Comparison of postoperative prognoses for resectable colorectal cancer with vs. without oncologic emergency using propensity score-matched analyses: A single-center retrospective observational study

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Abstract. While oncological emergencies in colorectal cancer present distinct challenges, existing literature offers conflicting evidence regarding long-term outcomes. Therefore, the present study compared the postoperative prognoses between patients with and without oncological emergencies. A retrospective evaluation was conducted on patients who had undergone radical surgery for pathological stages II and III colorectal cancer at a single center between January 2012 and December 2020. Patients were classified into the non-emergency and oncological emergency groups. The status of oncologic emergency was divided into obstruction and perforation. The outcomes were compared using propensity score matching. The primary objective was to compare the postoperative prognoses between non-emergency and oncological emergency situations. The secondary objectives included comparing prognoses between obstruction and perforation, identifying the type of recurrence depending on the status of oncologic emergency, and assessing the effect of adjuvant chemotherapy for oncologic emergencies. This study included 524 patients. After propensity score matching, the prognoses of oncological emergencies were worse compared with those without any emergency, whereas those of obstruction and perforation did not significantly differ. Regarding the type of recurrence, peritoneal dissemination in obstruction and local recurrence in perforation was more common compared with that in non-emergency cases. Adjuvant chemotherapy improved the recurrence-free survival for cases with oncological emergencies. The prognoses in cases with oncological emergencies could be worse compared with those without any emergency, whereas obstruction and perforation outcomes can be comparable. The administration of adjuvant chemotherapy should be strongly considered for oncological emergencies.

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Introduction

Colorectal cancer (CRC) is a leading cause of mortality and morbidity worldwide. It is the third most common malignancy and the fourth leading cause of cancer-related mortalities worldwide, accounting for ~1,400,000 new cases and 700,000 deaths (1). In Japan, CRC is the second most common cancer in terms of incidence rates among men and women. It is the second most common cause of cancer-related mortalities in the country and poses a significant health burden to other parts of the world (2).

Oncologic emergency (OE) develops in 9-33% of CRC cases (3-5). Patients with conditions presenting as OE associated with CRC show various symptoms, such as bowel obstruction and perforation. Surgery for OE patients is associated with higher postoperative morbidity and hospital mortality rates, and worse oncological outcomes than that for those without OE (6-10). The improvement in therapeutic outcomes for CRC with OE remains an issue to be resolved in the development of CRC prognosis. A conflicting report demonstrated no differences in long-term outcomes (11). Furthermore, the prognosis of patients with CRC with OE differs between patients with obstruction and perforation (10,12,13). However, most of these retrospective studies included patients from different backgrounds and used an unmatched design, leading to controversial findings. These ambiguities have hindered the development of standard therapeutic strategies for OE; for example, the indications for postoperative adjuvant chemotherapy for OE vary based on international guidelines (14-16).

Therefore, this study compared postoperative prognoses between patients with and without OE, with OE further divided into obstruction and perforation, using propensity score matching (PSM).

Materials and methods

Study design and patient population. This observational study was conducted retrospectively at a single center, following the STROBE guidelines (17). We included patients who had undergone radical surgery for primary CRC with pathological stages II and III in our department between January 2012 and December 2020. The exclusion criteria were 1) synchronous multicentric cancer; 2) synchronous or metachronous multiple colorectal cancers; 3) loss to follow-up; 4) pathological T1 and T2 tumor because there was no case with T1 or T2 in the oncologic emergency group. Preoperative chemotherapy or chemoradiotherapy was not administered in this cohort. The patients were classified into non-emergency (NE) and OE groups. The status of OE was divided into obstruction and perforation. Obstruction was defined as follows: 1) symptoms of bowel obstruction requiring fasting, bowel decompression, or emergency surgery; 2) imaging findings in patients with bowel intussusception. Per a previous report (11), perforation was defined as 1) free perforation showing feculent or purulent peritonitis on intraoperative findings; 2) contained perforation showing abscess formation or a fistulous connection to an adjacent organ or structure.

Study outcomes. The primary objective was to compare the postoperative prognoses between the NE and OE groups. The secondary objectives were to compare the prognoses between the obstruction and perforation groups, identify the type of recurrence depending on OE status, and assess the effect of adjuvant chemotherapy in patients with OE.

Data collection and follow-up. Clinicopathological data, including age, sex, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS), tumor location, clinical stage, surgical approach, primary anastomosis, D3 lymph node dissection, postoperative major complications, in-hospital mortality, postoperative hospital stay, pathological stage, lymphatic invasion, vascular invasion, resectability, postoperative adjuvant chemotherapy, and follow-up period, were collected from the hospital medical records. Staging was conducted according to the eighth edition of the Union for International Cancer Control tumor-node-metastasis classification (18). Postoperative complications were rated using the Clavien-Dindo classification (19). Postoperative adjuvant chemotherapy was considered for patients with high-risk stage II or all stage III, according to the Japanese guideline (14). Ultimately, the oncologist made the decision to administer the drug depending on the general condition and the patient's wishes. Other adjuvant therapies, such as radiation therapy, were not performed. Postoperatively, the patients visited our department every 3 months for 3 years and subsequently, every 6 months. At each follow-up, tumor markers were evaluated every 3 months, computed tomography scans were conducted every 6 months, and colonoscopy was performed every 2 years. Recurrence was identified through radiographic evidence of enlarged lesions or histological verification.

Statistical analysis. The outcomes were compared before and after PSM: NE vs. OE in the overall cohort and obstruction vs. perforation in the OE cohort. Propensity scores were calculated using a logistic regression model that considered age, sex, BMI, ASA-PS, tumor location, clinical T factor, and clinical N factor. A 1:1 nearest-neighbor matching without replacement was conducted using an optimal caliper width of 0.2, the logit of the standard deviation of the propensity score (20). Standardized mean differences (SMD) were evaluated to assess whether adequate balance was achieved after matching (SMD <0.2).

Quantitative data were analyzed using the Mann-Whitney U test, and categorical data were analyzed using Fisher's exact test and post-hoc Bonferroni test. The Kaplan-Meier technique was used to calculate recurrence-free survival (RFS) and cancer-specific survival (CSS) rates. The RFS was calculated excluding in-hospital cases of mortality. The univariate log-rank test was used to compare these survival rates between groups. Statistical significance was set at $P<0.05$. All statistical analyses were conducted using EZR (version 1.61; Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (version 4.2.2; The R Foundation for Statistical Computing, Vienna, Austria), which is a modified version of R Commander (version 2.8-0) that includes statistical functions commonly used in biostatistics (21).

Results

Patient flowchart and details of oncologic emergency. In total, 608 patients were eligible for this study. However, 33 patients with synchronous multicentric cancer, 13 with synchronous or metachronous multiple colorectal cancer, 7 lost to follow-up, and 31 with pathological T1 and T2 were excluded. Finally, the study included 524 patients. Altogether, 348 and 176 patients were included in the NE and OE groups, respectively. The OE group included 140 and 36 patients with obstruction and perforation, respectively. Among the 140 patients with obstruction, 73 underwent decompression using a self-expandable metallic stent (SEMS), 45 underwent elective surgery after fasting, 18 underwent decompression using a decompression tube, and 4 underwent emergency surgery. Among the 36 patients, 12 and 24 underwent surgery for free and contained perforations, respectively. After PSM, 158 and 27 patients from each group were included in the overall cohort (NE vs. OE) and the OE cohort (obstruction vs. perforation), respectively. Fig. 1 shows the patient flowchart.

Characteristics and prognoses before and after matching in the overall cohort. Table I lists the characteristics of 524 patients. After matching, no significant differences were noted in the patient backgrounds. There were significant differences in approach, primary anastomosis, and lymphatic invasion. Before and after matching, RFS and CSS in the OE group were worse than those in the NE group (Fig. 2).

Characteristics and prognoses before and after matching in the OE cohort. Table II lists the characteristics of 176 patients. After matching, no significant differences were noted in the patient backgrounds. There were significant differences in approach, primary anastomosis, postoperative hospital stays, and vascular invasion. The interval from operation to adjuvant chemotherapy tended to be longer in the perforation group than in the obstruction group. Before matching, RFS and CSS in

Table I. Patient characteristics and outcomes in the overall cohort.

Variables	Group	Before matching (n=524)				After matching (n=316)			
		Non-emergency (n=348)	Oncologic emergency (n=176)	P-value	SMD	Non-emergency (n=158)	Oncologic emergency (n=158)	P-value	SMD
Age (years), median (range)		75 (39-95)	72 (31-93)	0.021	0.242	74.5 (39-95)	72 (39-93)	0.319	0.089
Sex, n (%)	Male	216 (62.1)	95 (54.0)	0.090	0.165	85 (53.8)	89 (56.3)	0.734	0.051
	Female	132 (37.9)	81 (46.0)			73 (46.2)	69 (43.7)		
BMI (kg/m^2), median (range)		22.6 (13.6-34.9)	21.4 (13.1-39.8)	0.002	0.242	22.3 (14.1-33.1)	21.8 (13.1-39.8)	0.344	0.043
ASA-PS, n (%)	ASA-I, II	225 (64.7)	115 (65.3)	0.923	0.014	100 (63.3)	102 (64.6)	0.907	0.026
	ASA-III, IV	123 (35.3)	61 (34.7)			58 (36.7)	56 (35.4)		
Tumor location, n (%)	Colon	260 (74.7)	152 (86.4)	0.002	0.298	139 (88.0)	134 (84.8)	0.512	0.092
	Rectum	88 (25.3)	24 (13.6)			19 (12.0)	24 (15.2)		
Clinical T factor, n (%)	cT4	60 (17.2)	61 (34.7)	<0.001	0.405	42 (26.6)	43 (27.2)	1.000	0.014
	cT2, 3	288 (82.8)	115 (65.3)			116 (73.4)	115 (72.8)		
Clinical N factor, n (%)	Positive	168 (48.3)	98 (55.7)	0.116	0.149	87 (55.1)	82 (51.9)	0.652	0.063
	Negative	180 (51.7)	78 (44.3)			71 (44.9)	76 (48.1)		
Status of oncologic emergency, n (%)	Obstruction	-	140 (79.5)			-	127 (80.4)		
	Perforation	-	36 (20.5)			-	31 (19.6)		
Approach, n (%)	Laparotomy	3 (0.9)	16 (9.1)	<0.001		2 (1.3)	16 (10.1)	<0.001	
	Laparoscopy	343 (98.6)	155 (88.1)			156 (98.7)	137 (86.7)		
	Conversion	2 (0.6)	5 (2.8)			0 (0)	5 (3.2)		
Primary anastomosis, n (%)		318 (91.4)	138 (78.4)	<0.001		149 (94.3)	123 (77.8)	<0.001	
D3 lymph node dissection, n (%)		330 (94.8)	165 (93.8)	0.686		153 (96.8)	147 (93.0)	0.198	
Postoperative major complication (CD≥III), n (%)		29 (8.3)	15 (8.5)	1.000		10 (6.3)	13 (8.2)	0.666	
In-hospital mortality, n (%)		3 (0.9)	7 (4.0)	0.036		2 (1.3)	7 (4.4)	0.173	
Postoperative hospital stay (days), median (range)		8 (4-142)	9 (5-71)	0.077		8 (4-69)	9 (5-71)	0.100	
Pathological T factor, n (%)	pT3	309 (88.8)	139 (79.0)	0.009		129 (81.6)	131 (82.9)	0.904	
	pT4a	26 (7.5)	22 (12.5)			18 (11.4)	15 (9.5)		
	pT4b	13 (3.7)	15 (8.5)			11 (7.0)	12 (7.6)		
Pathological N factor, n (%)	pN0	196 (56.3)	94 (53.4)	0.640		83 (52.5)	89 (56.3)	0.774	
	pN1	112 (32.2)	57 (32.4)			51 (32.3)	48 (30.4)		
	pN2	40 (11.5)	25 (14.2)			24 (15.2)	21 (13.3)		

Table I. Continued.

Variables	Group	Before matching (n=524)				After matching (n=316)			
		Non-emergency (n=348)	Oncologic emergency (n=176)	P-value	SMD	Non-emergency (n=158)	Oncologic emergency (n=158)	P-value	SMD
Pathological stage, n (%)	IIA	176 (50.6)	77 (43.8)	0.064		68 (43.0)	74 (46.8)	0.682	
	IIB	14 (4.0)	7 (4.0)			9 (5.7)	6 (3.8)		
	IIC	6 (1.7)	10 (5.7)			6 (3.8)	9 (5.7)		
	IIIB	129 (37.1)	64 (36.4)			58 (36.7)	57 (36.1)		
	IIIC	23 (6.6)	18 (10.2)			17 (10.8)	12 (7.6)		
Lymphatic invasion, n (%)		316 (90.8)	169 (96.0)	0.034		142 (89.9)	152 (96.2)	0.044	
Vascular invasion, n (%)		294 (84.5)	145 (82.4)	0.533		138 (87.3)	130 (82.3)	0.273	
Resectability, n (%)	Positive	1 (0.3)	7 (4.0)	0.003		1 (0.6)	5 (3.2)	0.214	
Adjuvant chemotherapy, n (%)		163 (46.8)	101 (57.4)	0.026		74 (46.8)	84 (53.2)	0.311	
Interval from operation to adjuvant chemotherapy (days), median (range)		33 (10-108)	35 (15-163)	0.139		33.5 (15-108)	35 (15-163)	0.363	
Follow-up period (months), median (range)		54.0 (0.07-123.7)	48.1 (0.03-113.8)	0.051		54.0 (0.07-123.5)	46.4 (0.03-113.8)	0.085	

SMD, standardized mean differences; ASA-PS, American Society of Anesthesiologists physical status.

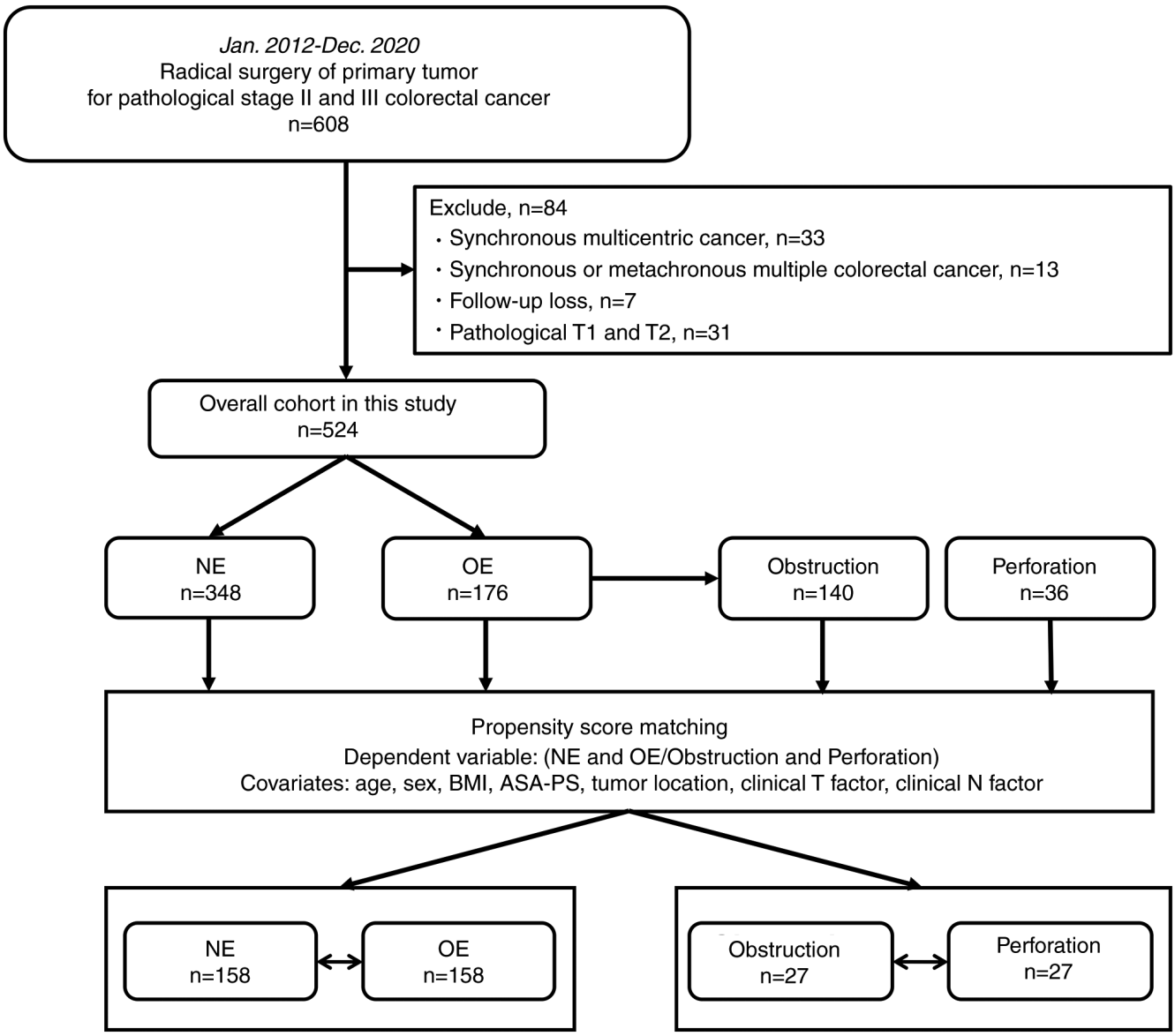

Figure 1. Study population and patient flow chart. NE, non-emergency; OE, oncological emergency; BMI, body mass index.

the perforation group were worse than those in the obstruction group. After matching, RFS and CSS were not significantly different between the groups (Fig. 3).

Recurrence types among three groups and effects of adjuvant chemotherapy for oncologic emergency. Table III shows the recurrence rates and types in the overall cohort. The total recurrence rates were 20.1, 27.9, and 41.7% in the NE, obstruction, and perforation groups, respectively. Particularly, significant differences were noted in the local recurrence between NE and perforation, and peritoneal dissemination rates between NE and obstruction groups. Of the 124 patients with recurrence, 14 (11.3%) underwent resection of the recurrent lesion (local, 4; liver, 4; lung, 3; peritoneal, 3). All resected cases had recurrences in a single organ. The 3-year CSS following recurrence was better in resected than in unresected cases (83.6% vs. 44.7%, P=0.113).

Among the 176 patients with OE, 94 and 82 were pathological stage II and III, respectively. Among pathological stage II cases, 37 (39.4%) patients received adjuvant chemotherapy, of which 8 and 29 received the regimens with oxaliplatin (CAPOX, 8) and without oxaliplatin (capecitabine, 17; TS-1, 11; UFT-LV, 1), respectively. Among pathological stage III cases, 64 (78.1%) patients received adjuvant chemotherapy, of which 60 and 4 received the regimens with oxaliplatin (CAPOX, 48 and FOLFOX, 12) and without oxaliplatin (capecitabine, 4), respectively. RFS in patients who received adjuvant chemotherapy was significantly better than that in those without adjuvant chemotherapy in pathological stage II and not in stage III (Fig. 4).

Discussion

This study reviewed the long-term outcomes of 524 patients who underwent radical surgery for pathological stages II and III CRC, with or without OE. The oncological outcomes in patients in the OE groups were significantly

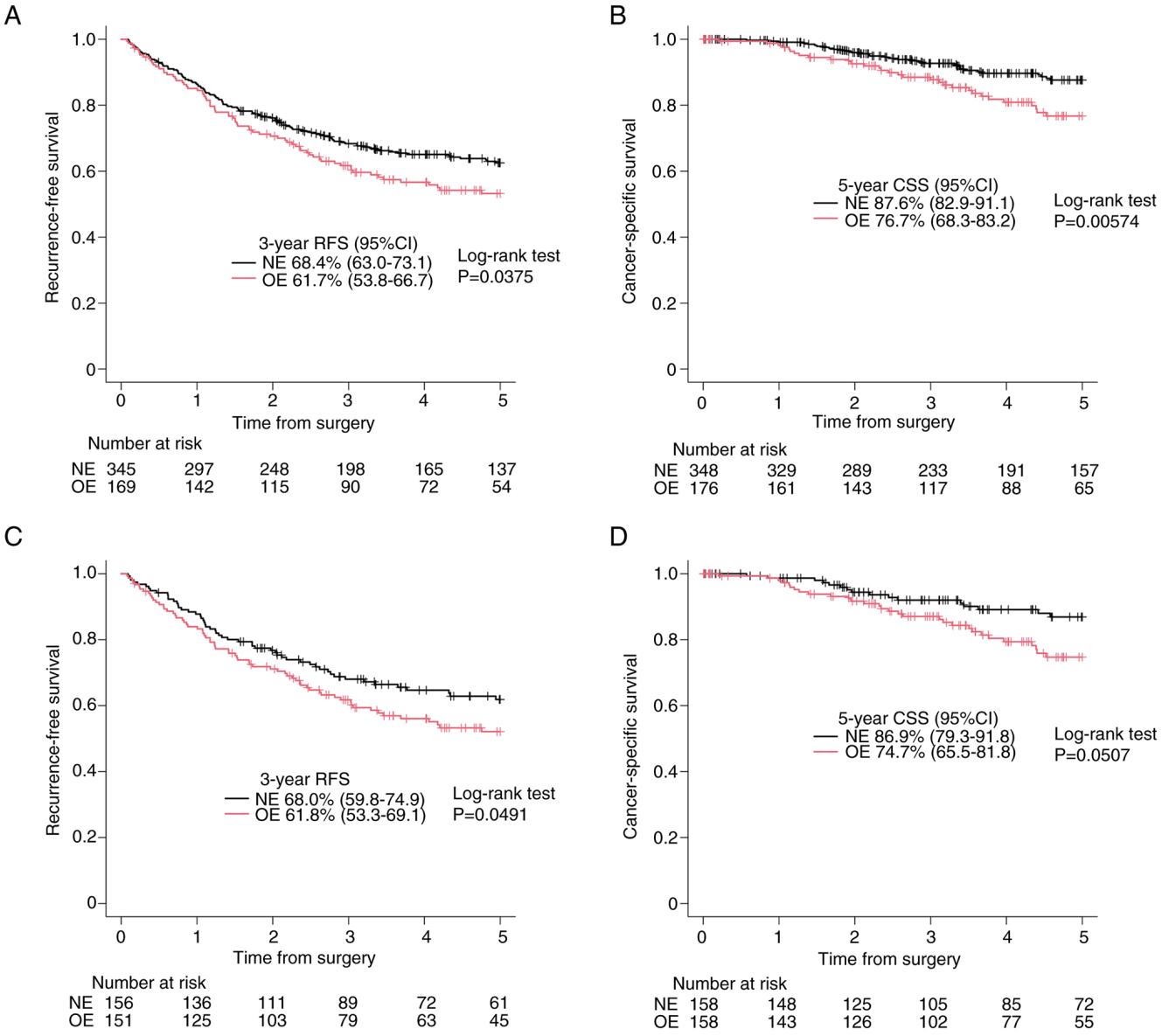

Figure 2. Kaplan-Meier curves of oncological NE and OE in the overall cohort. (A) RFS before matching. (B) CSS before matching. (C) RFS after matching. (D) CSS after matching. NE, non-emergency; OE, oncological emergency; RFS, recurrence-free survival; CSS, cancer-specific survival.

worse than those in patients with NE, and patients with obstruction and perforation had comparable outcomes after PSM. Local recurrence in the perforation group and peritoneal recurrence in the perforation group were more common than those in the NE group. Further, adjuvant chemotherapy improved the RFS in patients with OE, particularly in pathological stage II.

Previous retrospective reports have presented long-term outcomes of CRC with OE (6-8,10-13). Obstruction and perforation were related to poor survival in CRC in unmatched design studies (7,8), and those with OE (perforation) had comparable prognoses with those without OE (11). These reports in the existing literature offer conflicting evidence on the long-term outcomes using unmatched cohorts. Ogawa *et al* (10) found by matching 56 patients with OE with those with NE that those with OE had a poorer prognosis for survival than those without OE. The present study, which matched a larger number of 176 patients with OE than that in the previous report, further strengthens the evidence for the long-term prognosis of OE.

Previous studies implied that patients with perforation had a poorer prognosis than those with obstruction (10,12,13). However, these were retrospective studies with selection bias due to the unmatched design of the obstruction and perforation groups, and these studies included patients with distant metastasis. In this study, we used PSM to match obstruction and perforation cases and exclude patients with distant metastasis. The perforation group included patients with poorer ASA and more T4 cases than the obstruction group. Once the background differences are eliminated by PSM, the prognosis of obstruction was not significantly different from that of perforation, which is not in line with previous findings (10,12,13). To the best of our knowledge, no previous study has compared the long-term outcomes of obstruction and perforation using PSM. Although this discrepancy may be related to the relatively small number of cases in the matched

Table II. Patient characteristics and outcomes in the oncologic emergency cohort.

		Before matching (n=176)				After matching (n=54)			
Variables	Group	Obstruction (n=140)	Perforation (n=36)	P-value	SMD	Obstruction (n=27)	Perforation (n=27)	P-value	SMD
Age (years), median (range)		71.5 (39-93)	73 (31-93)	0.228	0.186	76 (54-92)	73 (53-93)	0.634	0.100
Sex, n (%)	Male	79 (56.4)	16 (44.4)	0.261	0.241	12 (44.4)	12 (44.4)	1.000	<0.001
	Female	61 (43.6)	20 (55.6)			15 (55.6)	15 (55.6)		
BMI (kg/m^2), median (range)		21.4 (14.0-39.8)	21.1 (13.1-32.6)	0.803	0.047	20.7 (15.4-29.1)	20.3 (13.1-28.8)	0.517	0.126
ASA-PS, n (%)	ASA-I, II	104 (74.3)	11 (30.6)	<0.001	0.974	12 (44.4)	11 (40.7)	1.000	0.075
	ASA-III, IV	36 (25.7)	25 (69.4)			15 (55.6)	16 (59.3)		
Tumor location, n (%)	Colon	124 (88.6)	28 (77.8)	0.105	0.292	22 (81.5)	23 (85.2)	1.000	0.100
	Rectum	16 (11.4)	8 (22.2)			5 (18.5)	4 (14.8)		
Clinical T factor, n (%)	cT4	40 (28.6)	21 (58.3)	0.001	0.629	14 (51.9)	13 (48.1)	1.000	0.074
	cT2, 3	100 (71.4)	15 (41.7)			13 (48.1)	14 (51.9)		
Clinical N factor, n (%)	Positive	79 (56.4)	19 (52.8)	0.711	0.073	15 (55.6)	14 (51.9)	1.000	0.074
	Negative	61 (43.6)	17 (47.2)			12 (44.4)	13 (48.1)		
Approach, n (%)	Laparotomy	4 (2.9)	12 (33.3)	<0.001		0 (0)	9 (33.3)	<0.001	
	Laparoscopy	134 (95.7)	21 (58.3)			26 (96.3)	16 (59.3)		
	Conversion	2 (1.4)	3 (8.3)			1 (3.7)	2 (7.4)		
Primary anastomosis, n (%)		125 (89.3)	13 (36.1)	<0.001		20 (74.1)	10 (37.0)	0.013	
D3 lymph node dissection, n (%)		135 (96.4)	30 (83.3)	0.010		25 (92.6)	22 (81.5)	0.420	
Postoperative major complication (CD≥III), n (%)		10 (7.1)	5 (13.9)	1.000		1 (3.7)	3 (11.1)	0.610	
In-hospital mortality		2 (1.4)	5 (13.9)	0.036		1 (3.7)	5 (18.5)	0.191	
Postoperative hospital stay (days), median (range)		8 (5-70)	20 (7-71)	<0.001		11 (6-69)	19.5 (7-44)	0.002	
Pathological T factor, n (%)	pT3	118 (84.3)	21 (58.3)	<0.001		19 (70.4)	17 (63.0)	0.192	
	pT4a	17 (12.1)	5 (13.9)			6 (22.2)	3 (11.1)		
	pT4b	5 (3.6)	10 (27.8)			2 (7.4)	7 (25.9)		
Pathological N factor, n (%)	pN0	71 (50.7)	23 (63.9)	0.360		13 (48.1)	18 (66.7)	0.073	
	pN1	47 (33.6)	10 (27.8)			9 (33.3)	9 (33.3)		
	pN2	22 (15.7)	3 (8.3)			5 (18.5)	0 (0)		
Pathological stage, n (%)	IIA	64 (45.7)	13 (36.1)	<0.001		10 (37.0)	11 (40.7)	0.474	
	IIB	5 (3.6)	2 (5.6)			2 (7.4)	2 (7.4)		
	IIC	2 (1.4)	8 (22.2)			1 (3.7)	5 (18.5)		

Table II. Continued.

Variables	Group	Before matching (n=176) Obstruction (n=140)	Perforation (n=36)	P-value	SMD	After matching (n=54) Obstruction (n=27)	Perforation (n=27)	P-value	SMD
	IIIB	54 (38.6)	10 (27.8)			10 (37.0)	7 (25.9)		
	IIIC	15 (10.7)	3 (8.3)			4 (14.8)	2 (7.4)		
Lymphatic invasion, n (%)		135 (96.4)	34 (94.4)	0.633		26 (96.3)	25 (92.6)	1.000	
Vascular invasion, n (%)		110 (78.6)	35 (97.2)	0.006		19 (70.4)	26 (96.3)	0.024	
Resectability, n (%)	Positive	2 (1.4)	5 (13.9)	0.004		2 (7.4)	4 (14.8)	0.669	
Adjuvant chemotherapy, n (%)		82 (58.6)	19 (52.8)	0.574		11 (40.7)	13 (48.1)	0.785	
Interval from operation to adjuvant chemotherapy (days), median (range)		35 (15-163)	40 (20-78)	0.133		29 (20-46)	36 (20-78)	0.065	
Follow-up period (months), median (range)		51.0 (0.1-113.8)	35.6 (0.03-100.0)	0.007		37.4 (0.95-87.4)	40.7 (0.03-100.0)	0.604	

SMD, standardized mean differences; ASA-PS, American Society of Anesthesiologists physical status.

Table III. Recurrence rates and types in the overall cohort.

Recurrence types	Non-emergency (n=348), n (%)	Obstruction (n=140), n (%)	Perforation (n=36), n (%)	P-value (non-emergency vs. obstruction)	P-value (non-emergency vs. perforation)	P-value (obstruction vs. perforation)
Total recurrence[a]	70 (20.1)	39 (27.9)	15 (41.7)	0.215	0.016	0.465
Local recurrence	13 (3.7)	5 (3.6)	8 (22.2)	1.000	<0.001	0.003
Liver metastasis	24 (6.9)	10 (7.1)	6 (16.7)	1.000	0.150	0.300
Lung metastasis	32 (9.2)	9 (6.4)	4 (11.1)	1.000	1.000	0.920
Peritoneal dissemination	8 (2.3)	12 (8.6)	4 (11.1)	0.011	0.056	1.000

[a]There is some duplication.

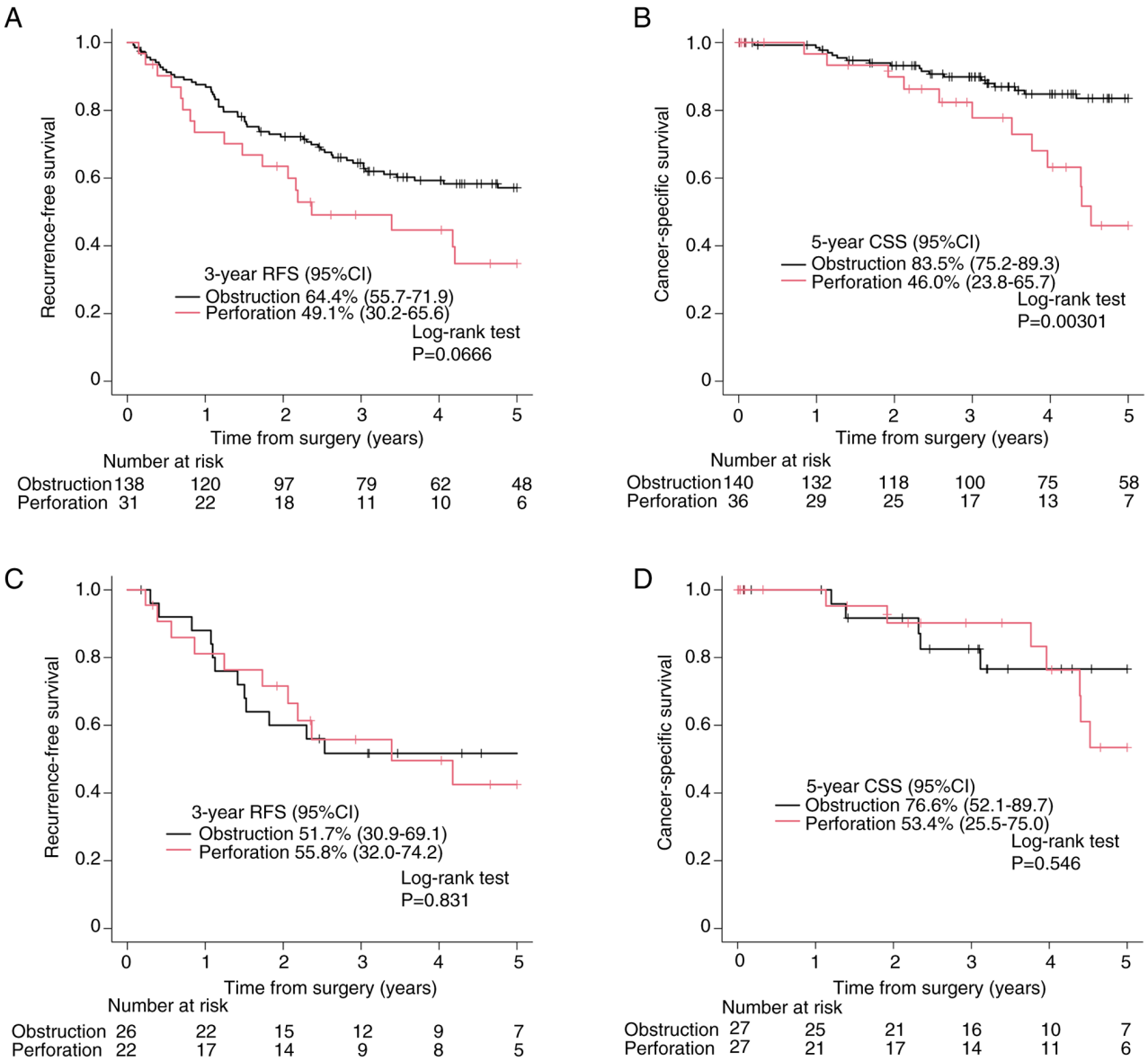

Figure 3. Kaplan-Meier curves of obstruction and perforation in the oncological emergency cohort. (A) RFS before matching. (B) CSS before matching. (C) RFS after matching. (D) CSS after matching. RFS, recurrence-free survival; CSS, cancer-specific survival.

cohort, obstruction should be regarded as a poor prognostic factor similar to perforation based on our results. This finding should be verified in a larger study.

The outcome for patients with bowel obstruction due to CRC is worse than that for those without obstruction because of the high likelihood of local invasion and metastasis to

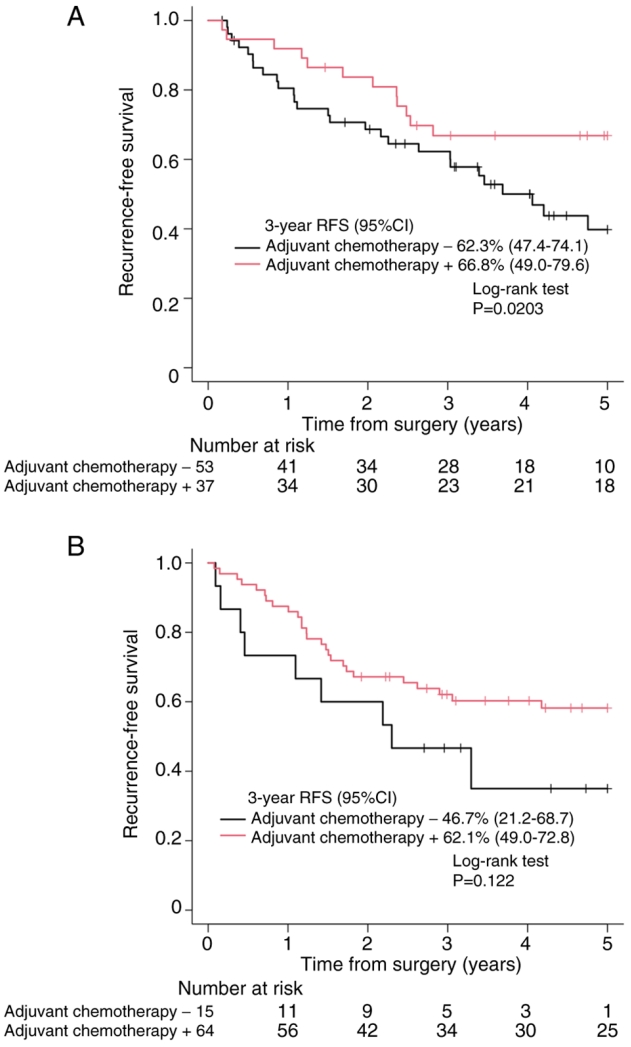

Figure 4. Kaplan-Meier curves of patients with and without adjuvant chemotherapy in the oncological emergency cohort. (A) RFS in pathological stage II. (B) RFS in pathological stage III. RFS, recurrence-free survival.

lymph nodes and other areas (7). In this study, recurrence of peritoneal dissemination was more common in patients with obstruction than in those without OE. A previous study reported that the peritoneum was the most frequent site of recurrence in obstructive CRC cases, particularly in patients undergoing SEMS (22). Regarding the obstruction group in this study, although peritoneal dissemination in patients with SEMS was somewhat higher than that in those without SEMS (9.6% vs. 7.5%, P=0.767), the long-term outcomes were not worse. Ueki *et al* (23) found that patients with obstructive cancer who underwent a bridge to surgery (BTS) using SEMS had similar outcomes comparable to those who underwent elective surgery without SEMS in the long term. In our previous report, the long-term oncological outcome of SEMS was better than that of transanal decompression tube (24). The European Society of Gastrointestinal Endoscopy guidelines currently suggest stenting as BTS for potentially curable left-sided obstructive colon cancer as an alternative to emergency resection (25). Although the long-term outcomes of BTS using SEMS remain controversial, these considerations suggest that other factors should be investigated to improve the prognosis of obstructive CRC, rather than the presence or absence of SEMS.

Perforation in CRC is a poor prognostic factor owing to cancer progression and fatal septic complications that accompany it (26). Tumor perforation promotes the spread of cancer cells, thereby increasing recurrence and decreasing survival (27). In the present study, postoperative complications and in-hospital mortality were higher in the perforation group than in the other groups, although not statistically significant. However, the prognosis of patients with obstruction and perforation did not significantly differ in the matched cohort, excluding cases with in-hospital mortality. Regarding the perforation types, local recurrence was common in the perforation group. Although no significant difference was observed, peritoneal dissemination was higher. If the tumor perforates freely, the cancer cells disseminate into the peritoneal cavity. If the tumor forms an abscess owing to a contained perforation, the abscess wall may persist after surgery, causing local recurrence. Consequently, the oncological outcomes of patients with perforations are poor.

The indications of postoperative adjuvant chemotherapy, particularly in stage I CRC, differ depending on the international guidelines (14-16). Regarding OE, although obstruction is listed as an indication of adjuvant chemotherapy in the European Society for Medical Oncology guideline (15), it is not listed in other guidelines (14,16). In this study, adjuvant chemotherapy improved RFS in OE patients, particularly in pathological stage II. However, in this cohort, ~40% of stage II OE patients received adjuvant chemotherapy, compared with ~80% of stage III patients. Furthermore, adjuvant chemotherapy was administered more often in the perforation group than in the obstruction group in the matched cohort, though without a significant difference. These results indicate that increasing the rate of adjuvant chemotherapy in both obstruction and perforation may improve the prognosis. A previous study reported that adjuvant chemotherapy improved prognosis in obstructive stage II colon cancer (28). However, the high incidence of postoperative complications, especially perforation, could delay the initiation of adjuvant chemotherapy for OE cases. To increase the administration of chemotherapy, neoadjuvant chemotherapy must also be considered. Recently, treatment strategies involving neoadjuvant chemotherapy have been reported for obstructive and perforated CRC (29,30). These issues should be addressed in future research.

This study has some limitations. Initially, we gathered data from a single-center surgical database and medical records retrospectively. Therefore, PSM was conducted due to the considerable differences in patient backgrounds among the three groups. As per a previous report, SMD <0.1 indicates an adequate balance of variables (31). However, the method is difficult to apply to small sample sizes, as was the case for our matched cohort. In such cases, SMD is occasionally set to <0.2 (32). Therefore, the SMD was set to <0.2. Second, the sample size might have been inadequate for examining each variable related to the outcomes. Third, the interpretation of the long-term results may be unreliable because the follow-up period in the perforation group was relatively shorter than that in the other groups. Multicenter studies with larger sample sizes can provide more data without prejudice and make statistical analyses more dependable. Despite these limitations,

our results contribute to determining perioperative adjuvant chemotherapy for OE cases.

In conclusion, our results showed that the long-term outcomes were worse in the OE group than in the NE group, and those in the obstruction group were comparable to those in the perforation group. Administration of adjuvant chemotherapy should be considered for OE. Establishing optimal perioperative adjuvant chemotherapy is an important goal for future research.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

KIm, HK, KS, KIc, AS, DY, YT, MU, MK and KN developed the concept and design of the study. KIm, HK, KS, KIc and AS gathered clinicopathological data. KIm composed the manuscript and conducted the statistical analyses. HK, KS, KIc, AS, DY, YT, MU, MK and KN analyzed the results and revised the manuscript. KN oversaw the study. All authors have read and approved the final manuscript and consented to its submission to the journal. KIm and HK confirm the authenticity of all the raw data.

Ethics approval and consent to participate

This study was approved by the Human Research Ethics Committee of Hakodate Municipal Hospital (Hokkaido, Japan; approval no. 2022-229). Furthermore, the study was conducted in accordance with the tenets of the 1964 Declaration of Helsinki and its later amendments. All patients gave their consent to participate through the opt-out method.

Patient consent for publication

All patients provided consent for publication through the opt-out method.

Competing interests

The authors declare that they have no competing interests.

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