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Impact of Operative Start Time on Surgical Outcomes in Patients Undergoing Primary Cytoreduction for Advanced Ovarian Cancer

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Abstract

Objectives—To evaluate the impact of operative start time (OST) on surgical outcomes in patients with advanced ovarian cancer.

Methods—All stage IIIB–IV serous ovarian cancer patients who underwent primary surgery at our institution from 1/01–1/10 were identified. Fourteen factors were evaluated for an association with surgical outcomes including OST and OR tumor index (1 point each for carcinomatosis and/or bulky (≥1cm) upper abdominal disease). Univariate logistic regression considering within-surgeon clustering was performed for cytoreduction to ≤1cm versus >1cm residual disease. In patients with ≤1cm residual disease, univariate logistic regression considering within-surgeon clustering was performed for 1–10mm residual disease versus complete gross resection (CGR, 0mm residual). A multivariate logistic model was developed based on univariate analysis results in the ≤1cm residual disease cohort.

Results—Of 422 patients, residual disease was: 0mm, 144 (34.1%); 1 10mm, 175 (41.5%); >10mm, 103 (23.3%). OST was not associated with cytoreduction to ≤1cm residual disease on univariate analysis. In the ≤1cm residual disease cohort, albumin, CA-125, ascites, ASA score, stage, OR tumor index, and OST were associated with CGR on univariate analysis. Earlier OSTs were associated with increased rates of CGR. On multivariate analysis, CA-125 was independently associated with CGR. OST was associated with CGR in patients with an OR tumor index of 2 but not an OR tumor index <2.

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Conflict of Interest/Disclosure Statement

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Conclusions—OST was not associated with cytoreduction to ≤1cm residual disease in patients with advanced serous ovarian cancer. In the cohort of patients with ≤1cm residual disease, later OSTs were associated with reduced rates of CGR in patients with greater tumor burden.

INTRODUCTION

Cytoreductive surgery followed by platinum-based chemotherapy is the cornerstone of treatment for advanced ovarian cancer. Numerous retrospective analyses have demonstrated that residual disease status at completion of attempted primary cytoreduction is a strong predictor of survival [1–3]. Resection of all disease larger than 1cm in diameter is recommended when feasible [4]. More recent evidence suggests that complete gross resection of all visible disease may provide an even greater survival advantage [5–7].

In an effort to improve the rate of cytoreduction to ≤1cm residual disease, extensive surgical techniques such as diaphragm resection, splenectomy, and bowel resection have been increasingly utilized safely even in patients with bulky upper abdominal disease (UAD) [8–10]. Although feasible, these procedures are associated with increased operative time, blood loss, and case complexity [8]. As gynecologic oncologists are well aware, these longer procedures are both physically and mentally taxing on the surgeon. When these procedures begin late in the day, the influence of surgeon fatigue on the success of these procedures is possibly increased.

Numerous studies outside the field of gynecologic oncology have explored the potential negative influence of both surgeon fatigue [11–17] and late operative start times (OSTs) [18–23] on complications and survival in patients undergoing complex surgical procedures. As the outcome of these studies have been inconsistent, we sought to explore the potential impact of OST on cytoreductive outcomes in patients undergoing attempted cytoreductive surgery for advanced serous ovarian cancer at our institution over a 10-year period. Our objective was to evaluate whether OST influenced the rate of cytoreduction to ≤1cm residual and/or complete gross resection in this setting.

METHODS

Following Institutional Review Board (IRB) approval, we identified all patients with International Federation and Gynecologic Oncology (FIGO) stage IIIB or higher serous ovarian carcinoma who underwent primary surgical cytoreduction at our institution between January 1, 2001 and January 31, 2010. Patients were excluded if they received neoadjuvant chemotherapy prior to attempted cytoreductive surgery or if they underwent attempted cytoreduction at the time of emergent exploratory laparotomy for existent or impending bowel obstruction. Demographics including age at diagnosis, medical comorbidities, preoperative laboratory values (eg, serum CA-125 level), FIGO stage, and histologic grade were identified from the medical records. Operative notes were evaluated for length of surgical procedures, procedures performed, volume of residual disease, and estimated blood loss. As described by Aletti and colleagues, a Surgical Complexity Score incorporating the number and complexity of surgical procedures performed was assigned to all patients (range, 0 – 18) [24]. Based on their Surgical Complexity Score, patients were then divided into low (score ≤3), intermediate (score 4 – 7), and high (score 8 – 18) complexity scoring groups.

Two novel factors were abstracted from the medical record. OST, defined as the time of skin incision, was obtained from the anesthesia operative report and available for all patients. OST was analyzed both as a continuous variable and a categorical variable. Cases were divided into three groups: early cases (before 11 AM), mid-day cases (between 11 AM and 3 PM), and late cases (after 3 PM). These three groups were created based upon the assumption that that these time periods roughly represent when the first, second, or third cases of the day are likely to begin. We were unable to ascertain whether later cases actually corresponded to second or third cases in most circumstances due to limitations of the medical record.

The structure of operative scheduling at our institution was stable for the duration of the study period. All surgeons have one or two scheduled OR days (ie, "block time") which generally begins at 7:30AM. Surgeons usually operate continuously throughout the day and are able to start long cases late in the day. None of the surgeons at our institution have block time starting later in the day although additional operative time on non-block days may only be available later in the day.

Since surgical scheduling may be influenced by the surgeon's preoperative suspicion of disease burden, we attempted to categorize the extent of disease at time of surgery. To do so, we created a second novel variable, the OR tumor index (range, 0 – 2), as a measure of the intraoperative assessment of disease burden at the time of surgery. Patients received one point each for the presence of carcinomatosis and/or bulky (≥1cm) UAD based upon review of the surgeon's operative note. If the operating surgeon commented on the presence or absence of carcinomatosis in the operative note, the response was noted accordingly. If not stated specifically, carcinomatosis was defined as the presence of ≥20 tumor implants within the abdominal cavity. As reported in a prior publication [25], bulky UAD disease was defined as the presence of ≥1cm tumor implants cephalad to the greater omentum such as tumor involvement of the diaphragm, liver, spleen, or pancreas. Patients with a score of 0 had neither carcinomatosis nor bulky UAD. Patients with a score of 1 had either carcinomatosis or bulky UAD. Patients with a score of 2 had both carcinomatosis and bulky UAD.

Statistical Analysis

Patient characteristics were compared using the chi-square test for categorical variables and the Kruskal-Wallis test for continuous variables among the three residual disease groups (0 mm versus 1 – 10 mm versus >10 mm residual disease). The association between surgical procedures and the three residual disease groups were tested by the Fisher exact test and the significances decided by applying Bonferroni criteria.

In order to fully explore the data, we performed two analyses based upon clinical experience. We hypothesized that there are two points during attempted cytoreductive surgery when the decision to stop versus continue may occur. The first decision occurs close to the beginning of the case when, after adequate survey of the abdomen, cytoreduction is attempted or aborted. The second decision occurs either at this time or later in the case, when the surgeon must decide whether complete gross resection is feasible or whether to leave the patient with visible disease ≤1cm in diameter. Because of this, two analyses of surgical outcomes are needed. One is the evaluation of factors associated with cytoreduction to ≤1cm residual disease in the entire cohort and the other is the evaluation of factors associated with complete gross resection in the subgroup of patients who underwent cytoreduction of all visible disease >1cm in diameter (≤1cm residual cohort).

Several surgeons performed the procedures in our study. Therefore, we needed to control for surgeon variability. Because patients treated by the same surgeons are likely to have similar outcomes in similar settings, we were able to perform univariate logistic regression considering surgeon clustering effects on both the complete cohort and the ≤1cm residual cohort [26]. Due to the identification of more compelling results in the ≤1cm residual cohort, additional analyses were performed in this subset.

In the ≤1cm residual cohort, the correlation between OST and other clinical factors were evaluated by applying Pearson's correlation coefficient between continuous variables and the Wilcoxon Rank sum test/Kruskal-Wallis test between continuous and categorical variables. Finally, a multivariate logistic model was developed based on clinical interest and significance of univariate results. The interaction relationship between OST and OR tumor index had also been modeled in the final multivariate setting.

Overall survival (OS) and progression-free survival (PFS) for the complete cohort were calculated. OS was defined as the time from the date of primary surgery to the date of death or last follow-up. PFS was defined as the time from the date of primary surgery to the date of documented first recurrence based on elevated CA-125, CT scan, or physical examination. Univariate OS and PFS stratified by residual disease status and OST were reported. The median OS and PFS were estimated using the Kaplan-Meier method. P-values were obtained using the log-rank test.

RESULTS

A total of 502 patients with FIGO stage IIIB – IV serous ovarian cancer underwent attempted primary cytoreductive surgery at our institution from January 1, 2001 to January 31, 2010. Eighty patients were excluded due to receiving neoadjuvant chemotherapy. No patients were excluded due to attempted debulking at time of bowel obstruction. The remaining 422 patients met inclusion criteria. The median age at diagnosis was 60 years (range, 23 – 95). The median preoperative CA-125 was 599 U/mL (range, 3 – 38,100). All patients underwent attempted cytoreductive surgery by exploratory laparotomy. The volume of residual disease at completion of cytoreductive surgery was as follows: 0 mm, 144 patients (34.1%); 1 – 10 mm, 175 patients (41.5%); and >10 mm, 103 patients (24.4%). Additional demographic characteristics can be found in Table 1. Several preoperative factors were distributed differently among the three residual disease groups (0 mm vs. 1 – 10 mm vs. >10 mm residual) including patient age, serum CA-125 level, FIGO stage, and grade (Table 1). The frequency of procedures performed, based on volume of residual disease, can be found in Table 2. Most procedures were performed more frequently in patients who underwent cytoreduction to ≤1cm residual disease versus patients left with >1cm residual disease. A corresponding increase in surgical complexity score was also observed in patients who underwent cytoreduction to ≤1cm residual versus patients who left with >1cm residual disease. Surgical complexity scores were similar in patients with 0mm versus 1 – 10 mm residual disease. Thirty patients (7.1%) had no surgical procedures performed at the time of laparotomy ("open and close"). In 9 cases, the same surgeon performed more than one debulking in the same day. The cytoreductive outcome of the second case as compared to the first was the same in five cases, better in two cases, and worse in two cases.

Median follow-up time for patients without progression or death was 23.6 months. Primary PFS (26.3 versus 16.5 versus 12.7 months, $P < 0.0001$) and OS (69.7 versus 45.7 versus 35.3 months, $P < 0.0001$) were significantly improved for patients who achieved a complete gross resection versus those left with 1 – 10mm residual disease or >10mm residual disease, respectively. Primary PFS ($P = 0.66$) and OS ($P = 0.27$) were not associated with OST.

Univariate logistic regression analysis was performed to identify preoperative factors associated with cytoreduction to ≤1cm versus >1cm residual disease. Age at diagnosis, preoperative serum albumin level, serum CA-125 level, ASA score, tumor grade, and OR tumor index were associated with ≤1cm residual disease on univariate analysis (Table 3). OST was not associated with ≤1cm residual disease in this analysis. As age, serum albumin, CA-125 level, ASA score, and tumor grade have a well-described association with cytoreduction to ≤1cm residual disease, no further analysis was performed on the complete cohort of patients.

Univariate logistic regression analysis was then performed on the ≤1cm residual cohort. The objective of this analysis was to identify preoperative factors associated with complete gross resection (0 mm versus 1 – 10 mm residual disease). OR tumor index was once again included as a surrogate for preoperative tumor burden. Preoperative serum albumin, serum CA-125 level, ASA scores, stage, OR tumor index, and OST were associated with complete gross cytoreduction on univariate analysis (Table 3). We evaluated for a correlation between OST and other interested clinical variables. OR tumor index was found to be significantly associated with OST in the ≤1cm residual cohort. OST and OR tumor index were included as an interaction effect in the multivariate analysis described below. Patient age, preoperative albumin, CA125 level, ASA score, and stage (III vs. IV) were not associated with OST in the ≤1cm residual cohort.

A multivariate logistic model was built based on clinical interest and factors significant in the univariate analysis. OST and OR tumor index were included in the model as an interaction effect. Although significant on univariate analysis, stage was excluded from the multivariate model as OR tumor index correlated with stage and therefore could be considered a surrogate for stage in the analysis. Other than OR tumor index, factors that were not known preoperatively (ie, surgical complexity score and estimated blood loss) were also not included in the multivariate model. The interaction term and preoperative CA-125 level were associated with complete gross cytoreduction (Table 4). In the subset of patients with an OR tumor index of 2, patients in the early OST group (before 11AM) had an improved rate of complete gross resection versus patients in the 11AM – 3PM group (Odds

Ratio for 11AM – 3PM vs. before 11AM = 0.29 [0.16 – 0.52], $P < 0.001$) or after 3PM group (Odds Ratio for after 3PM vs. before 11AM = 0.31 [0.11 – 0.88], $P = 0.028$). OST was not associated with the rate of complete gross cytoreduction in the subset of patients with an OR tumor index of 0 or 1.

In order to determine whether changes in surgical practice were responsible for the higher rate of complete gross resection observed in procedures performed before 11 AM, we explored the distribution of procedures performed in patients with an OR tumor index of 2 and ≤1cm residual disease. Only pelvic peritonectomy and abdominal peritonectomy were more likely to be performed earlier in the day (Table 5). Pelvic and para-aortic lymphadenectomy was also performed more often earlier in the day but these results did not reach statistical significance.

DISCUSSION

Our study demonstrates that OST had no impact on the rate of cytoreduction to ≤1cm residual disease in patients who underwent primary surgery for advanced serous ovarian cancer. It is reassuring to find that OST did not influence the most commonly accepted measure of success in these patients [4]. However, in the subset of patients with ≤1cm residual disease, earlier OSTs were associated with increased rates of complete gross resection in patients with more extensive disease (ie, OR tumor burden index = 2). Since complete gross cytoreduction has been associated with improved survival even in patients with bulky disease [25, 26], these results call into question whether modifications of surgical scheduling should be considered for at least some patients undergoing attempted cytoreduction.

Complete cytoreduction of bulky ovarian cancer requires a commitment of time, physical energy, and mental focus, often resulting in fatigue during long cases. Numerous studies have demonstrated that patient care deteriorates when physicians are subjected to fatigue [12,13,16]. Fatigue has been associated with increased medical errors, decreased operative dexterity, and impaired cognitive function [14,15,23]. In order to identify patients at risk for fatigue-related influences on surgeon behavior, our secondary objective was to identify ways to utilize these results to improve patient care.

Since the rate of complete gross resection only varied in the subgroup of patients with an OR tumor burden index of 2, efforts to schedule patients with more bulky disease would naturally focus on indentifying these patients preoperatively. Preoperative identification of patients with an OR tumor index of 2 could help surgeons decide whether a suspected ovarian cancer case should be scheduled for early in the day when the surgeon may be most likely to achieve a complete gross resection. The most straightforward way to identify patients with an OR tumor burden index of 2 would be to develop a correlation with preoperative imaging studies. We attempted to identify a correlation between preoperative CT findings and the OR tumor burden index but were unable to identify such a relationship (results not reported). Our inability to identify a reliable preoperative predictor of intraoperative tumor burden likely reflects the long-standing inability to predict preoperatively which patients will undergo “optimal cytoreduction”. Prior studies evaluating serum CA-125 level and imaging studies have been difficult to replicate and frequently lead to an unacceptably high false-positive rate of suboptimal cytoreduction [27]. For these reasons, it is not unexpected that we were unable to identify preoperative predictors of an OR tumor index of 2.

Even if we cannot identify which patients may benefit from earlier start times, it would be beneficial to explore how surgeon behavior changes later in the day. If a pattern of behavior modifications could be identified (ie, surgeons perform less rectal resections or diaphragm resections later in the day), perhaps behavior could be altered to account for this bias. In patients with ≤1cm residual disease and an OR tumor index of 2, only lymphadenectomy and peritonectomy were more often performed earlier in the day. While potentially time consuming, it seems unlikely that these procedures would represent the only reason for lower rates of complete gross resection later in the day. More plausibly, the lower rates of these procedures later in the day reflect subtle differences in surgeon behavior that are otherwise difficult to quantify. Furthermore, given the heterogeneity of disease distribution even among patients with bulky disease, it is not surprising that we were unable to identify any comprehensive explanation for changes in operative behavior in this group of patients.

Despite our inability to predict which patients may benefit from an earlier OST, these results will hopefully stimulate an honest assessment from individual surgeons who operate on patients with ovarian cancer. They raise important questions about the timing and sequence of case scheduling. For example, should a patient with suspected advanced ovarian cancer including bulky UAD and massive ascites be scheduled early in the day or after outpatient cases have been performed? Should a surgeon schedule more than one “big debulking” in a day? These are difficult questions to answer and likely require individualization for each surgeon, institution, and patient. These results have not changed official scheduling guidelines at our institution as we feel that additional validation is required prior to instituting any mandate. However, all faculty members are aware of these results and are mindful of the potential impact of operative start time on surgical outcomes. We recognize that our results may be unique to the practice environment of a cancer center routinely caring for high acuity patients and maintaining a large surgical team of residents, fellows, and other specialized support staff but hope that others will use these results as a starting point for a similar self-assessment.

As imaging modalities continue to improve, future studies evaluating the ability of preoperative imaging to accurately predict intraoperative tumor burden will hopefully lead to a secondary benefit of improving patient scheduling so that maximal resources and surgeon effort can be applied to achieve the best surgical outcomes. Until that time, surgeons may want to consider whether these results are applicable to their practice.

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Research Highlights

- OST was not associated with optimal cytoreduction in patients with advanced serous ovarian cancer.
- In the optimal debulking cohort, later OSTs were associated with reduced rates of CGR in patients with greater tumor burden.

Table 1

Distribution of Preoperative Factors Associated with Volume of Residual Disease in Patients Undergoing Cytoreductive Surgery for Advanced Serous Ovarian Cancer

Demographics	Total n = 422	0mm residual n = 144	1–10mm residual n = 175	>10mm residual n = 103	P
Age at diagnosis, median [range]	60 [23 – 95]	58 [23 – 81]	60 [37 – 95]	63 [41 – 84]	**0.002**
Comorbidities, median	0 [0 – 4]	1 [0 – 4]	0 [0 – 4]	0 [0 – 4]	0.478
Preoperative HgB, median	12.5 [8.1 – 16.4]	12.5 [8.6 – 14.9]	12.5 [8.1 – 16.4]	12.5 [9.4 – 16.1]	0.836
Preoperative platelets, median	363 [112 – 1150]	334 [168 – 742]	373 [112 – 1067]	381 [131 – 1150]	**0.028**
Preoperative creatinine, median	0.9 [0.4 – 4.4]	0.9 [0.4 – 1.5]	0.9 [0.4 – 4.4]	0.9 [0.5 – 2.1]	0.944
Preoperative albumin, median	4,1 [2.5 – 5.0]	4.2 [2.9 – 5.0]	4.1 [2.5 – 4.8]	3.9 [2.6 – 5.0]	**0.003**
Preoperative CA-125, median	599 [2.9 – 38100]	326 [3 – 24500]	632 [30 – 21952]	978 [3 – 38100]	**<0.001**
Body mass index, median	25.2 [16.3 – 54.6]	25.5 [18.8 – 41.1]	25.0 [16.3 – 54.6]	24.5 [16.8 – 42.2]	0.752
ASA score (%)					
1	26 (6.2)	12 (8.4)	9 (5.1)	5 (4.9)	0.071
2	264 (62.7)	100 (69.9)	106 (60.6)	58 (56.3)	
3	130 (30.9)	31 (21.7)	59 (33.7)	40 (38.8)	
4	1 (0.2)	0	1 (0.6)	0	
FIGO stage (%)					
IIIB	15 (3.6)	9 (6.3)	6 (3.4)	0	**0.023**
IIIC	333 (78.9)	119 (82.6)	129 (73.7)	85 (82.5)	
IV	74 (17.5)	16 (11.1)	40 (22.9)	18 (17.5)	
Histologic grade (%)					
1	12 (2.8)	9(6.3)	3 (1.7)	0	**0.005**
2	27 (6.4)	11(7.6)	14 (8)	2 (1.9)	
3	383 (90.8)	124(86.1)	158 (90.3)	101 (98.1)	
Operative Start Time, median	12:29 PM [7:40AM – 8:15PM]	11:41AM [7:48AM – 8:15PM]	12:53PM [7:48AM – 5:57PM	1:23PM [7:40AM – 6:40PM]	0.089

ASA, American Society of Anesthesiologists

FIGO, International Federation of Gynecology and Obstetrics

Table 2

Distribution of Major Procedures Performed and Intraoperative Characteristics Associated with Volume of Residual Disease in Patients Undergoing Cytoreductive Surgery for Advanced Serous Ovarian Cancer

Procedure	Total n = 422	0mm residual n = 144	1 – 10mm residual n = 175	>10mm residual n = 103	P[†]
TAH-BSO	387 (91.7)	144 (100)	175 (100)	68 (66.0)	**<0.0001**
Rectal resection	176 (41.7)	60 (41.7)	92 (52.6)	24 (23.3)	**<0.0001**
Colon resection	79 (18.7)	21 (14.6)	47 (26.9)	11 (10.7)	**0.0012**
Diaphragm resection/stripping	156 (37.0)	59 (41.0)	88 (50.3)	9 (8.7)	**<0.0001**
Splenectomy	65 (15.4)	19 (13.2)	40 (22.9)	6 (5.8)	**0.0004**
Liver resection	32 (7.6)	15 (10.4)	17 (9.7)	0	**0.0004**
Surgical complexity group					
Low (score 0 – 3)	114 (27.0)	19 (13.2)	32 (18.3)	63 (61.2)	**<0.001***
Intermediate (score 4 – 7)	188 (44.5)	82 (56.9)	72 (41.1)	34 (33)	
High (score ≥ 8)	120 (28.4)	43 (29.9)	71 (40.6)	6 (5.8)	
Length of procedure (hours), median	4.4 [0.6 – 14.9]	4.7 [0.6 – 12.7]	5.0 [1.7 – 14.9]	2.9 [0.6 – 9.9]	**<0.001**
OR Tumor Index					
Score 0	100 (23.7)	67 (46.5)	28 (16.0)	5 (4.9)	**<0.001***
Score 1	103 (24.4)	31 (21.5)	56 (32.0)	16 (15.5)	
Score 2	219 (51.9)	46 (31.9)	91 (52.0)	82 (79.6)	

[†]P-values with * were obtained by applying the chi square test. All other P-values were obtained by applying the Fisher exact test.

The Bonferroni correction was used for multiple comparisons; significance level is 0.05/20=0.0025. Not all 20 procedures listed.

TAH-BSO, total abdominal hysterectomy-bilateral salpingo-oophorectomy

Table 3

Univariate Logistic Regression Analysis[†] of Preoperative Variables Associated with Surgical Outcomes in Patients Undergoing Cytoreductive Surgery for Advanced Serous Ovarian Cancer

	≤ 1cm vs. >1cm Residual Disease		1–10mm vs. 0mm Residual Disease	
Variable	**Odds Ratio (95% CI)**	**P**	**Odds Ratio (95% CI)**	**P**
Age at diagnosis	0.97(0.96–0.98)	**<0.001**	0.97(0.94–1.01)	0.11
Comorbidities	0.96(0.76–1.2)	0.707	1.15(0.83–1.6)	0.389
Preoperative HgB, median [range]	0.97(0.86–1.1)	0.664	0.95(0.81–1.12)	0.571
Preoperative platelets, median [range]	0.82(0.41–1.65)	0.577	0.47(0.22–1.00)	0.05
Preoperative creatinine, median [range]	0.97(0.54–1.73)	0.908	0.67(0.32–1.38)	0.274
Preoperative albumin, median [range]	2.54(1.19–5.42)	**0.016**	1.88(1.14–3.09)	**0.013**
Preoperative CA-125, median [range]	0.8(0.72–0.89)	**<0.001**	0.75(0.67–0.85)	**<0.001**
Body mass index, median [range]	1.02(0.98–1.06)	0.398	0.99(0.95–1.02)	0.502
ASA score (1/2 vs. 3/4)	0.61(0.51–0.73)	**<0.001**	0.51(0.29–0.89)	**0.017**
Stage (III vs. IV)	0.91(0.66–1.25)	0.57	0.35(0.15–0.82)	**0.016**
Grade (1/2 vs. 3)	0.16(0.04–0.63)	**0.009**	0.67(0.44–1.02)	0.062
Operative start time				
Before 11AM	Ref. level	0.162	Ref. level	**<0.001**
11AM – 3PM	0.61 (0.35–1.08)		0.62 (0.50–0.77)	
After 3PM	0.93 (0.49–1.75)		0.86 (0.68–1.07)	
OR tumor index				
0	Ref. level	**0.001**	Ref. Level	**0.001**
1	0.25 (0.07–0.94)		0.24(0.14–0.41)	
2	0.07 (0.02–0.25)		0.17(0.09–0.33)	

[†]Considering Surgeon Clustering Effects

ASA, American Society of Anesthesiologists

Table 4

Multivariate Analysis[†] of Factors Associated with Complete Gross Resection in the Subset of Patients with ≤1cm Residual Disease

Variable	Odds Ratio (95% CI)	P
Age at Diagnosis	0.97 (0.93 – 1.02)	0.221
Preop CA-125 (in log)	0.78 (0.68 – 0.89)	**<0.001**
ASA Score (Score 3/4 vs. 2/1)	0.7 (0.35 – 1.42)	0.322
OR Tumor Index = 0		
Starting Time: 11AM – 3PM vs. Before 11AM	1.27 (0.58 – 2.78)	0.553
Starting Time: After 3PM vs. Before 11AM	0.57 (0.17 – 1.86)	0.35
OR Tumor Index = 1		
Starting Time: 11AM – 3PM vs. Before 11AM	0.83 (0.31 – 2.23)	0.706
Starting Time: After 3PM vs. Before 11AM	1.76 (0.68 – 4.57)	0.242
OR Tumor Index = 2		
Starting Time: 11AM – 3PM vs. Before 11AM	0.29 (0.16 – 0.52)	**<0.001**
Starting Time: After 3PM vs. Before 11AM	0.31 (0.11 – 0.88)	**0.028**

[†]Considering Surgeon Clustering Effects

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Table 5

Distribution of Procedures Performed in Patients Undergoing Cytoreductive Surgery for Advanced Serous Ovarian Cancer (Subset of Patients with an OR Tumor Index = 2 and ≤1cm Residual Disease)

Procedure	All n = 137	Before 11AM n = 65	11AM – 3PM n = 52	After 3PM n = 20	P[†]
TAH-BSO	137 (100)	65 (100.0)	52 (100.0)	20 (100.0)	-
Omentectomy	136 (99.3)	65 (100.0)	51 (98.1)	20 (100.0)	0.526
Pelvic LND	53 (38.7)	31 (47.7)	18 (34.6)	4 (20.0)	0.066
Para-aortic LND	52 (38.0)	31 (47.7)	17 (32.7)	4 (20.0)	0.052
Pelvic peritonectomy	39 (28.5)	25 (38.5)	12 (23.1)	2 (10.0)	**0.031**
Abdominal peritonectomy	21 (15.3)	17 (26.2)	4 (7.7)	0	**0.003**
Colon resection	39 (28.5)	18 (27.7)	18 (34.6)	3 (15.0)	0.267
Rectal resection	93 (67.9)	45 (69.2)	34 (65.4)	14 (70.0)	0.879
Small bowel resection	12 (8.8)	5 (7.7)	6 (11.8)	1 (5.0)	0.705
Colostomy	2 (1.5)	0	0	2 (10.0)	**0.020**
Ileostomy	14 (10.2)	7 (10.8)	6 (11.5)	1 (5.0)	0.860
Diaphragm resection/stripping	119 (86.9)	59 (90.8)	45 (86.5)	15 (75.0)	0.195
Splenectomy	51 (37.2)	27 (41.5)	14 (26.9)	10 (50.0)	0.114
Distal pancreatectomy	19 (13.9)	9 (13.8)	7 (13.5)	3 (15.0)	1.000
Liver resection	28 (20.4)	13 (20.0)	10 (19.2)	5 (25.0)	0.880
Other Upper Abdominal Resection	63 (46)	30 (46.2)	22 (42.3)	11 (55.0)	0.653
Mediastinal LND	10 (7.3)	5 (7.7)	4 (7.7)	1 (5.0)	1.000
VATS	10 (7.3)	6 (9.2)	3 (5.8)	1 (5.0)	0.903
IP catheter	53 (38.7)	29 (44.6)	17 (32.7)	7 (35.0)	0.422
Surgical complexity score	9 [2 – 14]	10 [2 – 14]	8 [4 – 13]	9 [3 – 11]	0.053*
Surgical complexity group					
Score 0 – 3	2 (1.5)	1 (1.5)	0	1 (5.0)	0.285*
Score 4 – 7	46 (33.6)	18 (27.7)	21 (40.4)	7 (35.0)	
Score ≥ 8	89 (65.0)	46 (70.8)	31 (59.6)	12 (60.0)	

[†] P-value with * was obtained by applying the Kruskal-Wallis test; P-value with ** was obtained by applying chi-square test. All other P-values were obtained by applying the Fisher exact test, and the Bonferroni correction was used for multiple comparisons; significance level is 0.05/18=0.0026. No factors reached this threshold.

TAH-BSO, total abdominal hysterectomy-bilateral salpingo-oophorectomy; LND, lymph node dissection; VATS, video-assisted thoracic surgery; IP, intraperitoneal