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Survival impact of low anterior resection in patients with epithelial ovarian cancer grossly confined to the pelvic cavity: a Korean multicenter study

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ABSTRACT

Objective: To evaluate survival impact of low anterior resection (LAR) in patients with epithelial ovarian cancer (EOC) grossly confined to the pelvis.


Methods: We retrospectively reviewed 397 patients who underwent primary staging surgery for treatment of 2014 International Federation of Gynecology and Obstetrics (FIGO) stage II–III A EOC: 116 (29.2%) IIA, 212 (53.4%) IIB, and 69 (17.4%) IIIA. Patients with grossly enlarged retroperitoneal lymph nodes positive for metastatic carcinoma were excluded. Of 92 patients (23.2%) with gross tumors at the rectosigmoid colon, 68 (73.9%) underwent tumorectomy and 24 (26.1%), LAR for rectosigmoid lesions. Survival outcomes between patients who underwent tumorectomy and LAR were compared using Kaplan-Meier curves.

Results: During the median follow-up of 55 months (range, 1–260), 141 (35.5%) recurrences and 81 (20.4%) deaths occurred. Age (52.8 vs. 54.5 years, $p=0.552$), optimal debulking (98.5% vs. 95.0%, $p=0.405$), histologic type (serous, 52.9% vs. 50.0%, $p=0.804$), FIGO stage ($p=0.057$), and platinum-based adjuvant chemotherapy ≥ 6 cycles (85.3% vs. 79.2%, $p=0.485$) were not different between groups. No significant difference in 5-year progression-free survival (PFS; 57.9% vs. 62.5%, $p=0.767$) and overall survival (OS; 84.7% vs. 63.8%, $p=0.087$), respectively, was noted between groups. Postoperative ileus was more frequent in patients subjected to LAR than those who were not (4/24 [16.7%] vs. 11/373 [2.9%], $p=0.001$). The 5-year PFS (60.3% vs. 57.9%, $p=0.523$) and OS (81.8% vs. 87.7%, $p=0.912$) between patients who underwent tumorectomy and those who did not were also similar.


Conclusion: Survival benefit of LAR did not appear to be significant in EOC patients with grossly pelvis-confined tumors.

Keywords: Colectomy; Epithelial Ovarian Cancer; Progression-Free Survival

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

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INTRODUCTION

Optimal debulking surgery is the most important factor for improving survival outcomes in patients with advanced or recurrent epithelial ovarian cancer (EOC) [1]. Extensive intraperitoneal seeding to the neighboring pelvic viscera often results in the need for rectosigmoid resection to achieve optimal debulking. The technique of low anterior resection (LAR) of pelvic tumor, adjacent rectosigmoid colon, and pelvic peritoneum with primary anastomosis has already been described by many surgeons, with acceptable associated morbidity in advanced or recurrent EOC [2,3].

Unlike in advanced or recurrent EOC, the salutary value of these practices in early-stage EOC confined to the pelvis is still questionable. A number of surgeons performed LAR for all rectosigmoid lesions without exception and irrespective of invasion depth or size of tumor. Although patients without gross residual tumor after LAR can have better prognosis, increased operation-related morbidity after LAR has also been reported in several studies [4-7]. Disruption of the anastomosis leading to clinical anastomotic leak is among the most troublesome complications after LAR. Anastomotic leak is associated with considerable morbidity, including impaired long-term functional outcome, and increased mortality. Several studies have found that prolonged operating time and blood-product transfusion were important factors associated with anastomotic leak. Thus, if the tumor infiltrating up to the serosa and subserosa of the rectosigmoid colon can be removed by only tumorectomy without gross residual tumor, the surgeons can possibly avoid unnecessary LAR in early-stage EOC. However, the oncologic safety of omitting LAR without compromising survival outcomes in early-stage EOC must be first established before the current practice patterns can be changed.

Until now, to the best of our knowledge, no studies have investigated the survival impact and safety of LAR in patients with early-stage EOC. Therefore, with this multicenter retrospective study, we aimed to evaluate the survival outcomes in patients with EOC grossly confined to the pelvis according to the methods of bowel surgery (tumorectomy vs. LAR). In addition, the survival outcomes between the patients who did not undergo any bowel surgery and those who underwent tumorectomy were compared to evaluate the prognostic implication of the resectional base after tumorectomy. The incidences of operation-related morbidity between patients who underwent LAR and those who did not were also compared.

MATERIALS AND METHODS

1. Patient cohort

The cohort under study was retrospectively recruited from 5 independent institutions. The study protocol was revised and accepted by each institutional ethics committees. We reviewed the medical records of 397 patients who underwent primary staging surgery for EOC between March 1990 and September 2015. All eligible patients were diagnosed as International Federation of Gynecology and Obstetrics (FIGO) stage IIA to IIIA by gynecologic pathologists of each institutions after staging surgery. Patients with grossly enlarged retroperitoneal lymph nodes proven positive for metastatic carcinoma were excluded.

Staging surgery included peritoneal washing cytology, total hysterectomy, bilateral salpingo-oophorectomy, pelvic lymph node dissection, paraaortic lymph node dissection, and infra/supracolic omentectomy. Additional biopsy for suspicious lesions according to the

surgeons' discretion was allowed. Tumorectomy for rectosigmoid lesions was performed by gynecologic oncologists or colorectal surgeons with each institution's policy. LAR was routinely performed by colorectal surgeons in each institution as follows: 1) The superior rectal vessel was ligated above the extent of the pelvic disease after the retrorectal space was developed; 2) The rectosigmoid colon was divided below the peritoneal reflection and approximately 7 cm above the anal verge; 3) The rectosigmoid colon was resected with a gastrointestinal anastomotic stapler in most patients; 4) End-to-end anastomosis (EEA) was performed with an EEA stapler. Unlike in the routine procedure, the inferior mesenteric artery was not sacrificed, except when mobilization of the distal bowel was necessary to allow tension-free anastomosis.

Information on intraoperative gross rectosigmoid lesions and residual tumors were retrospectively obtained from medical records. Optimal debulking surgery was defined as residual tumor ≤ 1.0 cm. Progression-free survival (PFS) was defined as the length of time from the date of primary staging surgery to the date of cancer recurrence or death from any cause. Women who were still alive without cancer recurrence at the time of the analysis were censored at the time of their last follow-up. Overall survival (OS) was defined as the length of time from the date of primary staging surgery to the date of death from any cause. Women who were still alive with/without the disease at the time of the analysis were censored at the time of their last follow-up. Operation-related morbidity, including ileus, bowel leakage, fever lasting 3 days postoperative, and wound dehiscence, was also evaluated in the study cohort. Aside from analysis in the whole study cohort (n=397), the same analysis was repeated in the cohort of patients who had rectosigmoid lesions infiltrating up to the muscle and mucosa, as recorded in the final pathologic reports were excluded to minimize the impact of the invasion depth of rectosigmoid lesions to survival outcomes (n=387).

2. Statistical analysis

Chi-squared test, Fisher's exact test, and Mann-Whitney U test were used to evaluate the dichotomous variables. Survival outcomes were compared using the Kaplan-Meier curves with log-rank test. Statistical analyses were performed using Statistical Package for the Social Sciences Version 22.0 (IBM Inc., Chicago, IL, USA). A p-value < 0.05 was considered significant.

RESULTS

1. Patient characteristics

A total of 397 patients were eligible for our study cohort. Patient characteristics are summarized in **Table 1**. The median age was 51 years (range, 17–88), and the median follow-up period was 55 months (range, 1–260). Colonoscopy was performed in 200 (50.4%) patients before surgery. Ninety-two (23.2%) patients had gross rectosigmoid lesions that did not have intraoperative evidence of invasion up to the muscle or mucosa according to the surgeon's judgment. Of these patients, 24 (26.1%) received LAR, and the other 68 (73.9%) received only tumorectomy without bowel resection. In our cohort, all patients with rectosigmoid lesions underwent bowel surgery to avoid residual tumors, tumorectomy, or LAR, while no patients without rectosigmoid lesions underwent any bowel surgery. Optimal debulking with residual tumor less than 1.0 cm was achieved in 335 patients (84.4%). Unfortunately, the residual tumors of 52 (13.1%) patients were not described in their operation records. After surgery, a large portion of the population was confirmed as FIGO stage IIB (212, 53.4%). A total of 335 patients (84.4%) received appropriate platinum-based adjuvant chemotherapy for 6 or more

Table 1. Patient characteristics (n=397)

Characteristics	Value
Age (yr)	51 (17–88)
Follow-up period (mo)	55 (1–260)
Preoperative CA-125 (U/mL)	161.0 (3.1–31,600.0)
Preoperative colonoscopy	
No	197 (49.6)
Yes	200 (50.4)
Rectosigmoid lesions	
Absent	305 (76.8)
Present	92 (23.2)
Rectum	51
Sigmoid colon	13
Unknown*	28
Bowel surgery	
No	305 (76.8)
Tumorectomy	68 (17.1)
LAR	24 (6.1)
Optimal debulking	
No	10 (2.5)
Yes	335 (84.4)
Unknown*	52 (13.1)
Histologic type	
Serous	209 (52.6)
Non-serous	188 (47.4)
FIGO stage	
IIA	116 (29.2)
IIB	212 (53.4)
IIIA	69 (17.4)
Adjuvant chemotherapy (cycles)	6 (0–20)
Adjuvant chemotherapy ≥ 6 cycles	
No	62 (15.6)
Yes	335 (84.4)
Recurrence	
No	256 (64.5)
Yes	141 (35.5)
Death	
No	316 (79.6)
Yes	81 (20.4)

Values are presented as number (%) or median (range).

CA-125, cancer antigen-125; FIGO, International Federation of Gynecology and Obstetrics; LAR, Low anterior resection.

*Without descriptions on operation records.

cycles. A total of 141 patients (35.5%) had cancer recurrence, and 81 (20.4%) died at time of analysis. Five-year PFS rates were 64.9%, 60.8%, and 47.0% in FIGO stage IIA, IIB, and IIIA, respectively ($p=0.136$). Meanwhile, 5-year OS rates were 84.3%, 80.3%, and 80.6% in each stage ($p=0.423$) (**Fig. 1**).

The logistic regression analysis for independent risk factors of survival outcomes was performed and its results were presented in **Table 2**. In multivariate analysis, the disease stage was not associated with PFS (FIGO \geq IIB, hazard ratio [HR]=1.402; 95% confidence interval [CI]=0.881–2.230; $p=0.052$) in this study population. Residual tumor ≥ 0.5 cm was a sole independent risk factor for OS (HR=2.129; 95% CI=1.124–4.033; $p=0.020$).

2. Tumorectomy vs. LAR

Comparison of clinicopathologic characteristics according to the type of bowel surgery (no bowel surgery [n=305], tumorectomy [n=68], and LAR [n=24]) is shown in **Table 3**. Optimal debulking was achieved in almost all patients who underwent tumorectomy and LAR (67

LAR in grossly pelvis-confined ovarian cancer

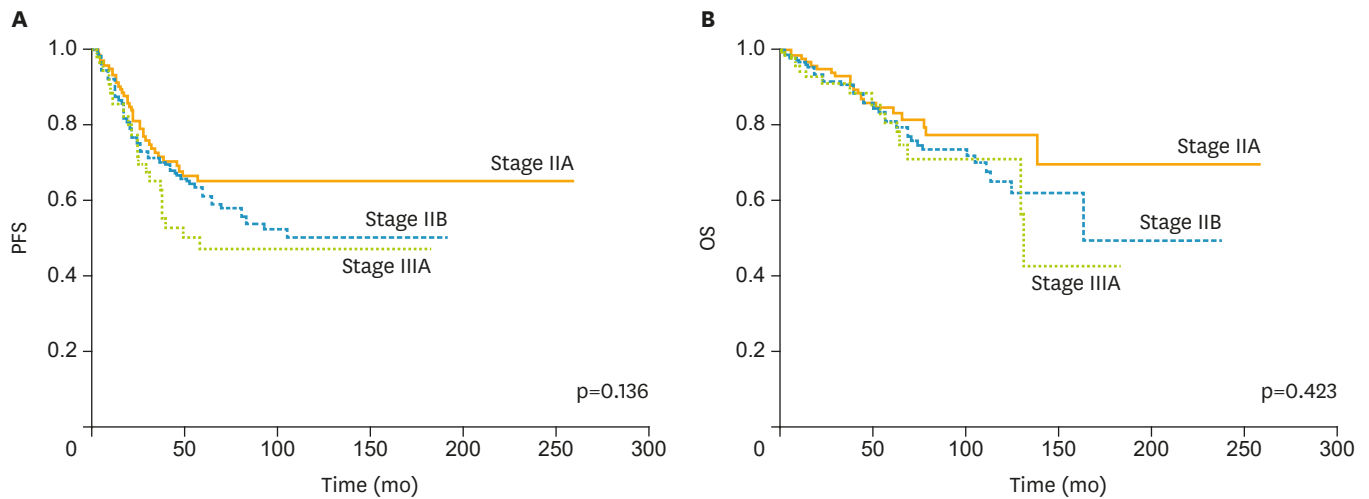


Fig. 1. (A) The 5-year PFS (64.9%, 60.8%, and 47.0%; $p=0.136$) and (B) 5-year OS (84.3%, 80.3%, and 80.6%; $p=0.423$) in the whole study population ($n=397$) (solid line: FIGO stage IIA; dotted line: FIGO stage IIB; and dot-and-dash line: FIGO stage IIIA). FIGO, International Federation of Gynecology and Obstetrics; OS, overall survival; PFS, progression-free survival.

Table 2. Univariate and multivariate analysis for independent risk factors of survival outcomes ($n=397$)

Characteristics	Univariate		Multivariate	
	HR (95% CI)	p	HR (95% CI)	p
PFS				
Age ≥ 51 yr	0.973 (0.645–1.468)	0.898		
Presence of rectosigmoid lesion	1.085 (0.668–1.761)	0.742		
Invasion depth of rectosigmoid lesion > subserosa	1.846 (0.525–6.487)	0.339		
Bowel surgery (tumorectomy vs. LAR)	1.238 (0.465–3.297)	0.669		
Residual tumor ≥ 0.5 cm	1.828 (1.029–3.249)	0.040	1.716 (0.960–3.066)	0.068
Residual tumor ≥ 1.0 cm	1.226 (0.339–4.431)	0.756		
Histology of non-serous	1.259 (0.834–1.901)	0.272		
FIGO stage \geq IIB	1.402 (0.881–2.230)	0.154	1.664 (0.995–2.784)	0.052
FIGO stage \geq IIIA	1.299 (0.763–2.211)	0.334		
OS				
Age ≥ 51 yr	1.206 (0.739–1.966)	0.454		
Presence of rectosigmoid lesion	1.111 (0.629–1.963)	0.717		
Invasion depth of rectosigmoid lesion > subserosa	2.684 (0.739–9.746)	0.133	3.261 (0.838–12.692)	0.088
Bowel surgery (tumorectomy vs. LAR)	1.286 (0.430–3.844)	0.653		
Residual tumor ≥ 0.5 cm	2.145 (1.136–4.048)	0.019	2.129 (1.124–4.033)	0.020
Residual tumor ≥ 1.0 cm	1.000 (0.208–4.818)	>0.999		
Histology of non-serous	1.334 (0.818–2.177)	0.248		
FIGO stage \geq IIB	1.331 (0.761–2.328)	0.316		
FIGO stage \geq IIIA	1.103 (0.586–2.076)	0.762		

CI, confidence interval; FIGO, International Federation of Gynecology and Obstetrics; HR, hazard ratio; LAR, low anterior resection; OS, overall survival; PFS, progression-free survival.

[98.5%] vs. 19 [95.0%], $p=0.405$). One patient (4.2%) who underwent LAR had residual tumor >1.0 cm after surgery. Non-serous histologic type was similarly detected between patients who underwent tumorectomy and LAR (32 [47.1%] vs. 12 [50.0%], $p=0.804$). Almost all patients who underwent tumorectomy were diagnosed as FIGO stage IIB after surgery (53, 77.9%). FIGO stage IIIA was more frequent in patients who underwent LAR than in those who underwent tumorectomy (10 [41.7%] vs. 12 [17.7%], $p=0.057$) due to retroperitoneal lymph node metastasis or microscopic extra-pelvic peritoneal involvement. However, the frequency was not significantly different. Platinum-based adjuvant chemotherapy for 6 or more cycles was performed in almost all patients in both groups (58 [85.3%] vs. 19 [79.2%], $p=0.485$). The cohort excluding the patients who had rectosigmoid lesions infiltrating up

Table 3. Comparisons of clinicopathologic factors (n=397)

Characteristics	No bowel surgery (n=305)	Tumorectomy (n=68)		LAR (n=24)		p [‡]
		Value	p [*]	Value	p [†]	
Age (yr)	52.0±11.5	52.8±11.4	0.618	54.5±12.7	0.552	0.567
Preoperative CA-125 (U/mL)	671.3±1,607.7	702.9±1,042.2	0.885	2,120.4±6,552.6	0.302	0.008
Location of rectosigmoid lesions [¶]	-	-	-	-	0.759	-
Rectum		33 (78.6)		18 (81.8)		
Sigmoid colon		9 (21.4)		4 (18.2)		
Optimal debulking ^{¶¶}			0.463		0.405	0.942
No	8 (3.1)	1 (1.5)		1 (5.0)		
Yes	249 (96.9)	67 (98.5)		19 (95.0)		
Histologic type			0.982		0.804	0.851
Serous	161 (52.8)	36 (52.9)		12 (50.0)		
Non-serous	144 (47.2)	32 (47.1)		12 (50.0)		
FIGO stage			<0.001		0.057	<0.001
IIA	113 (37.0)	3 (4.4)		0		
IIB	145 (47.5)	53 (77.9)		14 (58.3)		
IIIA	47 (15.4)	12 (17.7)		10 (41.7)		
Adjuvant chemotherapy (cycles)	5.8±1.8	5.9±1.6	0.760	5.5±2.5	0.568	0.774
Adjuvant chemotherapy ≥6 cycles			0.884		0.485	0.650
No	47 (15.4)	10 (14.7)		5 (20.8)		
Yes	258 (84.6)	58 (85.3)		19 (79.2)		
Recurrence			0.623		0.669	0.883
No	198 (64.9)	42 (61.8)		16 (66.7)		
Yes	107 (35.1)	26 (38.2)		8 (33.3)		
Death			0.913		0.652	0.612
No	244 (80.0)	54 (79.4)		18 (75.0)		
Yes	61 (20.0)	14 (20.6)		6 (25.0)		

Values are presented as number (%) or mean±standard deviations.

CA-125, Cancer antigen-125; FIGO, International Federation of Gynecology and Obstetrics; LAR, Low anterior resection.

*No bowel surgery vs. tumorectomy; †Tumorectomy vs. LAR; ‡Among 3 groups; ¶In patients with available data.

to the muscle and mucosa is described in **Supplementary Table 1**. FIGO stage between the patients treated with tumorectomy and LAR was significantly different (FIGO stage IIB, 12 [17.9%] vs. 8 [53.3%], $p=0.004$).

Survival outcomes in patients who received bowel surgery for rectosigmoid lesions are presented in **Fig. 2**. The 5-year PFS was similar between patients who underwent tumorectomy and those who underwent LAR (57.9% vs. 62.5%, $p=0.767$). The 5-year OS of patients who underwent tumorectomy was superior to those treated with LAR; however, it was not significantly different (84.7% vs. 63.8%, $p=0.087$). These survival outcome findings coincided with those of the cohort in which patients who had rectosigmoid lesions infiltrating up to the muscle and mucosa were excluded (**Supplementary Fig. 1**; 5-year PFS, 58.9% vs. 60.2%, $p=0.994$; 5-year OS, 90.1% vs. 66.7%, $p=0.147$).

3. No bowel surgery vs. tumorectomy

The rates of the optimal debulking (249 [96.9%] vs. 67 [98.5%], $p=0.463$) and non-serous histology (144 [47.2%] vs. 32 [47.1%], $p=0.982$) were not different between patients who did not undergo bowel surgery and who underwent tumorectomy. FIGO stage IIB was less frequent in patients who did not undergo any bowel surgery, compared to those of tumorectomy (145 [47.5%] vs. 53 [77.9%], $p<0.001$). In addition, adjuvant chemotherapy for 6 or more cycles was equally administered in both groups (258 [84.6%] vs. 58 [85.3%], $p=0.884$). Except for FIGO staging, no significant difference was noted in both groups after patients who had rectosigmoid lesions infiltrating up to the muscle and mucosa were excluded (**Supplementary Table 1**).

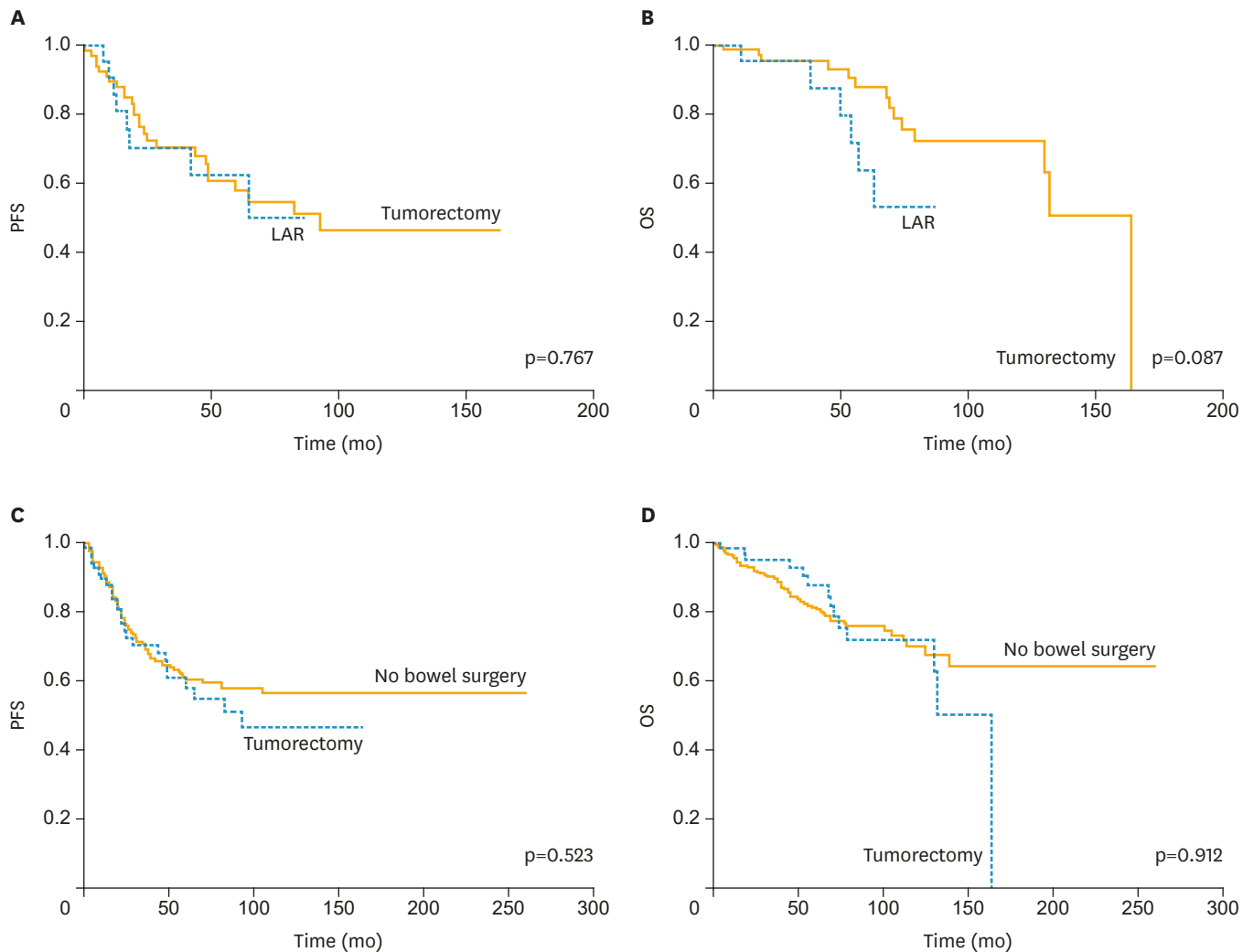


Fig. 2. (A) The 5-year PFS (57.9% vs. 62.5%, $p=0.767$) and (B) 5-year OS (84.7% vs. 63.8%, $p=0.087$) in patients who had rectosigmoid lesions (solid line: tumorectomy group [$n=68$]; dotted line: LAR group [$n=24$]). (C) The 5-year PFS (60.3% vs. 57.9%, $p=0.523$) and (B) 5-year OS (81.8% vs. 87.7%, $p=0.912$) in patients who did not receive LAR (solid line: no bowel surgery group [$n=305$]; dotted line: tumorectomy group [$n=68$]). LAR, low anterior resection; OS, overall survival; PFS, progression-free survival.

Survival outcomes in patients treated without bowel surgery and with tumorectomy are presented in **Fig. 2**. The 5-year PFS (60.3% vs. 57.9%, $p=0.523$) and 5-year OS (81.8% vs. 87.7%, $p=0.912$) in patients who underwent tumorectomy were not inferior to those of the patients who had no rectosigmoid lesions primarily. These survival outcome findings coincided with those of the cohort in which patients who had rectosigmoid lesions infiltrating up to the muscle and mucosa were excluded (**Supplementary Fig. 1**; 5-year PFS, 60.3% vs. 58.9%, $p=0.632$; 5-year OS, 81.2% vs. 90.1%, $p=0.929$).

4. Operation-related morbidity in patients treated with LAR

Operation-related outcomes and morbidity were presented in **Table 4**. Operation time was longer in patients with LAR than those without LAR (390.4 ± 142.8 minutes vs. 232.7 ± 80.6 minutes; $p < 0.001$). In addition, more intraoperative blood loss was estimated in patients with LAR (856.3 ± 753.3 mL vs. 570.2 ± 539.0 mL; $p=0.015$). Postoperative ileus was more common in patients who underwent LAR than those who did not (4 [16.7%] vs. 11 [2.9%], $p=0.001$). However, the incidences of bowel leakage, fever lasting more than 3 days

Table 4. Operation-related outcomes and morbidity (n=397)

Characteristics	No LAR (n=373)	LAR (n=24)	p
Operation time (min)	232.7±80.6	390.4±142.8	<0.001
Estimated blood loss (mL)	570.2±539.0	856.3±753.3	0.015
Ileus			0.001
No	362 (97.1)	20 (83.3)	
Yes	11 (2.9)	4 (16.7)	
Bowel leakage			>0.999
No	372 (99.7)	24 (100.0)	
Yes	1 (0.3)	0	
Fever >3 days			0.519
No	365 (97.9)	23 (95.8)	
Yes	8 (2.1)	1 (4.2)	
Wound dehiscence			0.271
No	355 (95.2)	24 (100.0)	
Yes	18 (4.8)	0	

LAR, low anterior resection.

postoperative, and wound dehiscence associated to LAR were not different. LAR-related morbidity in the cohort excluding the patients who had rectosigmoid lesions infiltrating up to the muscle and mucosa is described in **Supplementary Table 2**. Postoperative ileus was also frequently diagnosed in patients treated with LAR (3 [20.0%] vs. 12 [3.0%], p=0.001).

DISCUSSION

Our findings suggested that the survival outcomes depending on the procedure type for the extirpation of rectosigmoid lesions, i.e., tumorectomy vs. LAR, were not statistically different. Although retroperitoneal lymph node micro-metastasis was frequent in patients who underwent LAR, our findings are meaningful when considering that no gross seeding tumor existed above the pelvic brim in all patients. Notably, the survival outcomes in patients with rectosigmoid lesions who underwent tumorectomy only were not inferior to those in patients who had no rectosigmoid lesions primarily. Furthermore, optimal debulking was similarly achieved between patients who underwent tumorectomy and those who underwent LAR (67 [98.5%] vs. 19 [95.0%], p=0.405). These results imply that the tumors on the rectosigmoid colon are relatively well-controlled without bowel resection. In this study, the increased operation-related morbidity following LAR, such as ileus, could also in no way be negligible (4 [16.7%] vs. 11 [2.9%], p=0.001).

The effect of the procedure type for bowel resection on survival outcomes in patients diagnosed with advanced EOC (FIGO stage III–IV) had been proven in several researches. Most studies suggested that rectosigmoid resection might help improve the survival outcomes in patients with advanced EOC with acceptable complication rate [7-13]. However, Jaeger et al. [14] demonstrated that bowel resection could not improve the poor prognosis of bowel involvement in 194 patients with FIGO stage III disease. In their study, patients without bowel involvement and no residual tumor after surgery showed a significantly better survival rate than other patients irrespective of the resection status. However, all previous studies that evaluated the survival impact of bowel resection were based on advanced-stage EOC. FIGO stage II consists of a small and heterogeneous group, making up less than 10% of all EOC; therefore, many issues in therapeutic management remain unresolved. We hope that our findings could help surgeons regarding the prognostic implication of the resectional base after tumorectomy for tumors on the rectosigmoid colon.

The major site of bowel resection is the rectosigmoid (48%–55%), followed by the rest of the colon (18%–20%) and the small bowel (6%–27%), depending on the studies [9,15,16]. As the most important prognostic factor for operation-related morbidity, the extent of bowel resection can also affect optimal debulking. Kim et al. [17] on comparing the efficacy between LAR and Hartmann's operation in advanced or recurrent EOC, suggested that LAR may be the optimal procedure for bowel surgery in these patients and may improve postoperative quality of life. Surgical and survival outcomes between LAR and Hartmann's operation did not differ. Similarly, Plotti et al. [18] compared the safety and efficacy of partial rectosigmoid resection (PRR) to those of Hartmann's operation in advanced EOC through a case-control study. In their study, the optimal debulking rate and 5-year OS was not statistically different between the 2 groups. However, in Hartmann's operation group, they observed 4 cases of rectovaginal fistula compared with only 2 cases in PRR. In addition, adjuvant chemotherapy lasted 24 (19–28) days and 18 (15–24) days in Hartmann's operation and PRR groups ($p=0.05$), respectively. To the best of our knowledge, our study is the first to report the impact of tumorectomy without bowel resection for affected rectosigmoid lesions in EOC survival outcomes and operation-related morbidity. In the present study, the survival outcomes in patients treated with tumorectomy were not inferior to those of the patients with LAR, if optimal debulking could be guaranteed. However, evidence for the safety of the tumorectomy or serosectomy on rectosigmoid colon is lacking, and a global guideline has yet to be established. Therefore, our results should be cautiously applied in clinical practice.

Our study also has several limitations due to its retrospective nature. First, the sample size of the LAR group is relatively small compared with that of the control. Second, we could not fully obtain information about intraoperative characteristics of rectosigmoid lesions due to limited description. Recently, the National Comprehensive Cancer Network recommended that for ovarian cancer, surgeons should describe the initial disease intimately, including that in the pelvis, mid-abdomen, and upper abdomen [19]. Finally, we did not analyze the impact of neoadjuvant chemotherapy (NAC) to LAR performance or survival outcomes. Philip et al. [20] reported that NAC resulted in decreased bowel resection, which is necessary to achieve optimal debulking in advance EOC. Before NAC, at least 84 patients (87%) would have required bowel resection to obtain optimal debulking without residual tumor. After interval debulking surgery, only 47 patients (49%) required bowel resection, which corresponds to a decrease of 38% ($p<0.001$).

In the present study, the survival benefit of LAR was not significant in EOC patients with grossly pelvis-confined tumors. Furthermore, postoperative ileus was frequently detected in patients treated with LAR. If rectosigmoid lesions can be resected without residual tumors via tumorectomy, then LAR seems to be not mandatory to improve prognosis in patients with grossly pelvis-confined EOC. Further large prospective studies are necessary to establish standard methods and the safety of tumorectomy or serosectomy to eliminate rectosigmoid lesions.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Comparisons of clinicopathologic factors (n=387)

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Supplementary Table 2

Operation-related outcomes and morbidity (n=387)

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Supplementary Fig. 1

(A) The 5-year PFS (58.9% vs. 60.2%, $p=0.994$) and (B) 5-year OS (90.1% vs. 66.7%, $p=0.147$) in patients who had rectosigmoid lesions (solid line: tumorectomy group [n=67]; dotted line: LAR group [n=15]). (C) The 5-year PFS (60.3% vs. 58.9%, $p=0.632$) and (B) 5-year OS (81.2% vs. 90.1%, $p=0.929$) in patients who did not receive LAR (solid line: no bowel surgery group [n=305]; dotted line: tumorectomy group [n=67]).

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