year OS rates were 97.3%, 86.9%, and 83.6%, respectively, and the 1-, 3-, and 5-year DFS rates were 98.8%, 95.0%, and 86.4%. The OS and DFS curves after PSM for patients from the two groups are shown in Figure 2A and B. The P values of OS and DFS for the two groups were 0.0067 and 0.29, respectively. Moreover, after PSM, the 5-year RMST of BOTs was also longer than that of EOC, with a P value equal to 0.002 and 95%CI (-1.137 to -0.263) (Figure 2C).

Univariate and multivariate analyses of BOT patients' overall survival after PSM

Univariate and multivariate analyses were performed to identify the predictors that influenced OS after PSM, and the results are shown in Table 2. Univariate Cox analysis demonstrated that diagnosed age was an independent risk factor for tumor OS (*P* value < 0.05). After multivariate analysis, age and the surgical type became independent risk factors for tumor OS (*P* value < 0.05).

Development and evaluation of nomogram for BOT patients' overall survival

Nomograms are widely used as prognostic devices in oncology and medicine. To heighten the predictive capability of the model for the OS of patients with BOTs through a quantitative approach, we established a nomogram by using clinical factors included in multivariate Cox analysis to predict the 1-, 3-, and 5-year OS of BOT patients (Figure 3). The C-index (0.959, 95%CI: 0.0.8708-1.0472) and calibration plots at 1, 3, and 5 years showed that the nomogram was a valid tool (Figure 4A-C). In addition, the DCA showed that the nomogram yielded more important clinical applications for the prognostic prediction of women with BOTs than for those in the all-treatment cohort and no-treatment cohort. A net benefit was discovered for BOT patient survival risks (Figure 5), implying the good capability of our model.

DISCUSSION

Our results demonstrated that patients with BOTs had a significantly younger age and a better survival outcome than patients with EOC. In addition, the nomogram we constructed in the current study is the first to accurately predict the 1-, 3-, and 5-year OS of women with BOTs, and this model can be used as an aid to help clinicians assess the prognosis of patients with BOTs individually.

As mentioned earlier, several previous studies have shown that the median age at diagnosis of the BOT group was less than that of the EOC group[17,18], which was in accordance with our results. In addition, as age is reported to be associated with the prognosis of many diseases[6,19,20], and this study was retrospective, potentially confounding factors and selection biases may exist in the two groups. Moreover, our data showed that age at diagnosis was significantly different between the BOTs group and EOC group. Hence, PSM was performed by applying age as a matching variable.

As an important marker for ovarian cancer, CA125 has been widely studied in many studies to determine whether it should be applied to distinguish between benign and malignant tumors[21,22]. This study discovered that patients with BOTs had a lower proportion of elevated preoperative serum CA125 concentrations than EOC patients. However, Yang *et al*[4] found no apparent difference in preoperative serum CA125 Levels between BOTs and EOC. The probable reason for the difference is that their study population was BOT patients and stage I epithelial ovarian cancer patients, and the serum CA125 concentration was reported to have only 50% sensitivity for women with stage I ovarian cancer or with BOTs[23].

After PSM, we found that women with BOTs also had a more favorable 1-, 3-, and 5-year OS rate than women with EOC, and the 5-year RMST of BOTs was also longer than that of EOC, implying that BOTs patients truly had a better survival outcome than patients with EOC. These results coincide with those

Table 2 Univariate and multivariate Cox analyses of factors associated with borderline ovarian tumors patient overall survival after propensity score matching

Variables	Univariate Cox analysis		Multivariate Cox analysis	
	HR (95%CI)	*P* value	HR (95%CI)	*P* value
Age	1.1 (1.1-1.2)	3.3e-06	1.180 (1.093730-1.274)	2.04e-05
Surgical type	1 (0.66-1.6)	0.93	2.244 (1.164409-4.325)	0.0157
FIGO stage	3.3e-08 (0-Inf)	1	1.046e-08 (0-Inf)	0.9990
Tumor size	1.6 (0.21-12)	0.65	8.503 (0.006883-10503.344)	0.5557
CA125	1.7 (0.45-6.4)	0.44	1.046 (0.203595-5.370)	0.9574
CA199	1.2 (0.49-3.1)	0.66	2.156 (0.531390-8.746)	0.2823
BMI	1.1 (0.88-1.4)	0.4		
Menopausal status	1.9 (0.42-8.4)	0.41		
Parity	0.31 (0.056-1.7)	0.19		
Adjuvant therapy	0.69 (0.14-3.4)	0.65		

BMI: Body mass index; FIGO: Federation International of gynecology and obstetrics.

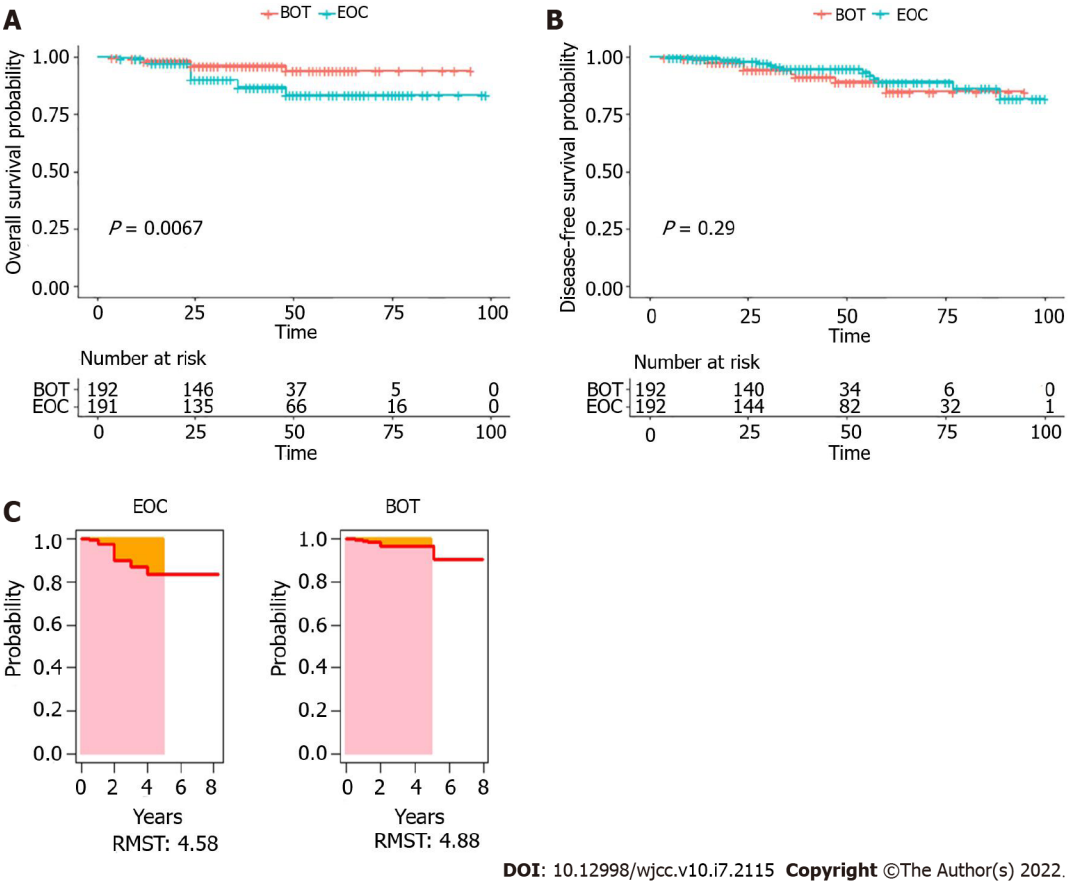

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Figure 2 Survival outcome after propensity score matching for patients with borderline ovarian tumors and epithelial ovarian cancer. A: Kaplan–Meier curves for overall survival; B: Kaplan–Meier curves for disease-free survival; C: Survival curves of restricted mean survival time. EOC: Epithelial ovarian cancer; BOT: Borderline ovarian tumor; RMST: Restricted mean survival time.

of previous studies showing that BOTs and EOC had significant differences in patient survival outcomes[6,13].

Notably, our results showed that age was an independent risk factor for OS in BOTs patients. Previously, a study including 801 patients with BOTs also showed that diagnosed age was important for

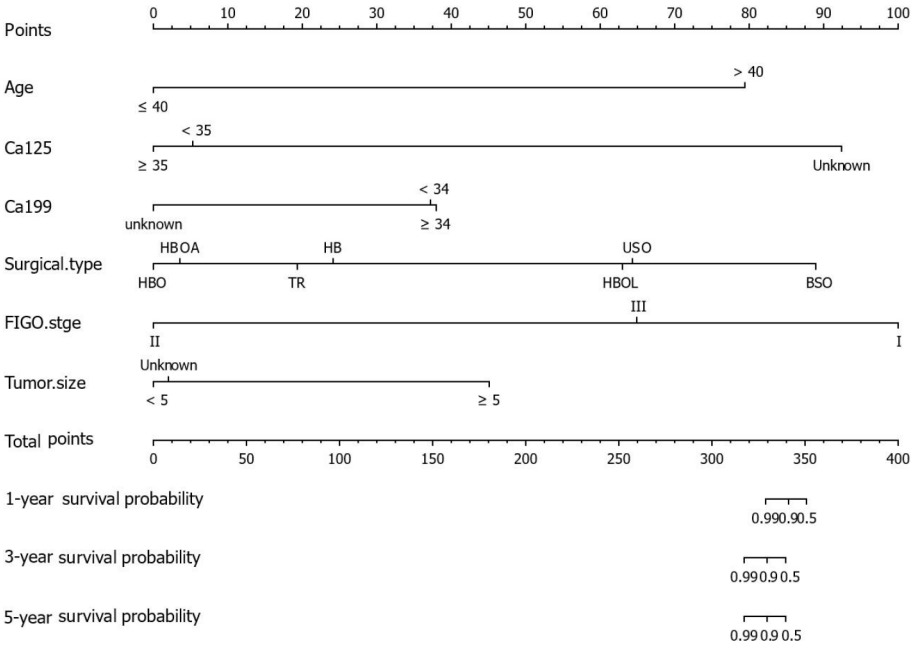

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Figure 3 A nomogram predicting the 1-, 3-, and 5-year overall survival of patients with borderline ovarian tumors by points identified on the points scale for each variable. The total points projected on the borderline ovarian tumors bottom scales determine the likelihood of 1-, 3-, and 5-year survival. BSO: bilateral salpingo-oophorectomy; FIGO: Federation international of gynecology and obstetrics; HBO: total hysterectomy with bilateral adnexectomy and omentectomy; HBOL: total hysterectomy with bilateral adnexectomy, omentectomy, and lymph node dissection; TR: tumor resection.

overall survival[24]. In addition, although menopause was associated with age, menopausal status was not identified as a risk factor for OS. Similar results were discovered by Tal *et al*[11], who found that menopause was not an independent risk factor for the prognosis of women with BOTs.

To date, the standard surgical procedure for BOTs is comprehensive staging surgery. For young fertile patients, fertility-sparing surgery (unilateral salpingo-oophorectomy and contralateral ovarian biopsy to assess the opposite ovary) is a first-line treatment[5,25]. Systematic lymphadenectomy is not required routinely; it was only suggested when patients with BOTs had invasive peritoneal implants [26], but lymphatic resection is preferred for endometrial mucinous BOTs with microinvasion, peritoneal implantation, advanced FIGO staging, and pathology[27]. Consistent with these conclusions, we noted that surgical type was significantly associated with the OS of women with BOTs in multivariate Cox regression analysis.

Moreover, whether postoperative adjuvant therapy should proceed is a controversial issue. Chemotherapy is not recommended for patients in the early stage after surgery, and opinions vary among scholars as to whether chemotherapy is recommended for advanced patients. Wang *et al*[28] suggested that chemotherapy should be advised to patients with BOTs who have high risks, such as invasive implants or residual tumors, and they found that chemotherapy was related to poorer disease-specific survival. However, a retrospective study based on 364 patients with BOTs from 14 gynecological oncology departments in Turkey and Germany demonstrated that chemotherapy had no connection with overall survival[29], and the results of our study implied that postoperative adjuvant therapy was not a meaningful factor for patients with BOTs.

As a widely used tool in oncology, nomograms have been shown to predict overall outcomes in personalized patients well[15]. The variables included in our nomogram are regarded as important clinical characteristics of BOTs. CA125 and CA199 have been reported as considerable tumor markers that could predict malignancy[21,30]. In addition, Ayhan *et al*[31] found that high concentrations of serum CA125 and CA199 may imply larger tumor sizes, and tumor size has been recognized as a critical prognostic factor of many diseases, such as esophageal cancer, rectal cancer, and endometrioid endometrial cancer[32-34]. In addition, Song *et al*[35] showed that the FIGO stage was associated with BOT overall survival. More importantly, the present study found that age and surgical type were independent risk factors for BOT overall survival. Finally, the nomogram was internally validated using 1000 repetitions of bootstrap samples.

Despite the advantageous outcomes of our research, there are several limitations of this study. First, the nomogram was established based on data collected from a single center. Second, this was a retrospective study. The cohort was not representative of all patients with BOTs.

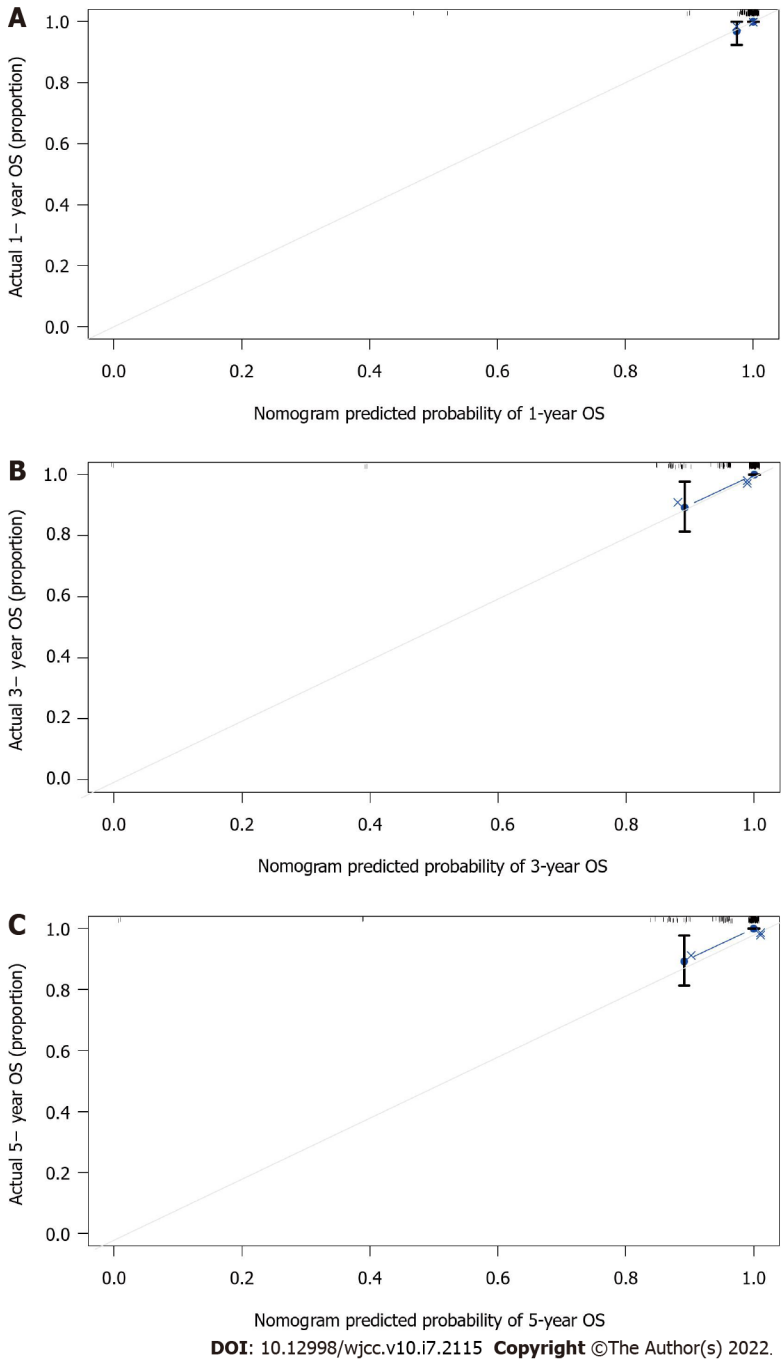

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Figure 4 Calibration curves of the nomogram. A: the 1-year overall survival (OS) nomogram calibration curves in patients with borderline ovarian tumors (BOTs); B: the 3-year OS nomogram calibration curves in patients with BOTs; C: the 5-year OS nomogram calibration curves in patients with BOTs. The x-axis indicates the predicted survival probability, and the y-axis indicates the actual survival probability. The 45-degree line (gray dashed line) shows the performance of the ideal nomogram, and the blue dashed line demonstrates the actual nomogram.

CONCLUSION

Considering its accuracy and clinical value, the current nomogram in the present study could provide an individualized evaluation of the prognosis of patients with BOTs. Our research will be beneficial for clinicians to make clinical treatment recommendations and patients to better know their therapeutic options, thus improving patients' compliance and prognosis. Besides, we will collect more BOTs patients from different cohorts to validate the model from the external aspect in the future. Additional data and studies are needed to determine whether it can be applied to the total BOTs cohort.

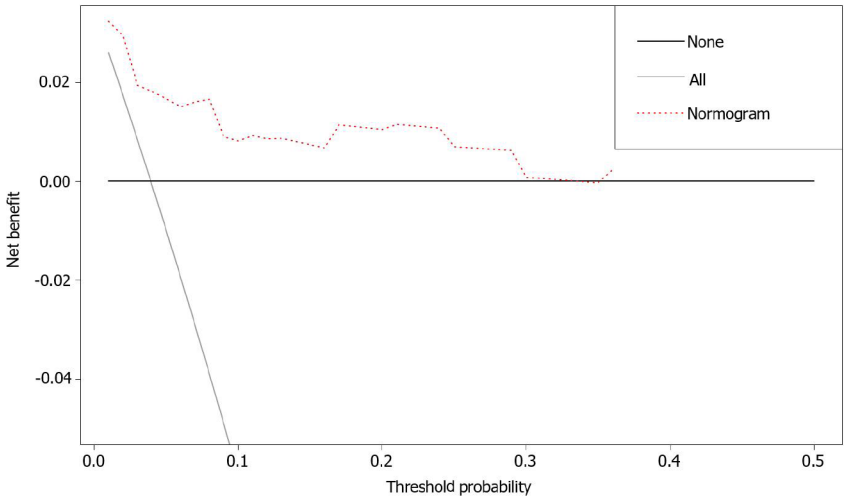

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Figure 5 Decision curve analysis of the nomogram predicting overall survival. The x-axis assumes the threshold probability, and the y-axis measures the net benefit. The black line represents that none of the patients died, whereas the gray line indicates that all patients died at a specific threshold probability. The red dashed line shows the net benefit of using the nomogram.

ARTICLE HIGHLIGHTS

Research background

Although patients with borderline ovarian tumors (BOTs) have been reported to have a better survival outcome as compared to patients with epithelial ovarian cancer (EOC), there are many risk factors of BOTs. Nomogram has been successfully applied to predict the prognosis of many cancers based on some meaningful prognostic factors, but there is no such model to study the 1, 3, 5 years' survival of BOTs.

Research motivation

Served as "semi-malignant ovarian tumors", the overall survival of BOTs after the operation has been paid high attention by the clinicians and patients. It was necessary to construct a prognostic model to assess the survival outcome of patients with BOTs.

Research objectives

This research aimed to develop a nomogram to predict the possibility of OS in patients with BOTs, thus contributing to making individualized treatment recommendations.

Research methods

Totally 192 patients with BOTs and 374 patients with EOC were involved. Based on meaningful independent prognostic factors identified by univariate and multivariate Cox regression analyses, a nomogram model was developed to predict the 1-, 3-, and 5-year overall survival of patients with BOTs.

Research results

Compared to patients with EOC, patients with BOTs had better overall survival after 1:1 propensity score matching analysis (P value = 0.0067). We established a nomogram to predict the 1-, 3-, and 5-year OS of BOT patients. The C-index (0.959, 95% confidence interval 0.8708-1.0472) and calibration plots at 1, 3, and 5 years showed that the nomogram was a valid tool.

Research conclusions

The current research constructed a nomogram that could accurately give a personalized prediction of the prognosis of patients with BOTs. The outcome gained from our study might provide convenience to patients and clinicians.

Research perspectives

The nomogram developed by this study is the first to predict the 1-, 3-, and 5-year OS of women with BOTs. Moreover, it has been precisely assessed by internal validation. The results gained from our study will provide advice to make treatment planning.

FOOTNOTES

Author contributions: Gong XQ and Zhang Y designed and performed the research, collected and analyzed the data; Gong XQ wrote the manuscript; Zhang Y revised the draft; all authors have read and approved the final manuscript.

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Informed consent statement: The data were anonymous and analyzed retrospectively. In accordance with the rules of the ethics committee, this study applied for exemption from informed consent.

Conflict-of-interest statement: The authors declare there are no conflicts of interest.

Data sharing statement: No additional data are available.

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