Fertility outcomes following surgery and multiagent chemotherapy in malignant ovarian germ cell tumor survivors: a survey study

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ABSTRACT

Objective To assess fertility outcomes in long-term survivors of malignant ovarian germ cell tumors treated with fertility-sparing surgery with or without additional chemotherapy.

Methods Women diagnosed and treated for malignant ovarian germ cell tumors at Charing Cross Hospital or Mount Vernon Cancer Centre between 1977 and 2015 were included. Questionnaires assessing fertility issues were sent to patients treated with fertility-sparing surgery. Fertility outcomes were evaluated according to the treatment received. The effect of the mean total dose of cyclophosphamide and cisplatin was assessed.

Results A total of 146 patients were sent the questionnaire; 77 (56.5%) patients were included in the analysis. A total of 49 (64%) patients received platinum-based chemotherapy after surgery, 39 (79.6%) of these with cisplatin, vincristine, methotrexate, bleomycin, actinomycin D, cyclophosphamide, and etoposide, while 10 (20.4%) with bleomycin, etoposide, and cisplatin. After any treatment, 39/46 patients (85%) became pregnant: the conception rate was not different between those receiving surgery only and those receiving also chemotherapy (85.7% vs 84.4%, p=1.0). Live birth rate was 80.4% (37/46), with no statistically significant difference between the treatment groups (p=0.42). Median age of women achieving conception was 29 years (IQR 26–33). The probability of live birth at 5 years was 48% and 40% for patients in the surgery only and chemotherapy group, respectively (p=0.55). Infertility and miscarriage rates did not differ significantly between the two treatment groups (p=0.30 and p=0.32). The mean doses of cisplatin and cyclophosphamide received by patients failing and achieving conception were not different (p=0.10, p=0.47).

Conclusions Our results suggest that fertility may not be hampered in patients with malignant ovarian germ cell tumor treated with fertility-sparing surgery or receiving additional chemotherapy.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Reproductive function of patients diagnosed with malignant ovarian germ cell tumors does not seem to be impacted significantly by chemotherapy, but available data are limited. Moreover, no clear comparison is available between women receiving, or not, additional chemotherapy and for women treated with regimens different from bleomycin, etoposide, and platinum.

WHAT THIS STUDY ADDS

⇒ This multicenter study provides an overview of fertility outcomes among women with all stages of malignant ovarian germ cell tumors, showing that fertility is not hampered in patients treated with fertility-sparing surgery or receiving additional chemotherapy.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Findings from this study should help to reassure patients with malignant ovarian germ cell tumors about their future fertility, even though larger investigations are needed to confirm these results.

INTRODUCTION

Malignant ovarian germ cell tumors are very rare, accounting for less than 5% of all ovarian malignancies.[1–3] These tumors typically present in young women of reproductive age and are highly curable, with 5-year survival rates ranging between 70% and 100%.[4 5] Most women present with stage I disease, and fertility-sparing surgery with unilateral salpingo-oophorectomy and peritoneal staging is the standard of care for patients desiring to preserve fertility. Several studies have shown how conservative surgery does not worsen the prognosis of early-stage malignant ovarian germ cell tumors.[6–10] Close surveillance rather than adjuvant chemotherapy is increasingly being offered as an option in stage I disease, with the aim of avoiding unnecessary toxicities and reserving systemic therapies in case of relapse.[11–14]

For advanced stages, fertility-sparing surgery should be considered a possible option, given the high chemosensitivity.[6–10] In these cases, patients either undergo conservative surgery followed by bleomycin, etoposide, and cisplatin or other platinum-based

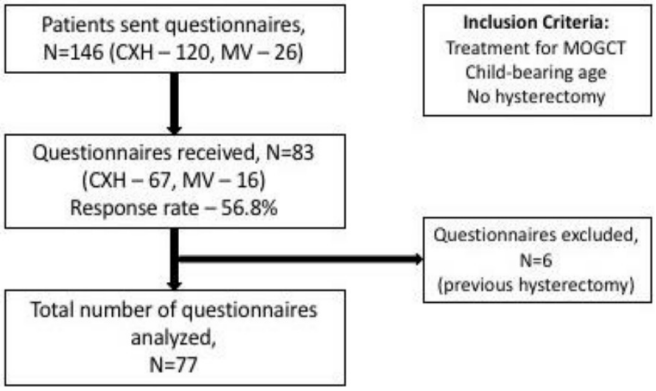

Figure 1 Flowchart of questionnaires distributed and analyzed within the study. CXH, Charing Cross Hospital, MOGCT, malignant ovarian germ cell tumor; MV, Mount Vernon Cancer Center.

regimens such as cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide. Alternatively, patients may receive neoadjuvant chemotherapy followed by surgery, particularly those patients for whom initial conservative surgery may prove difficult due to the high tumor burden.

Fertility preservation is of critical importance for young patients, given their young age, high chemosensitivity, and generally good prognosis. It is known that chemotherapy might impair fertility because of follicular damage and stromal fibrosis.[15 16] Few prior studies have looked at the fertility effects of chemotherapy in the survivors of male and female germ cell tumors. Many suggest that chemotherapy containing bleomycin, etoposide, and cisplatin exerts low gonadotoxic effect, with the majority of patients maintaining their menstrual cycles.[15–26] However, the resumption of normal menses is not automatically translated into maintained fertility, with premature menopause rates ranging from 3% to 6%.[10 15]

In patients who get pregnant, small retrospective studies suggest a good rate of healthy live births,[1 15 16 20 21] even though Solheim et al highlighted a dose-dependent relationship between cisplatin and infertility rates.[21] In these studies, different fertility assessment methods have been used, including recovery of normal menstrual cycles, conception, or live birth rates, making comparisons difficult. Moreover, none have compared fertility in women where one ovary was removed and who underwent surveillance versus additional chemotherapy. The former group might have increased infertility due to surgically induced ovarian damage, post-surgical adhesions, reduced ovarian reserve, or other unrecognized factors. Interestingly, it has been reported that women with cancer might have reduced anti-Müllerian hormone levels compared with healthy controls even before treatment, possibly reflecting a reduced ovarian reserve, even though the relationship with long-term infertility is

Table 1 Demographic information on women affected by malignant ovarian germ cell tumors who participated in the survey

			Treatment		
		Total (n=77)	Fertility-sparing surgery (n=28)	Fertility-sparing surgery+chemotherapy (n=49)	P value
Age at diagnosis	Median (IQR)	23 (19–28)	26 (21–33)	21 (18–27)	0.08
Age at time of survey	Median (IQR)	39 (29–47)	38 (28–44)	39 (29–48)	0.11
Stage	IA	21 (27.3%)	19 (67.9%)	2 (4.1%)	<0.005
	IC	22 (28.6%)	6 (21.4%)	16 (32.7%)	
	II	9 (11.7%)	1 (3.6%)	8 (16.3%)	
	III or IV	20 (26.0%)	0 (0%)	20 (40.8%)	
	Unknown	5 (6.5%)	2 (7.1%)	3 (6.1%)	
Histology	Dysgerminoma	16 (20.8%)	4 (14.3%)	12 (24.5%)	0.005
	Non-dysgerminoma	15 (19.5%)	2 (7.1%)	13 (26.5%)	
	Immature teratoma	17 (22.1%)	12 (42.9%)	5 (10.2%)	
	Mixed	15 (19.5%)	7 (25.0%)	8 (16.3%)	
	Unknown	14 (18.2%)	3 (10.7%)	11 (22.4%)	
Fertility pre-diagnosis	Attempted pregnancy	44 (57.1%)	13 (46.4%)	31 (63.3%)	0.96
	Pregnant	29 (65.9%)*	10 (76.9%)*	19 (61.3%)*	
	Live birth	20 (69.0%)†	6 (60.0%)†	14 (73.7%)†	
Chemotherapy	No chemotherapy	28 (36.4%)	28 (100%)		
	POMB/ACE	39 (50.6%)		39 (79.6%)	
	BEP	10 (13.0%)		10 (20.4%)	

*Actual pregnancies/number of patients who attempted pregnancy
†Number of live births/actuals
BEP, bleomycin, etoposide, and platinum; POMB/ACE, cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, etoposide .

Table 2 Outcomes of women whom attempted pregnancy according to treatment

Outcomes		Total (n=46)	Treatment		P value
			Fertility-sparing surgery (n=14)	Fertility-sparing surgery+chemotherapy (n=32)	
Post-treatment pregnancy	Yes	39 (84.8%)	12 (85.7%)	27 (84.4%)	1.00
	No	7 (15.2%)	2 (14.3%)	5 (15.6%)	
Age pregnancy	Median (IQR)	29 (26–33)	29 (23–34)	29 (27–32)	1.00
Post-treatment live birth	Yes	37 (80.4%)	10 (71.4%)	27 (84.4%)	0.42
	No	9 (19.6%)	4 (28.6%)	5 (15.6%)	
Post-treatment infertility	Yes	12 (26.1%)	5 (35.7%)	7 (21.9%)	0.30
	No	32 (69.6%)	8 (57.1%)	24 (75.0%)	
	Unknown	2 (4.3%)	1 (7.1%)	1 (3.1%)	
In vitro fertilization	Yes	5 (10.9%)	2 (14.3%)	3 (9.4%)	0.63
	No	41 (89.1%)	12 (85.7%)	29 (90.6%)	
	Live birth	4 (80%)*	2 (100%)*	2 (66.7%)*	
Miscarriages	Yes	16 (34.8%)	3 (21.4%)	13 (40.6%)	0.32
	No	30 (65.2%)	11 (78.6%)	19 (59.4%)	
Termination	Yes	7 (15.2%)	1 (7.1%)	6 (18.8%)	0.41
	No	39 (84.8%)	13 (92.9%)	26 (81.2%)	
Regular menstrual cycle	Yes	29 (63.0%)	9 (64.3%)	20 (62.5%)	0.74
	No	16 (34.8%)	4 (28.6%)	12 (37.5%)	
	Unknown	1 (2.2%)	1 (7.1%)	–	

*Actual pregnancies/number of patients who attempted pregnancy.

unknown.[21] The goal of this study was to assess fertility outcomes in long-term survivors treated with fertility-sparing surgery with or without chemotherapy.

METHODS

Women diagnosed and treated for malignant ovarian germ cell tumors at Charing Cross Hospital or Mount Vernon Cancer Centre between 1977 and 2015 were retrospectively retrieved from the institutional databases. Both hospitals are national tertiary referral centers for malignant ovarian germ cell tumors within the United Kingdom National Health System. Adult patients of childbearing age (18–45 years at the time of this study) treated with fertility-sparing surgery with or without chemotherapy were included. Fertility-sparing surgery was defined as preservation of the uterus and at least one ovary and fallopian tube, along with comprehensive surgical staging. Additional chemotherapy consisted either of cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide[4] or cisplatin, etoposide, and bleomycin regimen.[22] Bleomycin, etoposide, cisplatin was used in early-stage disease, whereas cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide were used in both early and advanced disease. Patients did not receive gonadotrophin-releasing hormone analogs as gonadoprotection during chemotherapy and were advised to avoid pregnancy for 2 years after completion of treatment. Cisplatin and cyclophosphamide doses for fertile and infertile patients were compared, where the number of cycles was available. All pathological analyses were made by experienced gynecologic pathologists. Central pathological review was done for all externally referred cases. Staging was assessed according to the International Federation of Gynecology and Obstetrics (FIGO) classification.[23] All clinical information was obtained from the clinical records from each site.

Questionnaires assessing fertility were established with help from patient representatives (Online supplemental index 1) and sent to all patients of childbearing age treated at Charing Cross Hospital and Mount Vernon Cancer Center. Fertility outcomes were assessed in terms of conception rate and live birth rates in women attempting pregnancy. Effect of mean total dose of cyclophosphamide and cisplatin on infertility was also evaluated. Infertility was defined as women who attempted pregnancy following treatment but were unable to conceive within 1 year or more. Time to pregnancy was assessed only for patients who attempted to become pregnant following treatment. The probability of live birth was plotted and stratified by treatment modality over time. The study was approved as a National Health Service England evaluation and improvement exercise by Imperial College Healthcare and Mount Vernon Cancer Center National Health Service trusts with removal of all identifiable patient data. In accordance with the journal's guidelines, we will provide our data for independent analysis by the editorial team for the purposes of additional data analysis or for the reproducibility of this study, if requested.

Continuous variables were presented as a median and range, and associations were tested using Mann-Whitney U-test or Student's t-test. Categorical variables with absolute or relative frequencies were tabulated and X^2 or Fisher's exact test were

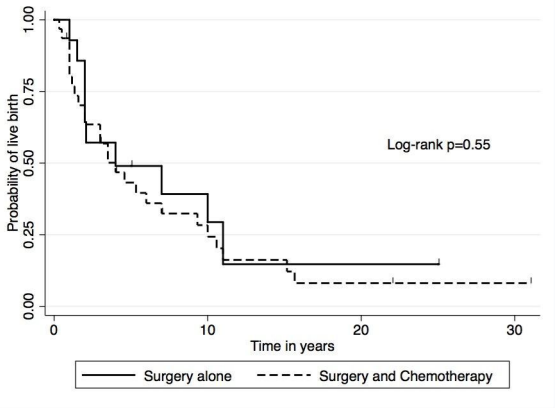

Figure 2 Distribution of live births over follow-up time in years among patients treated for malignant ovarian germ cell tumors with surgery or surgery and chemotherapy.

used. Probability of live birth curves were plotted according to Kaplan and Meier method. Patients were censored in the event of a live birth. Univariate and multivariable analyses were conducted to identify factors that impact the probability of a live birth among women who attempted to become pregnant following treatment. All statistical analyses were completed using two-sided test and statistical significance was achieved where p<0.05. Data analysis was conducted using STATA 13.0 (College Station, Texas, USA).

RESULTS

A total of 223 patients diagnosed and treated for malignant ovarian germ cell tumors were identified; 146 patients met the inclusion criteria and were sent the questionnaire. One-hundred and twenty patients received treatment at Charing Cross Hospital and 26 at Mount Vernon Hospital. Eighty-three patients (56.8%) consented to complete the questionnaire. Six of the responding patients had a hysterectomy as part of their treatment and were subsequently excluded from the analyses (Figure 1). Median follow-up duration was 144 months (range 12–180). Table 1 summarizes patients clinicopathological characteristics. Median age at diagnosis and at the time of the survey was 23 years (IQR 19–28) and 39 years (IQR 29–47), respectively. As shown in Table 1, 27.3% of patients were FIGO stage IA (n=21), 28.6% were IC (n=22), 11.7% stage II (n=9), and 26% were either stage III or IV (n=20). Stage was unknown for 6.5% of patients (n=5). Dysgerminomas accounted for 21% of cases (n=16) and non-dysgerminomatous cases for 19.5% (n=15), with 41.6% of the remaining cases distributed between immature and mixed malignant ovarian germ cell tumors (n=12 and 15, respectively) (Table 1).

Twenty-eight patients (36%) were treated with fertility-sparing surgery alone, while 49 (64%) patients were managed with both fertility-sparing surgery and chemotherapy. Among those receiving additional treatment, 79.6% (39/49) received cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide, while 20.4% (10/49) received bleomycin, etoposide, and cisplatin. As shown in Table 1, significant differences in adjuvant treatment were found according to stage at diagnosis: chemotherapy was more frequently administered in advanced stage disease (stage III and IV), while earlier stages in most cases received close surveillance.

As shown in Table 1, pre-treatment fertility outcomes, including attempts to conceive, conception rate and live birth rate were not significantly different between the two treatment groups (p=0.96). Following treatment, 46 (60%) patients attempted to become pregnant (Table 2). Among these, 14 patients were treated with unilateral salpingo-oophorectomy alone and 32 patients were treated with both unilateral salpingo-oophorectomy and chemotherapy. At least one pregnancy was achieved in 84.8% (39/46) following treatment, 12 having received surgery only (12/14, 85.7%) and 27 with additional chemotherapy (27/32, 84.4%). The conception rate was not significantly different between the two groups (p=1.0).

For patients who achieved at least one live birth, the overall rate was 80.4% (37/46), with no statistically significant difference between patients who received chemotherapy versus oophorectomy alone (p=0.42). Among women attempting to conceive following treatment, the median age at pregnancy was 29 years in both treatment groups.

Following any treatment, the overall probability of live birth at 5 years was 42% (95% CI 27% to 56%) and 22% at 10 years (95% CI 11% to 37%). At 5 years after fertility-sparing surgery alone, patients with malignant ovarian germ cell tumors had a 48% (95% CI 22% to 72%) probability of a live birth as compared with 40% (95% CI 22% to 56%) probability for patients treated with fertility-sparing surgery and chemotherapy. Over time, the probability of live births was not statistically different between the two treatment groups (Figure 2, log-rank p=0.55). No pre-treatment factors, such as age at diagnosis, histology, stage or treatment type, were statistically significant for predicting a pregnancy and subsequent live birth (Table 3).

Twelve patients (26%) reported infertility following treatment, with rates not significantly different between the two groups (35.7%

Table 3 Univariate analyses of patient and treatment characteristics to evaluate predictive factors for live birth among women who attempted to get pregnant following treatment for malignant ovarian germ cell tumors

	Univariate analysis		
	HR	CI	P value
Age at diagnosis	0.99	0.94 to 1.04	0.70
Histology			
Non-dysgerminoma	2.46	0.85 to 7.07	0.09
Immature teratoma	0.77	0.29 to 2.08	0.61
Mixed	0.76	0.24 to 2.44	0.65
Stage			
IC	0.86	0.35 to 2.09	0.73
II	0.82	0.24 to 2.74	0.74
III and IV	1.09	0.44 to 2.70	0.86
Pre-treatment live birth			
Yes	1.34	0.57 to 3.10	0.50
Cisplatin dose	0.99	0.99 to 1.00	0.32
Cyclophosphamide dose	0.99	0.99 to 1.00	0.17
Treatment modality	0.86	0.20 to 3.64	0.83
Surgery and chemotherapy	1.24	0.60 to 2.57	0.57

vs 21.9%, p=0.30). Of these, five patients (11%) underwent in vitro fertilization, two in the conservative surgery group (with 100% live birth rate), three in the fertility-sparing surgery plus chemotherapy group (live birth rate 66.7%). Sixteen patients (34.8%) reported a miscarriage. The miscarriage rate was not statistically different between the two treatment groups (21.4% vs 40.6%, p=0.32).

Seventy-four patients responded to the question about resumption of menstrual cycles following therapy, with 54 women (73.0%) reporting regular menstrual cycles. No statistically significant difference was found in pregnancy and miscarriage rates between patients receiving bleomycin, etoposide, cisplatin and those receiving cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide (pregnancy rate 84% vs 86%, p=1.0 and miscarriage rate 44% and 28%, p=0.6). The mean chemotherapy doses for patients whom treatment failed and those who achieved spontaneous conception were 1750 mg/m^2 and 1200 mg/m^2 for cyclophosphamide and 480 mg/m^2 and 413 mg/m^2 for cisplatin, respectively. No statistically significant difference was found between the two groups (p=0.10, p=0.47).

DISCUSSION

Summary of Main results

Our study showed that fertility outcomes in terms of conception, live birth, miscarriage, and infertility rates were comparable between patients treated with fertility-sparing surgery alone and those receiving additional chemotherapy for malignant ovarian germ cell tumors. No difference in fertility outcomes was observed between patients receiving bleomycin, etoposide, cisplatin and those receiving cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide.

Results in the context of published literature

Preservation of fertility is important among patients treated for malignant ovarian germ cell tumors, given their young age and excellent survival. Indeed, fertility-sparing surgery is currently considered the standard of care in this patient population. While most early-stage disease does not require chemotherapy unless there is a relapse, all advanced cases require chemotherapy using either bleomycin, etoposide, cisplatin or cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide, with possible concerns about gonadotoxicity. Surgery itself, even if fertility-sparing, can hamper ovarian reserve due to development of post-surgical adhesions or surgically induced ovarian damage, direct or indirect, due to impaired vascularization and inflammation.[27 28]

Three main factors limit the effective assessment of reproductive potential in these patients. First, the rarity of the disease, with only a few small-sample sized studies, often pooling all patients with non-epithelial ovarian cancer.[26] Second, modalities of fertility evaluation vary among studies, and may include recovery of menstrual cycles, conception rates, or live birth rates.[15–26 29 30] Simple recovery of menstruation does not prove fertility and while conception rates are important, live birth rates are probably the most important data when considering fertility. This heterogeneity in reporting makes it difficult to compare data and draw conclusions. Moreover, data are limited by the young patient age, often not yet interested in attempting to conceive.

Despite these limitations, available evidence from literature supports that reproductive function is scarcely affected by additional chemotherapy, even in advanced-stage malignant ovarian germ cell tumors.

Several studies have reported resumption of regular menstrual cycles following chemotherapy in this patient setting.[10 24 26] However, it is known that ovarian reserve can be depleted despite regaining regular periods,[26] therefore this should not be considered a reliable marker of preserved fertility. Regarding the live birth rates after chemotherapy for malignant ovarian germ cell tumors, data are scant but reassuring, with live birth rates ranging between 67% and 100% of patients attempting conception.[10 29 30] In most studies, however, no clear comparison between women undergoing surgery only and those receiving also additional chemotherapy is available.[30] Data from the present series confirm these reassuring results in both populations: in patients attempting pregnancy, the chemotherapy-treated group live birth rate was 84.4%, with no statistically significant difference from that of patients treated with surgery alone (85.7%).

Literature evaluating reproductive outcomes in survivors of malignant ovarian germ cell tumor mainly includes patients who have received bleomycin, etoposide, cisplatin chemotherapy and most commonly those with early-stage disease. Interestingly, in our series 26% of patients presented with advanced-stage disease, and almost 50% of included patients received chemotherapy with cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide. This seven-drug regimen is preferred in our institutions to treat high-risk patients, often in the neoadjuvant setting, when primary fertility-sparing surgery is not feasible due to high tumor burden and/or poor performance status.[4] One might expect this regimen to be associated with increased gonadotoxicity, specifically because of alkylating agents. Among chemotherapeutic drugs, this class, and in particular cyclophosphamide, are known to be associated with an increased risk of ovarian damage, also in relation to the total dose administered.[21] Gaffan et al reported in 2003 the fertility outcomes of 28 patients treated with cisplatin, vincristine, methotrexate, bleomycin, dactinomycin, cyclophosphamide, and etoposide at Charing Cross Hospital between 1977 and 1996, estimating the chemotherapy-induced infertility rate to be around 18%.[25] In this updated series, the live birth rate of patients attempting pregnancy is comparable to that reported in literature.

Available data regarding a potential correlation between cumulative chemotherapy dose and infertility in these patients are controversial. Tangir et al and Gaffan et al found no correlation between cyclophosphamide total dose and infertility, even when combined with other agents.[20 25] Conversely, Solheim et al reported higher rates of post-treatment fertility among patients treated with fewer than three cycles of cisplatin chemotherapy. The regimens used were cisplatin, vinblastine and bleomycin; cisplatin, etoposide; bleomycin, etoposide, cisplatin.[21] The current study found no differences in the cumulative doses of cyclophosphamide and cisplatin between women failing and achieving spontaneous conception. This might have been due to the small number of patients who failed conception after receiving both chemotherapy and surgery.[20 21]

Few data exist on patients with early-stage disease treated with fertility-sparing surgery alone for malignant ovarian germ cell tumors and managed with surveillance instead of adjuvant therapy. This latter group might have increased infertility due to surgically

induced ovarian damage, post-surgical adhesions, reduced ovarian reserve, or other unrecognized factors. Interestingly, some studies have found reduced anti-Müllerian hormone levels in patients with cancer, even before receiving any treatment.[22] In the present study, 28 patients (36%) underwent surveillance after fertility-sparing surgery. No statistically significant differences were found in conception and live birth rates in comparison with patients receiving chemotherapy. The type of treatment administered among all stages of disease did not influence conception and live births rate. There were no pre-treatment factors, such as age, stage, or histology or treatment factors, including the mean doses of chemotherapy drugs, that were predictive for a live birth. Fertility outcomes were similar irrespective of whether the patients were treated with surgery alone or surgery followed by chemotherapy. Furthermore, a trend towards more miscarriages was noted in patients who had surgery and chemotherapy, without reaching statistical significance.

Strengths and Weaknesses

To the best of our knowledge, this multicenter study represents the largest series that has comparatively investigated fertility outcomes among women treated with fertility-sparing surgery with or without chemotherapy for malignant ovarian germ cell tumors. There are limitations to this retrospective survey study, which relies on the patients to report their fertility status. Although patients helped in designing the questionnaire, responses might be influenced by the subjective interpretation of the question and the long time interval between treatment and inclusion. Moreover, responder bias could affect the results, given that women achieving conception might be more likely to participate. For these reasons, results should be interpreted with caution and need validation in a larger cohort. Moreover, as this study spans several decades, changes in treatment have not been taken into consideration, such as the more recent use of low-dose induction chemotherapy with etoposide and cisplatin.[31] This series partially includes patients whose outcomes in terms of fertility have already been described by Gaffan et al in 2003.[25]

Implications for Practice and Future Research

We have shown that fertility-sparing surgery with additional chemotherapy, even in patients with high-risk disease, does not appear to impair subsequent fertility. These data can be useful when counseling young patients and should reassure them about future fertility. Larger studies are needed to validate these findings.

CONCLUSIONS

Our data suggest that fertility is not hampered when patients diagnosed with malignant ovarian germ cell tumors are treated with conservative surgery and additional multiagent chemotherapy, even in high-risk disease.

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Patient consent for publication Not applicable.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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