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# Clinicopathological and prognostic factor analyses of primary fallopian tube carcinoma and high-grade serous ovarian cancer: a single-institution retrospective study

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## Abstract

**Objective** This study aimed to evaluate and compare the clinicopathologic features of primary fallopian tubal carcinoma (PFTC) and high-grade serous ovarian cancer (HGSOC) and explore the prognostic factors of these two malignant tumors.

**Methods** Fifty-seven patients diagnosed with PFTC from 2006 to 2015 and 60 patients diagnosed with HGSOC from 2014 to 2015 with complete prognostic information were identified at Women's Hospital of Zhejiang University. The clinicopathological and surgical data were collected, and the survival of the patients was followed for 5 years after surgery. The Cox proportional risk model was used to analyze the impact on survival.

**Results** For PFTC patients, the mean age was 57 years (range, 35–77 years). The most common clinical manifestations were abnormal vaginal bleeding and/or discharge (61%). A total of 72% of the cases were found at the early stage, and 90% of the tumors were high grade (51 cases). 51% of patients were diagnosed with PFTC before surgery, while the rest were misdiagnosed. Twenty-one patients relapsed. The overall survival (OS) rate was 82%. OS was significantly related to FIGO stage, the preoperative serum CA 125 level, lymphadenectomy, residual tumor size, appendectomy, and the number of cycles of chemotherapy. However, only FIGO stage was an independent prognostic variable for OS. For patients with HGSOC, the OS rate was 67%. OS was significantly related to FIGO stage, residual tumor size, and laterality. However, only residual tumor size was an independent prognostic variable for OS.

**Conclusions** Our study provides important clinicopathologic insights into PFTC and HGSOC. We identified FIGO stage as an independent prognostic factor for PFTC patients and residual tumor size as an independent prognostic factor for HGSOC patients. These findings emphasize the critical role of accurate staging and achieving a residual tumor size of less than 1 cm during surgery. Our research contributes to refining clinical decision-making, supporting the importance of optimal surgical outcomes, and guiding personalized treatment strategies to improve patient prognosis in both PFTC and HGSOC patients.

**Keywords** Primary fallopian tube carcinoma, High-grade serous ovarian cancer, Clinical features, Survival outcomes

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## Introduction

PFTC is a rare and poorly characterized gynecological malignancy [1]. Due to its rarity and frequent misdiagnosis, comprehensive data from both basic and clinical research are lacking. Recent studies have shown that the incidence of PFTC has increased twenty-fold over the past 20 years [2]. Moreover, because of its propensity for microscopic distant metastasis, PFTC is associated with a high risk of recurrence and poor prognosis [3]. Therefore, a deeper understanding of PFTC is urgently needed to facilitate early diagnosis and improve patient prognosis.

Epithelial ovarian cancer is the most lethal gynecological malignancy, and high-grade serous ovarian cancer (HGSOC) is the most common and invasive histological subtype, accounting for 60–80% of cases [4]. More than 75% of HGSOC patients are diagnosed with stages III and IV disease, leading to an unfavorable survival rate [5]. Epithelial ovarian cancer, primary fallopian tube carcinoma (PFTC), and primary peritoneal cancer are considered the same disease entity that occurs in different locations; the term "ovarian" cancer has long referred to malignancies that appear at the ovaries, fallopian tubes, and peritoneum [6, 7]. HGSOC and high-grade serous PFTC are presumed to have the same origin [8–11]. The gene expression profile of HGSOC is more similar to that of the fallopian tube epithelium than that of the ovarian surface epithelium, suggesting that HGSOC may originate in the fallopian tube. Tumors can develop into invasive tumors in the fallopian tube, and then HGSC in the fallopian tube can spread directly to the ovary and abdominal cavity or implant on the ovary or peritoneal surface [8, 12]. In conclusion, fallopian serous tubal intraepithelial carcinoma (STIC) is hypothesized to be a precursor of high-grade serous carcinoma originating in the ovaries, fallopian tubes, or peritoneum [8, 9, 13, 14]. Therefore, many similarities between PFTC and HGSOC exist in terms of diagnosis and treatment. The standard treatment for these patients is tumor cytoreductive surgery followed by platinum (Pt)/taxane-based chemotherapy. Optimal tumor-reducing surgery, in which less than 1 mm of tumor remains, is known to increase the likelihood of long-term disease-free survival [11, 15]. The biological characteristics of cancer may help to determine patient prognosis and predict the outcome of internal and surgical treatment. Although PFTC is similar to epithelial ovarian cancer, several differences should be emphasized based on additional clinical reports. Patients with PFTC are more likely to present with early-stage tumors and to have improved overall survival than are those with primary ovarian malignancies at advanced stages [16]. These findings indicate that PFTC may follow unique biological and clinical courses.

In the past 10 years, the number of PFTC patients admitted to our hospital has gradually increased from 8 in 2006 to 13 in 2015. The aim of this study was to investigate the clinicopathological features and survival predictors of PFTC and compare them with those of HGSOC, providing new insights into PFTC.

## Methods

### Patient enrolment

A total of 57 patients with PFTC diagnosed from March 2006 to December 2015 and 60 patients with HGSOC diagnosed from January 2014 to December 2015 with complete prognostic information were included from Women's Hospital of Zhejiang University. Both PFTC and HGSOC patients were enrolled consecutively. All patients included in the study were diagnosed with either PFTC or HGSOC based on histopathological examination. The diagnosis was confirmed by the presence of characteristic features such as high-grade serous histology and the involvement of the ovaries or fallopian tubes. The diagnosis was further validated by expert pathologists through review of tissue samples, including haematoxylin and eosin (H&E) staining and immunohistochemistry when necessary. Patient clinical information was collected and approved by the Ethics Committee of Women's Hospital of Zhejiang University. All cases were confirmed by postoperative pathological diagnosis. No patients received neoadjuvant chemotherapy or radiation therapy prior to surgery.

### Clinical and pathological data collection

Clinical and pathological data, including patient age, menstrual status, presenting symptoms, preoperative serum CA125 level, date and type of primary surgery, site and maximum diameter of the tumor, presence or absence of residual tumor size after initial surgery, histopathological diagnosis, stage classification according to FIGO 2014, indication of postoperative chemotherapy, date of recurrence, treatment after recurrence, last follow-up period and date of death, were collected. All patients underwent surgery as the first treatment; 54 patients with PFTC received postoperative chemotherapy; 53 patients with HGSOC underwent postoperative chemotherapy; and the remaining patients did not continue chemotherapy for personal, economic, or family reasons. Paclitaxel plus platinum was the first choice; if patients could not tolerate it, they received cyclophosphamide plus platinum. Patients with HGSOC were treated with paclitaxel plus platinum-based chemotherapy after surgery. Follow-up was conducted according to the National Comprehensive Cancer Network (NCCN) guidelines: every 3 months in the first two years, every 6 months in the third to fifth years, and annually thereafter. The follow-up period ended at 60 months after surgery in this study. All patients were evaluated for overall survival (OS) and disease-free survival (DFS). OS time referred

to the time from the date of primary surgery to the date of death or the latest observation. DFS time referred to the interval from the date of initial surgery to the date of detection of recurrence, which was determined via MRI or CT scans, or the end of the follow-up when no disease was detected.

**Table 1** Clinical and pathological features of 57 patients diagnosed with PFTC (2006–2015)

| Characteristics | No. Patients | % |
|---|---|---|
| **Age** | | |
| > 60 | 37 | 65% |
| ≤ 60 | 20 | 35% |
| **Menopause at diagnosis** | | |
| Yes | 34 | 60% |
| No | 23 | 40% |
| **Nulliparous** | | |
| Yes | 3 | 5% |
| No | 54 | 95% |
| **Main clinical manifestation** | | |
| Latzko triad symptom | 5 | 9% |
| Vaginal bleeding / discharge | 35 | 61% |
| Abdominal pain | 5 | 9% |
| Pelvic mass | 9 | 16% |
| Others | 3 | 5% |
| **Preoperative diagnosis** | | |
| FTC/Adnexal mass | 29 | 51% |
| Ovarian malignancy | 20 | 35% |
| Uterine malignacy | 2 | 4% |
| Cervical cancer | 1 | 2% |
| benign tumor | 5 | 9% |
| **Histological subtype** | | |
| High grade serous | 48 | 84% |
| Mucinous | 1 | 2% |
| Endometrioid | 4 | 7% |
| Clear cell | 2 | 4% |
| Sarcomatoid | 1 | 2% |
| Mixed | 1 | 2% |
| **FIGO Stage** | | |
| I | 26 | 46% |
| II | 15 | 26% |
| III | 16 | 28% |
| **Grade** | | |
| I | 1 | 2% |
| II | 2 | 3% |
| III | 51 | 90% |
| unkown | 3 | 5% |
| **Preoperative serum CA 125, U/mL** | | |
| ≥ 35 | 35 | 61% |
| < 35 | 22 | 39% |

PFTC: Primary fallopian tube carcinoma; FTC: fallopian tube carcinoma; CA125: Cancer Antigen 125

### Statistical analysis

All the statistical analyses were performed via SPSS 24.0 software (SPSS Inc., Chicago, IL, USA). A $p$ value of $<0.05$ was considered statistically significant. To determine prognostic factors for OS, we conducted univariate Cox regression analysis on all the clinical and pathological parameters. Parameters with p values $<0.05$ in the univariate analysis were then included in a multivariate Cox proportional hazards regression model. To validate the assumptions of the Cox model, we performed a time-dependent covariate analysis to assess the proportional hazards assumption.

## Results

### Patient characteristics for PFTC

During the period of 2006–2015, a total of 65 patients with primary fallopian tube carcinoma (PFTC) were identified in our hospital, 57 of whom had complete prognostic information. The clinical features of these patients are displayed in Table 1. The average patient age was 57 years (range, 35–77 years). 60% of the patients were menopausal at the time of diagnosis. The most common clinical presentation was abnormal vaginal bleeding and/or discharge (61%), followed by a pelvic mass (16%), Latzko's triad of symptoms (9%) (a set of symptoms combining pelvic pain, a pelvic mass, and vaginal discharge or bleeding), abdominal pain (9%), and other symptoms (5%). The high-grade serous type was histologically predominant (84%). Twenty-nine patients (51%) were diagnosed with PFTC, 2 with uterine malignancies, 1 with cervical cancer, and 5 with benign tumors, while 20 patients (35%) were misdiagnosed with ovarian cancer. Patients were more likely to be diagnosed at an early stage. Twenty-six patients (46%) were in stage I, 15 (26%) were in stage II, and 16 (28%) were in stage III. Most patients had high-grade disease ($n=54$, 95%). Preoperative serum cancer antigen (CA)-125 levels were elevated in 61% of patients with PFTC.

### Survival analysis for PFTC

For patients with PFTC, the mean follow-up from the time of initial surgery was 47 months (range, 4–60 months). Twenty-one patients developed recurrence. The overall survival (OS) rate was 82%. Univariate analysis revealed that OS was significantly related to FIGO stage ($p<0.01$), residual tumor size ($p=0.030$), preoperative serum CA 125 level ($p<0.01$), lymphadenectomy ($p=0.050$), appendectomy ($p=0.038$), and number of cycles of chemotherapy ($p<0.01$) (Table 2). Factors that were significantly different in the univariate analysis were then attributed to the multivariate analysis. However, we found that only FIGO stage was an independent prognostic variable for OS according to the Cox proportional hazards model (Fig. 1A; Table 3, $p<0.01$). As shown in

**Table 2** Impact of prognostic factors on OS by univariate analysis in PFTC

| Factors | No. patients | Hazard ratio | 95% CI | *p*-value |
|---|---|---|---|---|
| **Age** | | 0.506 | 0.146–1.749 | 0.273 |
| ≤ 60 | 37 | | | |
| > 60 | 20 | | | |
| **Menopause at diagnosis** | | 0.591 | 0.153–2.289 | 0.442 |
| No | 23 | | | |
| Yes | 34 | | | |
| **Histological subtype** | | 0.696 | 0.148–3.280 | 0.645 |
| Serous | 48 | | | |
| Non-serous | 9 | | | |
| **FIGO Stage** | | 0.031 | 0.004–0.248 | ***p* < 0.01** |
| I/II | 41 | | | |
| III | 16 | | | |
| **Grade** | | 0.046 | 0.000-6148.234 | 0.436 |
| I/II | 3 | | | |
| III/unkown | 54 | | | |
| **Preoperative serum CA 125, U/mL** | | 0.02 | 0.000-3.610 | ***p* < 0.01** |
| < 35 | 22 | | | |
| ≥ 35 | 35 | | | |
| **Residual tumor size at initial surgery (cm)** | | | | **0.030** |
| 0 | 53 | | | |
| > 0,≤1 | 2 | 0.117 | 0.024–0.570 | |
| > 1 | 2 | 0.655 | 0.059–7.285 | |
| **Tumor diameter (cm)** | | 0.495 | 0.105–2.330 | 0.364 |
| < 5 | 19 | | | |
| ≥ 5 | 38 | | | |
| **Lymphadenectomy** | | 5.539 | 1.429–21.466 | **0.050** |
| No | 5 | | | |
| Yes | 52 | | | |
| **Omentectomy** | | 0.04 | 0.000-112.275 | 0.214 |
| No | 7 | | | |
| Yes | 50 | | | |
| **Appendectomy** | | 0.285 | 0.080–1.010 | **0.038** |
| No | 47 | | | |
| Yes | 10 | | | |
| **Chemotherapy (courses)** | | 0.083 | 0.023–0.301 | ***p* < 0.01** |
| ≤ 6 | 53 | | | |
| > 6 | 4 | | | |

OS: Overall survival; PFTC: Primary fallopian tube carcinoma; CA125: Cancer Antigen 125

Table 4, the overall survival of patients with PFTC was 100% for stage I patients, 93.33% for stage II patients, and 43.75% for stage III patients. Disease-free survival was 85.19% for stage I patients, 60.00% for stage II patients, and 31.25% for stage III patients. To assess the proportional hazards assumption, we performed Cox time-dependent covariate analysis. The FIGO stage was not time-dependent ($p=0.079$), indicating that the proportional hazards assumption was met.

#### Patient characteristics and survival analysis for HGSOC

During the period from 2014 to 2015, 60 cases of high-grade serous ovarian cancer were identified in our hospital. The average patient age was 54 years (range, 34–77 years). 25% of patients were diagnosed at early stages I and II, while 75% were at advanced stages III and IV. Patients were more likely to be diagnosed at an advanced stage. Preoperative serum carbohydrate antigen (CA)-125 levels were elevated in 98% of patients ($n=59$) with HGSOC. Thirty-eight patients developed recurrence. The overall survival (OS) rate was 67%. Univariate analysis revealed that OS was significantly related to FIGO stage ($p<0.01$), residual tumor size ($p<0.01$), and laterality ($p=0.026$) (Table 5). Factors that were significantly different in the univariate analysis were then attributed to the multivariate analysis. The Cox proportional hazards model revealed that residual tumor size ($p=0.039$) was an independent prognostic variable for OS (Fig. 1B; Table 6).

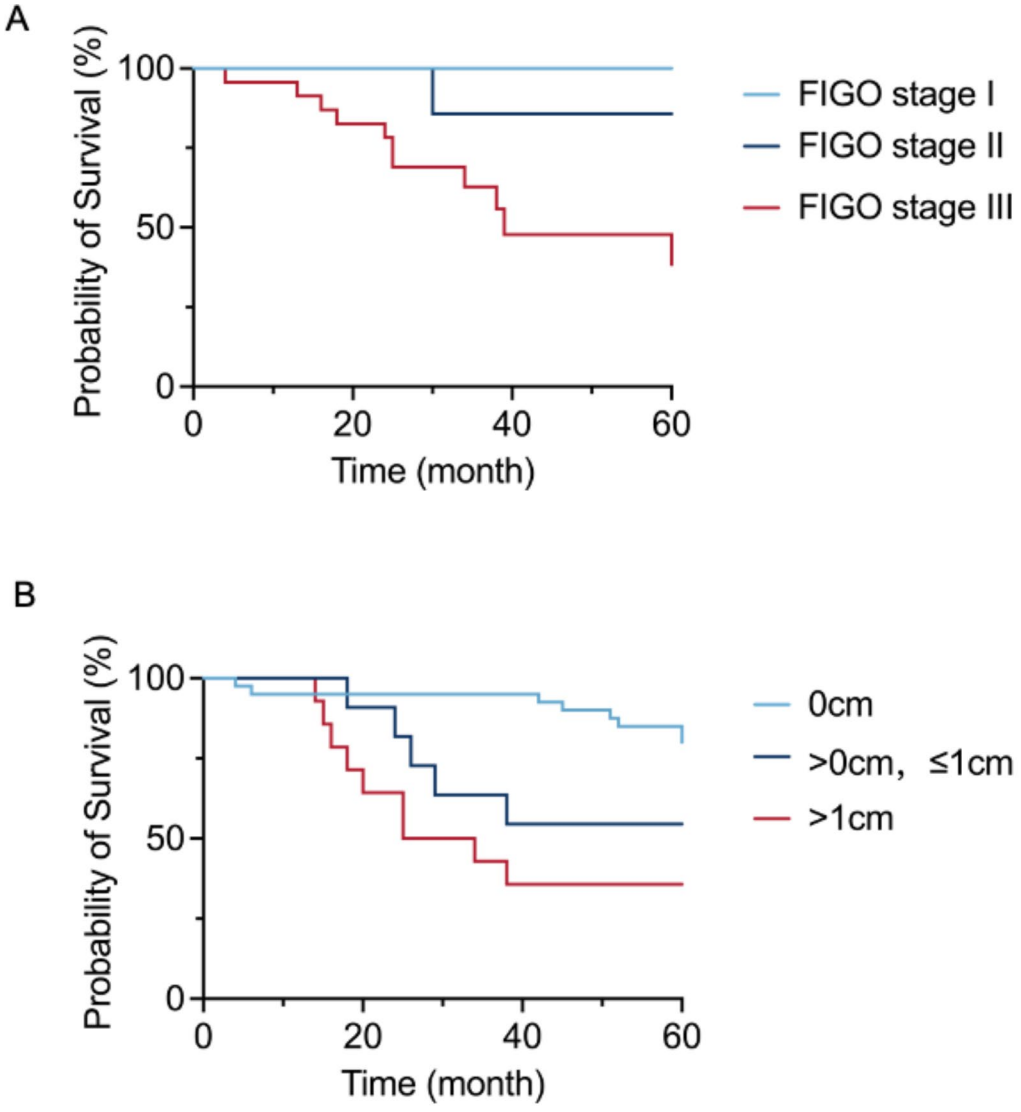


**Fig. 1** Overall survival Kaplan-Meier curves. **A**: Overall survival Kaplan-Meier curve of FIGO stage for PFTC patients. **B**: Overall survival Kaplan-Meier curve of residual tumor size for HGSOC patients

**Table 3** Multivariate analysis of variables predictive of OS by COX proportional hazards model in PFTC

| | Hazard ratio | 95% CI | *p*-value |
|---|---|---|---|
| FIGO Stage | 0.031 | 0.004–0.248 | $p < 0.01$ |
| Preoperative serum CA 125, U/mL | 0.02 | 0.000-2.905 | 0.184 |
| Residual tumor size at initial surgery | 2.823 | 1.351–5.897 | 0.498 |
| Lymphadenectomy | 0.205 | 0.054–0.775 | 0.507 |
| Appendectomy | 3.063 | 0.896–10.467 | 0.887 |
| Chemotherapy | 12.59 | 3.742–42.367 | 0.145 |

OS: Overall survival; PFTC: Primary fallopian tube carcinoma; CA125: Cancer Antigen 125

**Table 4** Cancer-survival of PFTC

| | OS | | DFS | |
|---|---|---|---|---|
| FIGO stage | No. Patients | % | No. Patients | % |
| I | 26 | 100.00% | 22 | 85.19% |
| II | 14 | 93.33% | 9 | 60.00% |
| III | 7 | 43.75% | 5 | 31.25% |

PFTC: Primary fallopian tube carcinoma; OS: Overall survival; DFS: Disease-free survival

For stage I and stage II patients, the overall survival of patients with HGSOC was 100.00%, 54.76% for stage III patients, and 33.33% for stage IV patients. Disease-free survival was 100.00% for stage I HGSOC, 77.78% for stage II HGSOC, 21.43% for stage III HGSOC, and 0.00% for stage IV HGSOC (Table 7). Cox time-dependent covariate analysis was performed, and residual tumor size

**Table 5** Impact of prognostic factors on OS by univariate analysis in HGSOC

| Factors | No. patients | Hazard ratio | 95% CI | *p*-value |
|---|---|---|---|---|
| Age | | 0.463 | 0.200-1.072 | 0.066 |
| ≤ 60 | 42 | | | |
| > 60 | 28 | | | |
| FIGO Stage | | 0.027 | 0.001–1.251 | ***p* < 0.01** |
| I/II | 15 | | | |
| III/IV | 45 | | | |
| Laterality | | 0.429 | 0.105–0.919 | **0.026** |
| unilateral | 22 | | | |
| bilateral | 38 | | | |
| Preoperative serum CA 125, U/mL | | 0.048 | 0.000-25449.637 | 0.498 |
| < 35 | 1 | | | |
| ≥ 35 | 59 | | | |
| Residual tumor size at initial surgery (cm) | | | | ***p* < 0.01** |
| 0 | 37 | | | |
| > 0, ≤1 | 10 | 0.177 | 0.067–0.465 | |
| > 1 | 13 | 0.534 | 0.178–1.597 | |
| Lymphatic metastasis | | 0.980 | 0.383–2.506 | 0.967 |
| No | 45 | | | |
| Yes | 15 | | | |
| Chemotherapy (courses) | | 0.491 | 0.200-1.206 | 0.113 |
| ≤ 6 | 48 | | | |
| > 6 | 12 | | | |

OS: Overall survival; HGSOC: high-grade serous ovarian cancer; CA125: Cancer Antigen 125

**Table 6** Multivariate analysis of variables predictive of OS by COX proportional hazards model in HGSOC

| | Hazard ratio | 95% CI | *p*-value |
|---|---|---|---|
| Residual tumor size at initial surgery | | | **0.039** |
| 0 | | | |
| > 0, ≤1 | 0.327 | 0.113–0.947 | |
| > 1 | 0.366 | 0.121–1.107 | |
| FIGO Stage | 0.509 | 0.119–2.184 | 0.953 |
| Laterality | 0.311 | 0.105–0.919 | 0.936 |

OS: Overall survival; HGSOC: high-grade serous ovarian cancer

**Table 7** Cancer-survival of HGSOC

| | OS | | DFS | |
|---|---|---|---|---|
| FIGO stage | No. Patients | % | No. Patients | % |
| I | 6 | 100.00% | 6 | 100.00% |
| II | 9 | 100.00% | 7 | 77.78% |
| III | 24 | 54.76% | 9 | 21.43% |
| IV | 1 | 33.33% | 0 | 0.00% |

HGSOC: high-grade serous ovarian cancer; OS: Overall survival; DFS: Disease-free survival

was not statistically significant ($p=0.803$), suggesting that it does not violate the proportional hazards assumption.

## Discussion

In this study, we analyzed the records of 57 patients with PFTC and 60 patients with HGSOC, all of whom had complete prognostic follow-up data. Our aim was to compare the prognostic factors affecting these two conditions and identify factors that may aid in the diagnosis and treatment of PFTC.

In clinical practice, notable biopathological differences between HGSOC and PFTC can assist in their diagnosis. HGSOC typically exhibits well-defined glandular formations, which may be irregular or destructive in nature. In contrast, the glandular structures in PFTC are less pronounced and often appear as smaller, more regular glands. Additionally, HGSOC tends to have a significant stromal reaction that promotes fibrous tissue proliferation, while the stromal response in PFTC is relatively unpronounced. However, these biopathological characteristics can be assessed only after surgery, making preoperative differences between PFTC and HGSOC challenging [17, 18]. Moreover, both tumors are often located deep within the pelvic cavity, making them difficult to detect and further complicating early diagnosis [19, 20]. Our study highlights the clinicopathological features and independent prognostic factors that impact OS, providing new insights for the early detection and prognosis of these diseases. To improve early diagnosis, we plan to investigate multiomics approaches that integrate genomic, proteomic, and metabolomic data to develop a more comprehensive diagnostic tool for early detection. We hope these advancements will increase the sensitivity and specificity of current diagnostic methods.

Similar to patients in other studies [19, 21, 22], patients with PFTC had a mean age of 57 years in our study, with 65% younger than 60 years and 35% older than 60 years.

Age has been reported to be associated with poor survival [16, 18], and young age appears to improve PFS and OS in HGSOC patients [23]. Our study did not find that age was statistically significant for OS in either univariate or multivariate analyses in patients with PFTC and HGSOC. The preoperative diagnosis of PFTC remains difficult. Most often, it is difficult to distinguish from ovarian cancer [8, 24]. In our study, although 51% of the patients were preoperatively diagnosed with a PFTC/adnexal mass (a tumor growing in the ovaries and/or fallopian tubes), 35% were presumed to have ovarian cancer, and the remaining 14% had other tumors. PFTC is thought to behave similarly to epithelial ovarian cancer. However, studies have shown that PFTC is more often diagnosed at an early stage than at an advanced stage. This differs from ovarian cancer, where most tumors are diagnosed at an advanced stage [25]. In our study, 72% of PFTC patients were diagnosed at early stages I and II, whereas 28% were at advanced stage III. Patients with stage IV disease were not found in our cohort. Among patients with HGSOC, 25% were diagnosed at early stages I and II, whereas 75% were at advanced stages III and IV. These differences in stage may be due primarily to women with PFTC being more likely to develop symptoms [26, 27]. Abnormal vaginal bleeding or discharge was the main clinical manifestation (61%) found in patients with PFTC, indicating its important role in diagnosis. However, the Latzko's triad symptoms were present in only 9% of the patients in our study. However, no specific tumor marker has been identified for PFTC. CA-125 is clinically used as a tumor marker for HGSOC [15], and it is also clinically used as a tumor marker for PFTC, such as ovarian cancer [28]. An increased preoperative CA-125 level was reported to be correlated with poor prognosis [22, 29]. We found that CA-125 was elevated in 61% of patients and was associated with OS. Among the 60 patients with HGSOC, 59 had elevated CA-125 levels. Most patients had high-grade (90%) and serous subtypes (84%), but no significant correlation was found between grade and survival or histology in our study.

Stage is the most important prognostic factor in many PFTC studies. The reported survival rates for women with FIGO stage I, II, III, and IV malignancies are 59-95%, 37-75%, 19-69%, and 12-45%, respectively [16, 26, 30, 31]. Our results revealed a 100% overall survival rate for patients with stage I disease and a 93.33% overall survival rate for patients with stage II disease, which were higher than the reported data; this could be because there were fewer people in the study or because the medical conditions at the time of the study were better than before. The survival rate for patients with stage III disease was 43.75%, similar to findings from other reported studies. A retrospective multicentre study involving 88 PFTC patients also revealed that FIGO stage was an important prognostic factor for survival [32]. Another clinicopathological study of 105 patients revealed that stage was a highly significant prognostic factor and emphasized the need to incorporate staging for noninvasive PFTC [33]. In addition to the literature, our findings are consistent with the NCCN guidelines, which recommend tailored treatment approaches based on distinct FIGO stages. In patients with HGSOC, our study revealed that FIGO stage was a statistically significant predictor of OS in univariate analyses but not in multivariate analyses. PFTC is usually treated in a similar manner as ovarian cancer [15]. Comprehensive staging, including pelvic and paraaortic lymphadenectomy, is the primary surgical principle for PFTC. The effect of lymphadenectomy on survival is controversial in reported studies. Some studies have reported that lymphadenectomy is an independent prognostic factor for OS, whereas others have not reported a difference [34–36]. In our study, although lymphadenectomy was found to be a prognostic factor for OS by univariate analysis, it was not an independent indicator for OS by multivariate analysis. Because multivariate analysis accounts for interactions between variables, the combined effect of multiple variables can differ from their individual effects. These interactions were not considered in the univariate analysis, which may explain why certain variables that were significant in the univariate analysis did not retain statistical significance in the multivariate analysis. Appendectomy was used as an example in our study. For advanced-stage disease, surgical cytoreduction followed by chemotherapy is recommended. Previous studies have reported that PFTC responds well to platinum- and/or paclitaxel-based chemotherapy [37–40]. However, in this study, multivariate analysis revealed that the number of cycles of chemotherapy had no significant effect on survival. Residual tumor size is also a predictive factor reported in several studies [22, 26, 41, 42]. The residual tumor size at initial surgery is the most important prognostic factor in many HGSOC studies [29]. In our study, residual tumor size was also found to be an important prognostic factor. This parameter did not differ significantly in the multivariate analysis of outcomes in patients with PFTC, but it was an independent prognostic factor for overall survival in patients with HGSOC. Notably, only 2 patients with PFTC had residual tumor sizes larger than 1 cm, and 2 patients with PFTC had residual tumor sizes larger than 0 cm in our records, which may be because most patients were in early stages I and II. Thus, the effect of residual tumor size on survival needs further study for confirmation.

Our study has several limitations. This study was retrospective, with data not collected prospectively for research purposes, which may introduce selection and data collection biases, although we minimized selection bias by including consecutive patients. Variations

in treatment plans, such as differences in chemotherapy regimens or surgical approaches, can contribute to outcome variability. Expanding the sample size and performing subgroup analyses could help reduce this variability. In addition, the study was conducted at a single institution with a relatively small sample size, so validation in a larger cohort is necessary. We plan to collaborate with other hospitals to further validate these findings.

In conclusion, our study identified FIGO stage as an independent prognostic factor for OS decline in PFTC patients, whereas residual tumor size was an independent prognostic factor for OS decline in HGSOC patients but not in PFTC patients. Additionally, factors such as residual tumor size, preoperative serum CA 125 levels, lymphadenectomy, appendectomy, and chemotherapy cycles influence survival in PFTC patients. This study highlights the importance of surgical management by a gynecological oncologist, as well as the need for complete staging and achieving a residual tumor size less than 1 cm. Our findings also emphasize the value of multidisciplinary treatment, underscoring the importance of thorough preoperative evaluation and striving for complete tumor resection to improve patient outcomes.

#### Author contributions

J.X. conceived and designed the study. J.X. and X.G. was involved in data acquisition. J.X., M.T., X.G., T.G. and W.L. analyzed the data. J.X. and M.T. wrote the manuscript. J.X. revised the manuscript. All authors read and approved the final manuscript.

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#### Data availability

The data supporting the findings of this study are available upon request from the corresponding author.

## Declarations

#### Ethics approval and consent to participate

The study protocols were approved by the Ethics committee of Women's Hospital of Zhejiang University (IRB20210122R). Written informed consent was obtained from all patients participating in the study. We confirmed that all methods were carried out in accordance with relevant guidelines and regulations.

#### Competing interests

The authors declare no competing interests.

#### Conflict of interest

The authors declare that there is no conflict of interest.

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