

Clinicopathological Progress of Colorectal Resection in Gynecological Malignancy Patients : Does the risk of anastomotic leakage increase after surgery?

Ayoung Kang

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

Byung-Soo Park

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

Sung Hwan Cho

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

Gyung Mo Son

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

Yong Jung Song

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

Hyun Sung Kim (✉ gustohs@gmail.com)

Pusan National University Yangsan Hospital, Pusan National University School of Medicine

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Abstract

Objective: This study was conducted to investigate the clinicopathological outcomes of colorectal resection in patients with advanced gynecological malignancies.

Methods: We reviewed the medical records of 104 patients of gynecological cancer with co-operation for colorectal resection from December 2008 to August 2020 by retrospective cohort study in a single center (PNUYH). Variables for risk factors and postoperative complications were compared by descriptive statistics. We excluded the cases with malignancies from other than female genital organs, gynecological benign diseases, primary creation of stoma, and any other bowel surgeries except colorectal resection.

Results: Of 104 patients in total, the mean age was 62.0 years. The most common gynecological malignancy was ovarian cancer(85 patients, 81.7%) and the most commonly performed operation was low anterior resection(80 patients, 76.9%). 61 patients(58.7%) had postoperative complications, while only 3 patients(2.9%) with anastomotic leakage. Only preoperative albumin was statistically significant($p=0.019$) among the risk factors.

Conclusion: Our experience suggests that colorectal resection can be safely and efficaciously performed in patients with advanced gynecological malignancy.

I. Background

Gynecological malignancies such as cervical cancer, ovarian cancer, and endometrial cancer often invade adjacent organs at advanced stages, and in particular, colonic, and rectal invasions are frequent [1–3]. In most gynecological malignancies, curative surgical resection is the key to treatment and survival rate. Advanced gynecological malignancies often accompany intraabdominal metastasis, and sometimes induce intestinal obstruction too so that colectomy and proctectomy are required. Therefore, surgical collaboration is often required for colonic and rectal resections during gynecological malignancy surgery, and in cases where cooperative surgery has been performed, more careful post-operative management is required, and regular follow-up is important.

Patients who underwent colectomy may experience various complications during the recovery process. The range of complications is wide, from general ones that may occur after surgery performed under general anesthesia, to those caused by gastrointestinal surgery due to conditions such as intestinal obstruction and gastrointestinal tract bleeding, enteritis, and anastomotic leakage. The main goal of postoperative management of surgical patients is the recovery processes and the prevention and treatment of complications as such. However, there are not many studies on the progress after cooperative colorectal resection was performed in gynecological malignancy patients, and most of these studies were conducted from the perspective of obstetrics and gynecology.

In this paper, cooperative colorectal resection for gynecological malignancies performed at a single institution for 12 years was studied. This study aims to find a way to prevent postoperative complications

and improve the survival rate by examining the progress after performing colorectal resection in gynecological malignancy patients from the viewpoint of the colorectal surgeon.

II. Methods

This study was conducted as a retrospective cohort study in a single institution. A database of patients who underwent cooperative surgery due to obstetrics and gynecological diseases at Pusan National University Yangsan Hospital between December 2008 and August 2020 was obtained, and through database classification and medical record analysis, patients who underwent colorectal resection due to gynecological malignancies were finally selected as the subjects. Cases of malignancies that originated from other organs than female reproductive organs (Krukenberg tumor, metastasis of colon cancer, etc.) or benign gynecological diseases (endometriosis, female pelvic inflammatory disease, rectovaginal fistula, etc.), cases where any kind of enterostomy was performed at the time of the first surgery, cases where only enterectomy was performed excluding the colon and the rectum (appendectomy only, small intestine resection, etc.), and cases where there was no anastomotic site because only primary repair was performed were excluded (Fig. 1).

Among the medical records collected, the records of the first medical examination at the department of obstetrics and gynecology or surgery, progress records, consultation request forms, operative notes, pre-anesthesia evaluation tables, anesthesia records, and hospitalized nursing records were analyzed. Examination results, histopathologic examination results, and imagery interpretation reports were also included. Referring to previous studies, observation items and variables necessary to analyze risk factors were selected [1, 4–6]. As patient factors, age, height, weight, body mass index (BMI), whether diabetic, whether smoking, steroid administration history, and American Society of Anesthesiology (ASA) classifications were included. Diagnosis and disease stages were determined according to the standards of the International Federation of Gynecology and Obstetrics (FIGO). Preoperative and postoperative hemoglobin (Hb) levels, preoperative albumin (Alb) levels, and preoperative levels of CA125, CA19-9, and SCC, which are the most widely used tumor markers in gynecological malignancies, were investigated. The most recent examination results before entering the operating room were collected as preoperative examination results, and the results of the examination conducted for the first time after surgery were collected as postoperative examination results. As preoperative status-related factors, whether the relevant disease was diagnosed for the first time or had recurred, and whether chemotherapy and radiation therapy were carried out before surgery were included, and as intraoperative status-related factors, the total operation time, estimated blood loss (EBL), whether blood was transfused, and transfusion volume were included. As surgery-related factors, whether the surgery was emergency surgery, whether laparotomy was performed, types of surgery, whether an additional enterectomy accompanied, the distance from the anal verge (AV) to the anastomotic site, and anastomosis method (whether an automatic stapler was used) were investigated. In addition, whether the obstetrics and gynecology department requested cooperation from the department of surgery before the surgery was investigated and included in the variables.

Whether complications occurred after surgery was investigated to find out the frequencies of surgical wound infection, anastomotic leakage, anastomotic site infection, intraabdominal infection, cardiovascular complications, respiratory complications, and urinary complications separately. Whether anastomotic leakage occurred was judged by putting together medical records and examination results using the diagnostic criterion set as corresponding to at least one of 1) cases where amylase and lipase were detected in the intraabdominal drainage tube contents in amounts exceeding the reference values, 2) cases where findings indicating anastomotic leakage such as fluid retention around the anastomotic site were identified in radiological findings such as computed tomography (CT)[5, 7]. Cases that did not meet this diagnostic criterion were classified as anastomotic site infection, and intraabdominal inflammations and infection of areas other than anastomotic sites were separately classified as intraabdominal infection. In order to explore and analyze risk factors for anastomotic leakage, the study subjects were divided into two groups: patients in whom anastomotic leakage occurred and patients in whom no anastomotic leakage occurred, and statistical analysis was attempted.

All statistical analyses were conducted using IBM SPSS Statistics version 25 (SPSS Inc, Chicago, IL, USA). Some scale variables were converted into nominal variables through grouping and analyzed thereafter. Chi-square tests and Fisher's exact tests were used for nominal variables and Mann-Whitney's U tests were used for scale variables. The P-value to determine statistical significance was set to below 0.05.

This study is a retrospective cohort study conducted through medical record analysis and was exempted from review by the Institutional Review Board (IRB) of Pusan National University Yangsan Hospital. (IRB No. 05-2020-203). Written informed consent forms concerning cooperative colorectal resection were obtained for publication of the study.

iii. Results

According to the inclusion and exclusion criteria, 104 patients were finally selected as study subjects. Due to the characteristic of the patient group having gynecological malignancies, all patients were adult women.

The mean age of the study subjects was 62.0 years. Of the study subjects, 66 (63.5%) were younger than 65 years and 38 (36.5%) were 65 years old or older. The mean BMI was 22.9, and 35 patients (33.7%) had a BMI not lower than 24.0, which is commonly used as the standard for obesity in Korea. As for ASA classifications, 42 patients (40.4%) were class I, 49 patients (47.1%) were class II, 13 patients (12.5%) were class III, and there were no patients corresponding to class IV or V. In the classifications by diagnosis, ovarian cancer accounted for the highest ratio with 85 patients (81.7%), followed by cervical cancer (six patients), endometrial cancer (five patients), peritoneal cancer (four patients), uterine sarcoma (two patients), fallopian tubal cancer (one patient), and other cancer (one patient, malignant mixed Mullerian tumor (MMMT)). Among the study subjects, one patient was diagnosed with cervical cancer and endometrial cancer simultaneously and one patient was diagnosed with endometrial cancer and

ovarian cancer simultaneously. These patients corresponded to double primary cancer cases in which two primary cancers were simultaneously diagnosed. In the database used for statistical analysis, these patients were classified based on the diagnosis with the higher stage between the two diagnoses. Anticancer treatment including preoperative concurrent chemo-radiotherapy (CCRT) was performed in a total of 16 patients and radiation therapy was performed in a total of four patients (Table 1).

Table 1
Demographics of patient characteristics (n = 104)

Factors	
Age (years)	31–90 (62.0)
< 65	66 (63.5%)
≥ 65	38 (36.5%)
BMI	16.5–30.8 (22.9)
< 24.0	69 (66.3%)
≥ 24.0	35 (33.7%)
ASA	
I	42 (40.4%)
II	49 (47.1%)
III	13 (12.5%)
IV	0
V	0
Diagnosis*	
Cervical cancer	6 (5.8%)
Endometrial cancer	5 (4.8%)
Uterine sarcoma	2 (1.9%)
Ovarian cancer	85 (81.7%)
Fallopian tubal cancer	1 (1.0%)
Peritoneal cancer	4 (3.8%)
Others**	1 (1.0%)

* 2 patients with double primary cancer were classified as the diseases with higher stage.

** Malignant mixed Mullerian tumors (MMMT)

*** Adjuvant chemotherapy after the first operation for gynecological malignancies in patients with colorectal resection for recurred gynecological malignancies

* Data is presented as min – max (mean) or number (%).

Factors	
Preoperative chemotherapy	
No	88 (84.6%)
Preoperative neoadjuvant	4 (3.8%)
Preoperative CCRT	3 (2.9%)
Postoperative chemotherapy***	9 (8.7%)
Preoperative radiotherapy	
No	100 (96.2%)
Preoperative CCRT	3 (2.9%)
Preoperative radiotherapy only	1 (1.0%)
* 2 patients with double primary cancer were classified as the diseases with higher stage.	
** Malignant mixed Mullerian tumors (MMMT)	
*** Adjuvant chemotherapy after the first operation for gynecological malignancies in patients with colorectal resection for recurred gynecological malignancies	
* Data is presented as min – max (mean) or number (%).	

Among colorectal resections, the most frequently performed operation was low anterior resection (LAR), which was performed in a total of 80 patients (76.9%) followed by anterior resection (AR) performed in 10 patients (9.6%), total colectomy (TC) (six patients, 5.8%), and total proctocolectomy (TPC) (five patients, 4.8%), and right hemicolectomy (RHC) (three patients, 2.9%). Other combined gastrointestinal resections in addition to the main operation were performed in 25 patients. Cases where only appendectomy was accompanied were the most frequent (10 patients, 9.6%), followed by small intestine resection (eight patients, 7.7%) and colectomy (seven patients, 6.7%). Among the 104 patients, 103 (99.0%) patients underwent laparotomy before surgery. In the case of the one remaining patient, surgery began with diagnostic laparoscopy but was switched to open surgery after the obstetrics and gynecology department identified the surgical findings and the actual surgical operation began as open surgery. Therefore, it is reasonable to assume that all 104 subjects underwent open surgery. Anastomosis using an automatic stapler was performed in 102 patients (98.1%), and hand-sewn anastomosis was performed in two patients (1.9%). The mean operation time was 402.2 minutes, ranging from a minimum of 60 minutes to a maximum of 935 minutes (Table 2).

Table 2
Operation characteristics of colorectal resection

Operation	
Low anterior resection	80 (76.9%)
Anterior resection	10 (9.6%)
Total colectomy	6 (5.8%)
Total proctocolectomy	5 (4.8%)
Right hemicolectomy	3 (2.9%)
Additional bowel resection	
No	79 (76.0%)
Colectomy	7 (6.7%)
Small intestine resection	8 (7.7%)
Appendectomy	10 (9.6%)
Laparotomy or laparoscopy	
Laparotomy	103 (99.0%)
Laparoscopy	0
Laparoscopy converted to open laparotomy*	1 (1.0%)
Anastomosis	
Stapler	102 (98.1%)
Hand-sewn	2 (1.9%)
Operation time (min)	60–935 (402.2)
* Began as diagnostic laparoscopy by gynecologist and switched to open laparotomy before the start of co-operation with general surgeon	

Postoperative complications occurred in 61 (58.7%) of the 104 patients. Among them, three cases (2.9%) were clinically confirmed as anastomotic leakage. All three patients underwent reoperation immediately upon confirmation of leakage, and they improved and were discharged normally, although there were differences in their recovery periods. Three cases (2.9%) of anastomotic site infection excluding leakage, and six cases (5.8%) of intraabdominal infection other than anastomotic sites were identified. In addition, there were wound infections in eight patients (7.7%), gastrointestinal complications such as enteroplegia and intestinal obstruction in 18 patients (17.3%), cardiovascular complications in seven patients (6.7%), respiratory system complications in five patients (4.8%), and urinary system complications in 16 patients (15.4%). Other complications identified were lymphedema in two patients, obturator nerve damage in one

patient, poor blood sugar control in one patient, and multi-organ failure in one patient. There was no case of death as a direct result of postoperative complications except for one patient with multiple organ failure (Table 3).

Table 3
Postoperative mortality and morbidity

Postoperative mortality	0 (0%)
Postoperative morbidity	61 (58.7%)
Surgical wound infection	8 (7.7%)
Anastomotic leakage	3 (2.9%)
Anastomotic site infection (except leakage)	3 (2.9%)
Intraabdominal infection (except anastomosis site)	6 (5.8%)
Gastrointestinal complications	18 (17.3%)
Cardiovascular complications	7 (6.7%)
Respiratory complications	5 (4.8%)
Urinary complications	16 (15.4%)
Others	5 (4.8%)
* Multiple complications in one patient were counted respectively	

The data on the comparison of individual characteristics according to whether there was anastomotic leakage were organized in Table 4. Analysis was conducted to identify risk factors for anastomotic leakage. Among the risk factors, the preoperative albumin level ($p = 0.019$) was the only risk factor that showed a statistically significant difference, and none of the remaining risk factors showed statistical significance.

Table 4
Comparison between patients with and without anastomotic leakage

	Total (n = 104)	No leakage (n = 101)	With leakage (n = 3)	P-value
Age (years)	62.0 (31–90)	62.0 (31–90)	64.7 (50–78)	0.301
< 65	66 (63.5%)	65 (64.4%)	1 (33.3%)	
≥ 65	38 (36.5%)	36 (35.6%)	2 (66.7%)	
Height (cm)	156.1 (141.2–169.2)	156.0 (141.2–169.2)	160.3 (156.4–163.4)	0.197
Weight (kg)	55.80 (40.00–72.30)	55.89 (40.00–72.30)	53.00 (49.00–57.98)	0.433
BMI	22.90 (16.47–30.78)	22.97 (16.47–30.78)	20.71 (18.35–23.70)	0.288
< 24.0	69 (66.3%)	66 (65.3%)	3 (100.0%)	
≥ 24.0	35 (33.7%)	35 (34.7%)	0	
ASA				
I	42 (40.4%)	41 (40.6%)	1 (33.3%)	0.915
II	49 (47.1%)	49 (48.5%)	0	
III	13 (12.5%)	11 (10.9%)	2 (66.7%)	
IV	0	0	0	
V	0	0	0	
DM				
No	95 (91.3%)	92 (91.1%)	3 (100.0%)	0.760
Yes	9 (8.7%)	9 (8.9%)	0	
Smoking				
No	101 (97.1%)	99 (98.0%)	2 (66.7%)	0.085
Yes	3 (2.9%)	2 (2.0%)	1 (33.3%)	
Steroid therapy				
No	101 (97.1%)	98 (97.0%)	3 (100.0%)	0.915
Yes	3 (2.9%)	3 (3.0%)	0 (0.0%)	

	Total (n = 104)	No leakage (n = 101)	With leakage (n = 3)	P-value
Preop Alb (g/dL)	3.83 (2.0-4.7)	3.86 (2.0-4.7)	2.80 (2.1–3.8)	0.019
< 3.0	9 (8.7%)	7 (6.9%)	2 (66.7%)	
≥ 3.0	95 (91.3%)	94 (93.1%)	1 (33.3%)	
Preop Hb (g/dL)	11.95 (7.0-15.2)	11.92 (7.0-15.2)	12.87 (11.6–14.9)	0.456
Postop Hb (g/dL)	11.60 (6.0-16.5)	11.55 (6.0-16.5)	13.70 (11.6–15.1)	0.078
Operation time (min)	402.2 (60–935)	400.8 (60–935)	446.7 (330–540)	0.422
Emergency operation	93 (89.4%)	90 (89.1%)	3 (100%)	0.713
Elective	11 (10.6%)	11 (10.9%)	0	
Emergency				
Consult				
Outpatient	1 (1.0%)	1 (1.0%)	0	0.984
Preoperative	33 (31.7%)	32 (31.7%)	1 (33.3%)	
Postoperative	0	0	0	
No	70 (67.3%)	68 (67.3%)	2 (66.7%)	
EBL (cc)	1239.4 (100–5000)	1236.60 (100–5000)	1333.33 (200–2300)	0.817
Intraop transfusion				
No	29 (27.9%)	29 (28.7%)	0	0.371
Yes	75 (72.1%)	72 (71.3%)	3 (100.0%)	
Transfusion (pint)				
RBC	2.5 (0–29)	2.4 (0–29)	3.7 (1–5)	0.226
FFP	0.9 (0–29)	0.9 (0–29)	1.22 (0-3.6)	0.686
Laparotomy or laparoscopy				
Laparotomy	103 (99.0%)	100 (99.0%)	3 (100.0%)	0.971
Laparoscopy	0	0	0	
Laparoscopy converted to laparotomy	1 (1.0%)	1 (1.0%)	0	

	Total (n = 104)	No leakage (n = 101)	With leakage (n = 3)	P-value
Diagnosis				
Cervical cancer	6 (5.8%)	6 (5.9%)	0	0.756
Endometrial cancer	5 (4.8%)	5 (5.0%)	0	
Uterine sarcoma	2 (1.9%)	2 (2.0%)	0	
Ovarian cancer	85 (81.7%)	82 (81.2%)	3 (100%)	
Fallopian tubal cancer	1 (1.0%)	1 (1.0%)	0	
Peritoneal cancer	4 (3.8%)	4 (4.0%)	0	
Others	1 (1.0%)	1 (1.0%)	0	
Type of operation				
LAR	80 (76.9%)	78 (77.2%)	2 (66.7%)	0.212
AR	10 (9.6%)	10 (9.9%)	0	
TC	6 (5.8%)	6 (5.9%)	0	
TPC	5 (4.8%)	4 (4.0%)	1 (33.3%)	
RHC	3 (2.9%)	3 (3.0%)	0	
Associated bowel resection				
No	79 (76.0%)	77 (76.2%)	2 (66.7%)	0.282
Colectomy	7 (6.7%)	6 (5.9%)	1 (33.3%)	
Small intestine resection	8 (7.7%)	8 (7.9%)	0	
Appendectomy	10 (9.6%)	10 (9.9%)	0	
Level of anastomosis from AV (cm)				
< 5	15 (14.4%)	13 (12.9%)	2 (66.7%)	0.072
5 ~ 8	63 (60.6%)	62 (61.4%)	1 (33.3%)	
> 8	6 (5.8%)	6 (5.9%)	0	
No data	20 (19.2%)	20 (19.8%)	0	

	Total (n = 104)	No leakage (n = 101)	With leakage (n = 3)	P-value
FIGO stage				
I	4 (3.8%)	4 (4.0%)	0	0.991
II	13 (12.5%)	13 (12.9%)	0	
IIa	3 (2.9%)	3 (3.0%)	0	
IIb	6 (5.8%)	6 (5.9%)	0	
IIc	4 (3.8%)	4 (4.0%)	0	
III	48 (46.1%)	47 (46.6%)	1 (33.3%)	
IIIa	2 (1.9%)	2 (2.0%)	0	
IIIb	2 (1.9%)	2 (2.0%)	0	
IIIc	44 (42.3%)	43 (42.6%)	1 (33.3%)	
IV	36 (34.6%)	34 (33.3%)	2 (66.7%)	
IVa	13 (12.5%)	12 (11.9%)	1 (33.3%)	
IVb	23 (22.1%)	22 (21.8%)	1 (33.3%)	
No data	3 (2.9%)	3 (2.9%)	0	
Recurrence				
First diagnosis	92 (88.5%)	89 (88.1%)	3 (100%)	0.690
Recurrence	12 (11.5%)	12 (11.9%)	0	
Anastomosis				
Stapler	102 (98.1%)	99 (98.0%)	3 (100.0%)	0.943
Hand-sewn	2 (1.9%)	2 (2.0%)	0	
Preop chemotherapy				
No	88 (84.6%)	85 (84.2%)	3 (100.0%)	0.905
Preop neoadjuvant	4 (3.8%)	4 (4.0%)	0	
Preop CCRT	3 (2.9%)	3 (3.0%)	0	
Postop adjuvant	9 (8.7%)	9 (8.9%)	0	

	Total (n = 104)	No leakage (n = 101)	With leakage (n = 3)	P-value
Preop radiotherapy				
No	100 (96.2%)	97 (96.0%)	3 (100%)	0.940
Preop CCRT	3 (2.9%)	3 (3.0%)	0	
Preop radiotherapy only	1 (1.0%)	1 (1.0%)	0	
Tumor marker				
CA125	(98)	(95)	(3)	0.697
Normal (< 36)	11 (11.2%)	11 (11.6%)	0	0.396
Abnormal	87 (88.8%)	84 (88.4%)	3 (100%)	-
CA19-9	(79)	(76)	(3)	
Normal (< 36)	65 (62.5%)	62 (61.4%)	3 (100%)	
Abnormal	14 (13.5%)	14 (13.9%)	0	
SCC	(7)	(7)	(0)	
Normal (< = 1.0)	1 (14.3%)	1 (14.3%)		
Abnormal (> 1.0)	4 (57.1%)	4 (57.1%)		
No data	2 (28.6%)	2 (28.6%)		

Iv. Discussion

Since gynecological malignancies, including ovarian cancer, frequently invade adjacent organs in the pelvis at advanced stages, lower colonic and rectal resections are often combined for complete resection of the lesion [3, 4]. In the case of ovarian cancer, it was reported that colorectal resection was performed concurrently in about 26% of patients who underwent cytoreductive operations for complete resection of the tumor [8]. In tumor reduction surgery for ovarian cancer, colectomy occupies an important position due to frequent invasions into the colon (about 50% or more in some previous studies), technical problems, and postoperative complications. In many studies, colectomy for complete tumor reduction was found to have a positive effect on survival rate [8, 9].

The most commonly invaded parts of the gastrointestinal tract were the sigmoid colon and the rectum [3, 8, 10], followed by the ileocecum [8]. In this study as well, LAR, which is rectal resection, showed the highest frequency at 76.9% followed by AR at 9.6%, which were confirmed to be similar to previous studies.

There was no case of death as a direct result of postoperative complications among the subjects of this study. One patient died of multi-organ failure one month after the operation. However, she was old at the

time of diagnosis, and it was judged that the multi-organ failure had progressed due to the rapid progression of the cancer as the cancer was at FIGO stage IVb. The frequencies of postoperative complications by type were gastrointestinal system complications (17.3%), urinary system complications (15.4%), wound infection (7.7%), cardiovascular system complications (6.7%), and intraabdominal infection (excluding anastomotic site-related ones) (5.8%). Given the surgical sites and anatomical positions, the relatively higher frequencies of gastrointestinal and urinary system complications can be regarded to be reasonable.

Anastomotic leakage is one of the most fatal complications after colorectal resection. It is diagnosed by checking intestinal contents such as digestive fluid coming out of the drainage tube or fluid retention in the abdominal cavity or abdominal wall. It has been reported in 2.8 ~ 23% of general colorectal surgery and in 0.8 ~ 6.8% of gynecological malignancy surgery [1, 4]. Commonly known major risk factors for anastomotic leakage include cases where the anastomotic site is located under the peritoneal reflection, preoperative radiotherapy, advanced stage, emergency surgery, blood transfusion, malnutrition, obesity, smoking, steroid therapy, and automatic stapler-related factors [4–6]. In this study, the frequency of anastomotic leakage that occurred was three patients (2.9%) out of the 104 patients, which was lower compared to the frequency of anastomotic leakage after colon and rectal cancer surgery (2.8 ~ 23%) mentioned earlier. It was shown to be similar to the frequency of anastomotic leakage after colorectal resection for primary colorectal cancer (81 out of 2391 patients, 3.4%) performed at the same research institute during the same period (December 2008 to August 2020) and was similar to that of the primary colorectal cancer patients.

According to some previous studies, the reason why the frequency of anastomotic leakage in collaborated coloproctectomies in gynecological malignancies is lower than in coloproctectomies in primary colon cancer is that the blood flow and tissues of the intestine in the case of gynecological malignancies are relatively stable compared to those in the case of primary colon cancer because the invasion of lesions is mostly confined to the superficial layers of the colon and the rectum, and anastomotic sites are much stable because they are located at relatively higher positions from the anal verge [3, 11, 12]. The low frequency of anastomotic leakage in this study is also thought to be due to these characteristics of gynecological malignancies.

Among the risk factors for anastomotic leakage analyzed in this study, the preoperative albumin level was the only variable of which the statistical significance was identified. In some previous studies, it was identified that the risk of anastomotic leakage increased when the albumin level was low [4, 6]. Since albumin is a serum protein, which is an indicator of the patient's nutritional status, delay in the anastomotic site wound recovery process due to malnutrition seems to increase the risk of leakage [6]. However, there were also studies where there was no significant association between albumin levels and anastomotic leakage [5], and some studies mentioned that it was difficult to accurately analyze albumin levels as a risk factor because a considerable amount of preoperative albumin level data were missing [4, 5]. In this study, since albumin was included in the basic preoperative examination items of all subject

patients, the correlation between preoperative albumin levels and anastomotic leakage could be identified.

This study has a limitation that it is a single-center retrospective study with a small number of samples. In addition, since the frequency of occurrence of anastomotic leakage was extremely low, there was no statistical significance in the comparison of risk factors in most cases. However, since the findings of this study are data from a comprehensive investigation and analysis of cases of collaborative colorectal resection among gynecological malignancy patients treated at the study target institution for 12 years since the opening of the institution, the data are thought to be valuable as preceding research data when studies are conducted later with more patients.

V. Conclusion

When colonic and rectal metastasis have been confirmed in a gynecological malignancy patient, colorectal resection can be performed simultaneously. Complications accompanying intestinal resection, especially fatal complications such as anastomotic leakage, may occur, but the frequency is extremely low. Therefore, radical resection can be actively performed in consideration of the patient's overall conditions and risk factors.

Abbreviations

Alb, albumin; AR, anterior resection; ASA, American Society of Anesthesiology; AV, anal verge; BMI, body mass index; CCRT, concurrent chemoradiation therapy; DM, diabetes mellitus; EBL, estimated blood loss; FFP, fresh frozen plasma; FIGO, International Federation of Gynecology and Obstetrics; Hb, hemoglobin; LAR, low anterior resection; RBC, red blood cell; RHC, right hemicolectomy; SCC, squamous cell carcinoma antigen, TC, total colectomy; TPC, total proctocolectomy

Declarations

Ethics approval and consent to participate

This study protocol was approved by the Institutional Review Board (IRB) of Pusan National University Yangsan Hospital. (IRB No. 05-2020-203). Written informed consent forms concerning cooperative colorectal resection were obtained for publication of the study.

Consent for publication

We obtained written consent to publish all the personal details included in our dataset from all participants prior to surgery.

Availability of data and materials

All datasets on which the conclusions of the manuscript rely was provided as additional supporting file.

Competing interests

The authors declare that they have no competing interest.

Funding

The authors declare that no funding was received for the study.

Authors' contributions

HSK designed the study, analyzed and interpreted the data, and made a draft and revised the manuscript. AK analyzed and interpreted data and wrote the manuscript. BP, SHC helped to acquire the data and performed the statistical analysis. KMS, YJS was responsible for the study's conception and design. All authors have read and approved the final manuscript.

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Figures

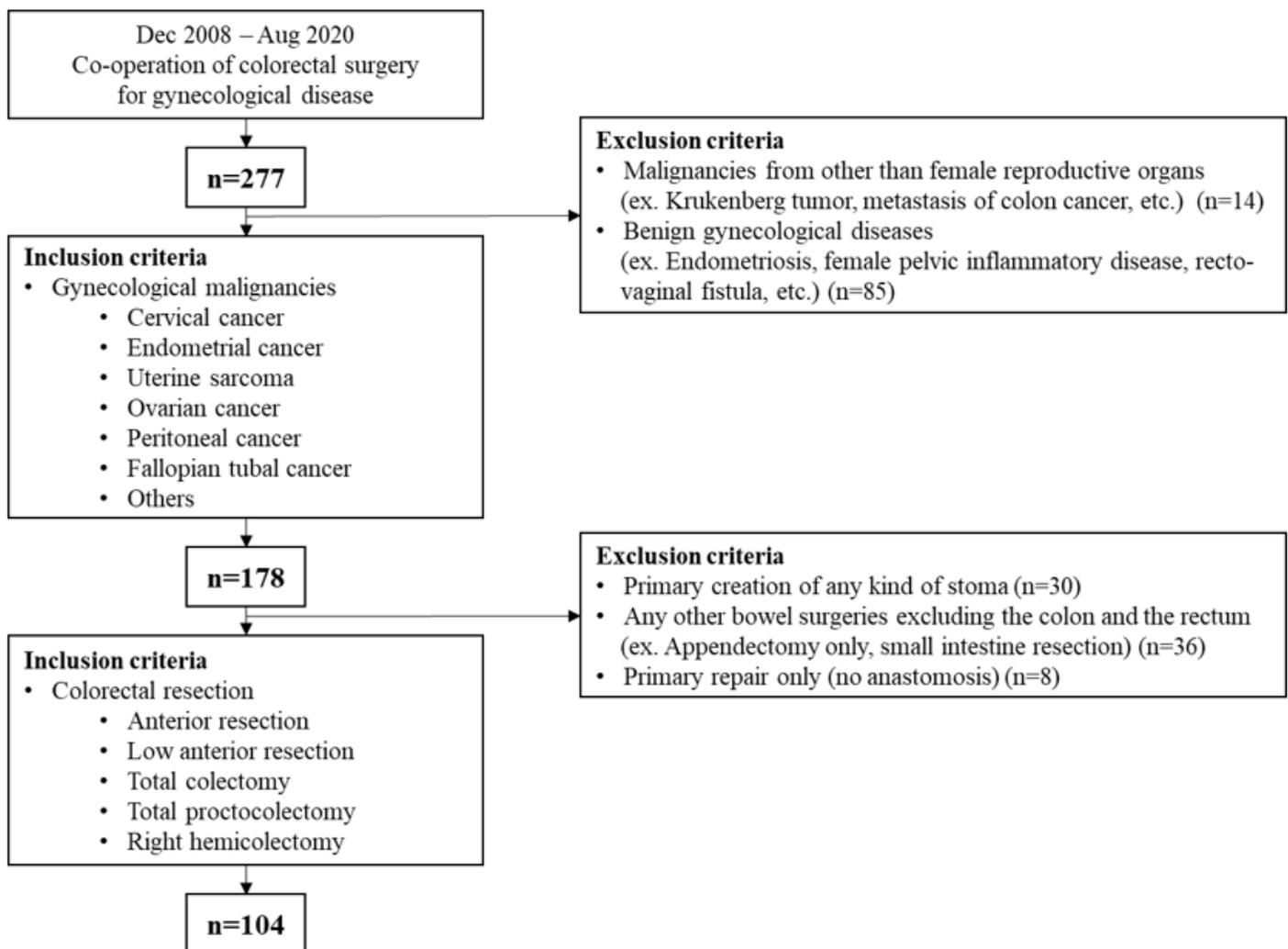


Figure 1

Flowcharts for inclusion and exclusion