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Analysis of Short-Term Results for Gastric Cancer Surgery in Dialysis Patients: A Single-Center Study in Japan

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Abstract

Purpose: Dialysis patients undergoing gastrointestinal surgery experience many intraoperative and postoperative complications. We examined short-term surgical results of dialysis patients undergoing gastric cancer surgery.

Methods: We targeted 22 dialysis patients and 36 nondialysis patients undergoing gastric cancer surgery. We retrospectively examined clinical data, postoperative complications, and short-term results.

Results: There were no significant differences in postoperative complications or short-term results in the dialysis group compared with the nondialysis group. In patients undergoing laparoscopic surgery only (11 dialysis group, 19 nondialysis group), no significant difference was found in postoperative complications or short-term results. We evaluated the correlation between complications of Clavien–Dindo classification class 2 or higher and clinicopathological features of 22 dialysis patients. Odds ratios (ORs) showed that a C-reactive protein level ≥2.34 was significantly associated with complications of Clavien–Dindo class 2 or higher (univariate OR, 18.667; 95% confidence interval (CI), 1.5–23.229; $p = .0098$, multivariate OR, 12.663; 95% CI, 1.772–23.755; $p = .0063$).

Conclusions: Nondialysis and dialysis patients undergoing gastric cancer surgery had similar complications and short-term postoperative results, suggesting that endoscopic surgery can be performed safely. However, patients with a high preoperative C-reactive protein level need to be aware of the risk of postoperative complications.

Keywords: Gastric Cancer, Dialysis Patients, Perioperative Complications.

Abbreviations: BMI: Body Mass Index; **BNP:** Brain Natriuretic Peptide; **CRP**: C-Reactive Protein; **ALB**: Albumin; **PNI**: Prognostic nutritional index; **NLR**: Neutrophile Lymphocyte Ratio; **PLR**: Platelet Lymphocyte Ratio; **LMR**: Lymphocyte Monocyte Ratio; **CD:** Clavien Dindo; **SD:** Standard Deviation; **OR:** Odds Ratio; **CI:** Confidence Interval

Introduction

In Japan, the population of patients on dialysis continues to increase annually, exceeding 330,000 in the 2019 report [1]. In addition, advances in dialysis technology have extended the life expectancy of patients with chronic renal failure, and dialysis patients are more likely to develop malignant tumors such as gastrointestinal cancer than healthy patients are. It is expected that the number of operations for malignant tumors will increase in dialysis patients. However, it is expected that dialysis patients will experience many intraoperative and postoperative complications because of myriad problems such as hemodynamic instability, susceptibility to infection, and tissue fragility [2,3]. Delayed postoperative wound healing in dialysis patients is particularly troublesome [4-6]. In addition to these surgical complications, patients on dialysis require more rigorous weight and fluid management during the perioperative period. Thus, there is a need for a careful perioperative plan, especially focusing on dialysis timing for several days after surgery, but there remains no consensus. Because about 60% of surgical patients are dialysis patients in our hospital, we are planning various surgical operations for dialysis patients in cooperation with physicians. In this report, we examined the short-term surgical results of dialysis patients who underwent gastric cancer surgery at our hospital and clarified the problems. Furthermore, in recent years, there has been an increase in laparoscopic surgery, and it is now actively performed on dialysis patients. However, there are still very few reports of laparoscopic gastrectomy for dialysis patients, and there is no consensus regarding the type of patients who are candidates and attention to be paid during the perioperative period. In consideration of tissue fragility and delayed postoperative wound healing, we are actively introducing laparoscopic gastrectomy for some locally advanced gastric cancer. In this study, we examined cases of laparoscopic gastrectomy for dialysis patients at our hospital.

Materials and Methods

Patient Selection

This retrospective study included 58 consecutive patients who underwent gastrectomy for gastric cancer between January 2015 and December 2020 at the Japan Community Health Care Organization Sendai Hospital in Miyagi, Japan. Of these patients, 22 were on dialysis. The clinical and pathological findings of these 58 patients were retrieved from the medical records and compared between the group of 22 dialysis and the group of 36 nondialysis patients. Furthermore, we extracted 30 patients who underwent laparoscopic gastrectomy from and divided them into a group of 11 dialysis patients (distal gastrectomy = 5 cases, total gastrectomy = 6 cases) and a group of 19 nondialysis patients (distal gastrectomy = 13 cases, cardia gastrectomy = 3 cases, total gastrectomy = 3 cases) for comparison.

Clinical and Pathological Parameters

Clinical parameters included age, gender, history, history of oral anticoagulants, cardiac function, body mass index (BMI), surgical procedure, operation time, bleeding volume, degree of lymph node dissection, reconstruction method, and blood transfusion. Preoperative blood-sampling test items examined carcinoembryonic antigen, carbohydrate antigen 19-9, brain natriuretic peptide (BNP), C-reactive protein (CRP), albumin (ALB), leukocytes, prognostic nutritional index (PNI), neutrophil–lymphocyte ratio (NLR), platelet–lymphocyte ratio (PLR), and lymphocyte–monocyte ratio (LMR). Histopathological findings were examined for depth of invasion, lymphovascular invasion, and lymph node metastasis. Postoperative evaluation included the day oral intake was started, length of postoperative hospital stay, and the presence of recurrence. Perioperative complications were evaluated according to the Clavien–Dindo (CD) classification. Based on the above data, we first divided all cases into two groups, a dialysis patient group and a nondialysis patient group, and compared them. Next, we limited the subjects to those who underwent laparoscopic surgery and similarly divided them into the same two groups and compared them. Finally, dialysis patients were divided into a complication group of CD classification class 2 or higher and a noncomplication group regardless of the surgical method, and the risk factors for complications were examined. The study and all described procedures were conducted in accordance with the Helsinki Declaration, and the study protocol was approved by the Ethics Committee of Japan Community Health Care Organization Sendai Hospital (2021-1).

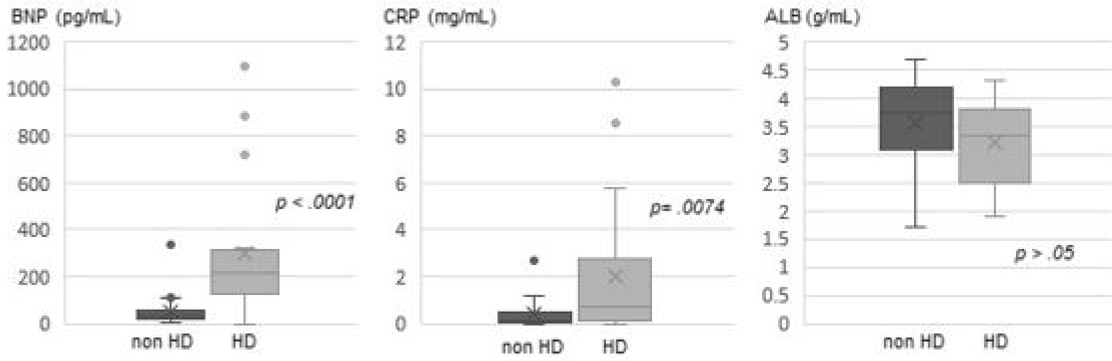
Statistical Analysis

Data were expressed as mean ± standard deviation (SD) as appropriate. Statistically significant differences were determined using Student's *t* test for normally distributed data, Wilcoxon's signed-rank tests for skewed data, and Fisher's exact or the chi-squared test for dichotomous data. To predict the risk of complications in dialysis patients, we used logistic regression analysis for the multivariate analysis. We used odds ratios (ORs) from the univariate and multivariate logistic regression to estimate the relative risk of complications in dialysis patients. Based on the univariate analysis, the ORs were adjusted for potential confounding variables, and 95% confidence intervals (CIs) were calculated. We analyzed these based on the cutoff value calculated by the receiver-operating characteristic (ROC) curve for each factor. All analyses were performed using JMP Pro 15 statistical software (SAS Institute, Cary, NC). A p value of less than 0.05 was considered to indicate statistical significance.

Results

Overall Comparison of Dialysis and Nondialysis Patient Groups

Table 1 summarizes the clinical and pathological features of all 58 patients included in the study. Briefly, there was no significant difference in patient background between the two groups, and, except for venous invasion, no significant difference in histopathological findings was observed. In addition to BNP (295.7 ± 294.5 pg/mL [mean ± SD]; $p < .0001$), the dialysis patient group had significantly higher CRP levels (1.97 ± 2.83 mg/dL; $p = .0074$) and significantly lower PNI (38.3 ± 8.3; $p = .046$) and LMR (3.15 ± 1.12; $p = .008$). The differences in BNP, CRP and ALB between the two groups are shown in Figure 1 using box plot. Complications of CD classification ≥2 were observed in each group, with a frequency of about 22%.



HD: Hemodialysis; BNP: brain natriuretic peptide; CRP: C-reactive protein; Cr: Creatinine; ALB, albumin

Figure 1: Comparison between the two groups of overall dialysis patients and non-dialysis patients by the boxplot

Table 1: Overall comparison of dialysis and non-dialysis patient groups

	HD n=22	non HD n=36	*p*
Age (Mean ±SD; y)	70.1 ± 8.0	72.4 ± 8.5	*0.305*
Sex (M/F)	14/8	23/13	*0.985*
DM	9 (40.9%)	13 (36.1%)	*0.784*
HT	18 (81.8%)	24 (66.7%)	*0.243*
HL	9 (40.9%)	13 (36.1%)	*0.784*
Anticoagulant	8 (36.4%)	6 (16.7%)	*0.118*
EF (Mean ±SD; %)	70.5 ± 10.5	69.6 ± 7.6	*0.344*
BMI (Mean ±SD)	21.6 ± 3.6	23.5 ± 4.3	*0.124*

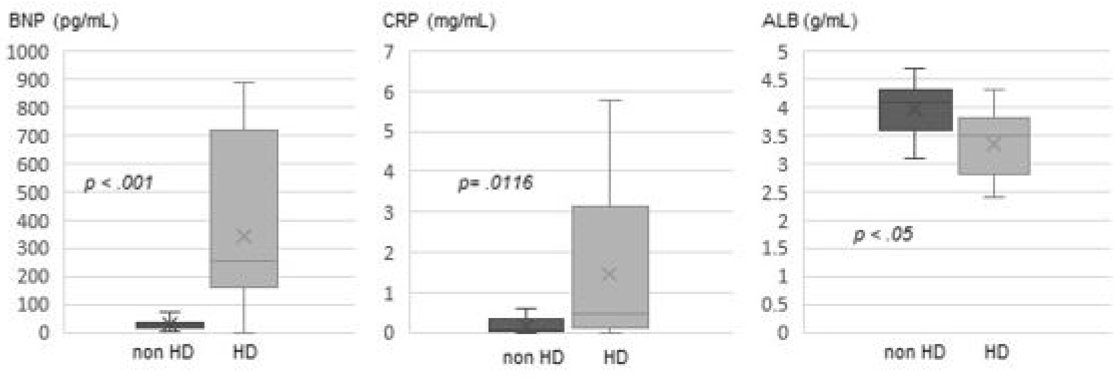
Procedure of gastrectomy			
Distal gastrectomy	13 (59.1%)	21 (58.3%)	*0.955*
Proximal gastrectomy	0 (0%)	3 (8.3%)	*0.164*
Total gastrectomy	9 (40.9%)	12 (33.3%)	*0.585*
Laparoscopy	11 (50%)	19 (52.8%)	*0.837*
Operative time (Mean ±SD; minutes)	232.5 ± 73.9	222.2 ± 59.6	*0.779*
Bleeding volume (Mean ±SD; mL)	180.4 ± 257.0	187.2 ± 208.4	*0.671*
Lymph node dissection			
D1	8 (36.4%)	7 (19.4%)	*0.153*
D1+	9 (40.9%)	13 (36.1%)	*0.784*
D2	5 (22.7%)	16 (44.4%)	*0.159*
Reconstruction			
B1	3 (13.6%)	12 (33.3%)	*0.0965*
B2	3 (13.6%)	6 (16.7%)	*0.757*
R-Y	16 (72.7%)	18 (50%)	*0.0882*
Perioperative blood transfusion	2 (9.1%)	1 (2.8%)	*0.551*
Invasion depth			
T1	14 (63.6%)	16 (44.4%)	*0.156*
T2	2 (9.1%)	2 (5.6%)	*0.606*
T3	1 (4.6%)	6 (16.7%)	*0.169*
T4	5 (22.7%)	12 (33.3%)	*0.389*
Lymph node metastasis	6 (27.3%)	14 (38.9%)	*0.367*
v+	9 (40.9%)	25 (69.4%)	*0.0323*
ly+	13 (59.1%)	25 (69.4%)	*0.421*
CEA (Mean ±SD; U/mL)	3.6 ± 1.6	2.9 ± 0.4	*0.248*
CA19-9 (Mean ±SD; U/mL)	22.2 ± 25.1	31.8 ± 38.2	*0.32*
BNP (Mean ±SD; pg/mL)	295.7 ± 294.5	48.7 ± 56.9	< *.0001*
CRP (Mean ±SD; mg/dL)	1.97 ± 2.83	0.40 ± 0.64	*0.0074*

ALB (Mean ±SD; g/dL)	3.21 ± 0.74	3.58 ± 0.73	*0.0662*
WBC (Mean ±SD; /μL)	6679 ± 2615	6791 ± 2454	*0.522*
PNI (Mean ±SD)	38.3 ± 8.3	43.4 ± 7.8	*0.046*
NLR (Mean ±SD)	4.16 ± 2.38	3.86 ± 3.18	*0.259*
PLR (Mean ±SD)	196.5 ± 107.6	192.1 ± 112.3	*0.904*
LMR (Mean ±SD)	3.15 ± 1.12	4.60 ± 2.21	*0.008*
Postoperative starting solid diet (Mean ±SD; days)	3.2 ± 2.3	4.2 ± 8.7	*0.297*
Postoperative length of stay (Mean ±SD; days)	27.8 ± 24.1	24.7 ± 11.8	*0.324*
Postoperative complications (CD≧III))	2 (9.1%)	2 (5.6%)	*0.63*
Postoperative complications (CD≧II))	5 (22.7%)	8 (22.2%)	*0.964*

HD: Hemodialysis; SD: Standard Deviation; y: Years; M: Male; F: Female; DM: Diabetes Mellitus; HT: Hypertension; HL: Hyperlipemia; EF: Ejection Fraction; BMI: Body Mass Index; B1: Billroth I; B2: Billroth II; R-Y, Roux-en-Y; VI: venous invasion; LY: Lymphatic Invasion; CEA: carcinoembryonic antigen; CA19-9: carbohydrate antigen 19-9; BNP: brain natriuretic peptide; CRP: C-reactive protein; ALB: Albumin; WBC: white blood cell; PNI: prognostic nutritional index; NLR: neutrophil to lymphocyte ratio; PLR: platelet to lymphocyte ratio; LMR: lymphocyte to monocyte ratio; CD: Clavien–Dindo classification

Comparison of Dialysis and Nondialysis Patient Groups Limited to Cases of Laparoscopic Surgery

Table 2 summarizes the comparison of patients who underwent laparoscopic surgery, divided into the dialysis group and nondialysis group. In terms of patient background, hypertension was observed in ≥90% of the dialysis group, whereas the nondialysis group had a significantly higher BMI ($p = .015$). Regarding surgical procedure, total gastrectomy was significantly more frequent in the dialysis group. Blood data showed that the dialysis group had an average of ≥3 g/dL albumin but significantly lower (3.34 ± 0.62 g/dL; $p = .0096$) than that of the nondialysis group; therefore, PNI was also significantly lower (40.4 ± 6.1; $p = .0179$). The differences in BNP, CRP and ALB between the two groups are shown in Figure 2 using box plot.



HD, hemodialysis; BNP, brain natriuretic peptide; CRP, C-reactive protein; Cr, creatinine; ALB, albumin

Figure 2: Comparison between the two groups of dialysis patients and non-dialysis patients limited to cases of laparoscopic surgery by the boxplot

Table 2: Comparison of dialysis and non-dialysis patient groups limited to cases of laparoscopic surgery

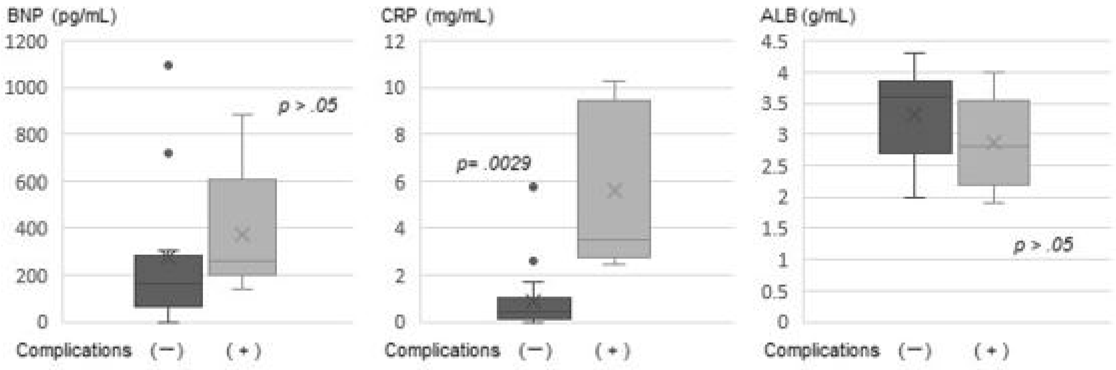
	HD n=11	non HD n=19	*p*
Age (Mean ±SD; y)	69.8 ± 7.5	71.9 ± 9.6	*0.389*
Sex (M/F)	5/6	10/9	*0.705*
DM	3 (27.3%)	5 (26.3%)	*0.955*
HT	10 (90.9%)	10 (52.6%)	*0.0321*
HL	4 (36.4%)	6 (31.6%)	*0.789*
Anticoagulant	3 (27.3%)	3 (15.8%)	*0.449*
EF (Mean ±SD; %)	73.7 ± 5.8	70.3 ± 5.8	*0.155*
BMI (Mean ±SD)	20.2 ± 3.9	24.8 ± 4.6	*0.015*
Procedure of gastrectomy			
Distal gastrectomy	5 (45.5%)	13 (68.4%)	*0.216*
Proximal gastrectomy	0 (0%)	3 (15.8%)	*0.165*
Total gastrectomy	6 (54.6%)	3 (15.8%)	*0.0256*
Operative time (Mean ±SD; minutes)	258.6 ± 44.0	246.1 ± 50.8	*0.636*
Bleeding volume (Mean ±SD; mL)	116.1 ± 154.2	99.6 ± 179.5	*0.682*
Lymph node dissection			
D1	4 (36.4%)	4 (21.1%)	*0.361*
D1+	5 (45.5%)	10 (52.6%)	*0.705*
D2	2 (18.2%)	5 (26.3%)	*0.612*
Reconstruction			
B1	1 (9.1%)	11 (57.9%)	*0.0086*
R-Y	10 (90.9%)	8 (42.1%)	*0.0086*
Perioperative blood transfusion	2 (18.2%)	0 (0%)	*0.0544*
Invasion depth			
T1	8 (72.7%)	13 (68.4%)	*0.804*
T2	1 (9.1%)	1 (5.3%)	*0.686*
T3	1 (9.1%)	3 (15.8%)	*0.603*

T4	1 (9.1%)	2 (10.5%)	*0.9*
Lymph node metastasis	2 (18.2%)	1 (5.3%)	*0.256*
v+	3 (27.3%)	10 (52.6%)	*0.177*
ly+	6 (54.6%)	9 (47.4%)	*0.705*
CEA (Mean ±SD; U/mL)	3.89 ± 2.03	2.49 ± 1.67	*0.0407*
CA19-9 (Mean ±SD; U/mL)	20.7 ± 25.6	27.2 ± 36.3	*0.505*
BNP (Mean ±SD; pg/mL)	345.1 ± 292.6	28.6 ± 18.0	*0.0003*
CRP (Mean ±SD; mg/dL)	1.45 ± 1.90	0.16 ± 0.20	*0.0116*
ALB (Mean ±SD; g/dL)	3.34 ± 0.62	3.97 ± 0.49	*0.0096*
WBC (Mean ±SD; /μL)	6234 ± 2239	6544 ± 1789	*0.491*
PNI (Mean ±SD)	40.4 ± 6.1	47.4 ± 6.7	*0.0179*
NLR (Mean ±SD)	3.36 ± 2.16	3.86 ± 3.25	*0.606*
PLR (Mean ±SD)	200.5 ± 127.4	190.6 ± 124.0	*0.897*
LMR (Mean ±SD)	3.72 ± 1.14	4.82 ± 2.44	*0.245*
Postoperative starting solid diet (Mean ±SD; days)	3.8 ± 5.5	3.3 ± 8.9	*0.691*
Postoperative length of stay (Mean ±SD; days)	24.5 ± 21.4	22.4 ± 12.0	*0.567*
Postoperative complications (CD≧III)	2 (18.2%)	0 (0%)	*0.0544*
Postoperative complications (CD≧II)	2 (18.2%)	4 (21.1%)	*0.85*

HD, hemodialysis; SD, standard deviation; y, years; M, male; F, female; DM, diabetes mellitus; HT, hypertension; HL, hyperlipemia; EF, ejection fraction; BMI, body mass index; B1, Billroth I; R-Y, Roux-en-Y; v, venous invasion; ly, lymphatic invasion; CEA, carcinoembryonic antigen; CA19-9, carbohydrate antigen 19-9; BNP, brain natriuretic peptide; CRP, C-reactive protein; ALB, albumin; WBC, white blood cell; PNI, prognostic nutritional index; NLR, neutrophil to lymphocyte ratio; PLR, platelet to lymphocyte ratio; LMR, lymphocyte to monocyte ratio; CD, Clavien–Dindo classification

Comparison Between Patients with CD Classification Class ≥2 and Patients without Complications Limited to Dialysis Patients

The data are shown in Table 3. There was a significant difference in preoperative CRP (5.58 ± 3.58 mg/dL vs 0.91 ± 1.44 mg/dL; p = .0029). The differences in BNP, CRP and ALB between the two groups are shown in Figure 3 using box plot. The rate of D2 dissection was significantly higher in the group with complications (60% vs 11.8%; p = .0237). With regard to the postoperative course, there was a significant difference in the start time of oral intake, but there was no significant difference in the length of hospital stay after surgery.



BNP, brain natriuretic peptide; CRP, C-reactive protein; Cr, creatinine; ALB, albumin

Figure 3: Comparison between group with Clavien–Dindo classification class 2 or higher and non-complication group limited to dialysis patients by the boxplot

Table 3: Comparison between group with Clavien–Dindo classification class 2 or higher and non-complication group limited to dialysis patients

	Complications (+) n=5	Complications (−) n=17	*p*
Dialysis history (Mean ±SD; days)	1125.4 ± 1044.7	2543.5 ± 3247.7	*0.433*
Age (Mean ±SD; y)	67.0 ± 9.7	71.0 ± 7.6	*0.556*
Sex (M/F)	4/1	10/7	*0.387*
DM	2 (40%)	7 (41.2%)	*0.963*
HT	5 (100%)	13 (76.5%)	*0.231*
HL	3 (60%)	6 (35.3%)	*0.323*
Anticoagulant	1 (20%)	7 (41.2%)	*0.387*
EF (Mean ±SD; %)	72.6 ± 4.8	69.8 ± 11.7	*0.969*
BMI (Mean ±SD)	21.7 ± 5.1	21.6 ± 3.3	*1*
Procedure of gastrectomy			
Distal gastrectomy	3 (60%)	10 (58.8%)	*0.963*
Proximal gastrectomy	0 (0%)	0 (0%)	—
Total gastrectomy	2 (40%)	7 (41.2%)	*0.963*
Laparoscopy	3 (60%)	8 (47.1%)	*0.611*
Operative time (Mean ±SD; minutes)	265.8 ± 127.8	222.6 ± 51.4	*0.389*

Bleeding volume (Mean ±SD; mL)	281.4 ± 390.6	150.6 ± 210.8	*0.695*
Lymph node dissection			
D1	1 (20%)	7 (41.2%)	*0.387*
D1+	1 (20%)	8 (47.1%)	*0.279*
D2	3 (60%)	2 (11.8%)	*0.0237*
Reconstruction			
B1	0 (0%)	3 (17.7%)	*0.312*
B2	1 (20%)	2 (11.8%)	*0.637*
R-Y	4 (80%)	12 (70.6%)	*0.678*
Perioperative blood transfusion	1 (20%)	1 (5.9%)	*0.334*
Invasion depth			
T1	2 (40%)	12 (70.6%)	*0.211*
T2	1 (20%)	1 (5.9%)	*0.334*
T3	0 (0%)	1 (5.9%)	*0.579*
T4	2 (40%)	3 (17.7%)	*0.294*
Lymph node metastasis	2 (40%)	4 (23.5%)	*0.467*
v+	3 (60%)	6 (35.3%)	*0.323*
ly+	4 (80%)	9 (52.9%)	*0.279*
CEA (Mean ±SD; U/mL)	2.82 ± 0.90	3.83 ± 1.74	*0.308*
CA19-9 (Mean ±SD; U/mL)	16.2 ± 11.4	23.9 ± 27.9	*0.814*
BNP (Mean ±SD; pg/mL)	374.0 ± 294.2	272.7 ± 299.5	*0.21*
CRP (Mean ±SD; mg/dL)	5.58 ± 3.58	0.91 ± 1.44	*0.0029*
Cr (Mean ±SD; mg/dL)	8.95 ± 3.32	6.88 ± 2.00	*0.137*
ALB (Mean ±SD; g/dL)	2.86 ± 0.78	3.32 ± 0.73	*0.272*
WBC (Mean ±SD; /μL)	6104 ± 1732	6848 ± 2845	*0.695*
PNI (Mean ±SD)	35.2 ± 9.2	39.2 ± 8.1	*0.389*

NLR (Mean ±SD)	4.25 ± 2.46	4.14 ± 2.43	*0.876*
PLR (Mean ±SD)	157.7 ± 66.4	207.9 ± 116.2	*0.481*
LMR (Mean ±SD)	3.23 ± 1.56	3.13 ± 1.02	*0.814*
Postoperative starting solid diet (Mean ±SD; days)	8.1 ± 6.8	4.2 ± 1.4	*0.006*
Postoperative length of stay (Mean ±SD; days)	32.9 ± 28.8	26.2 ± 23.0	*0.31*

SD, standard deviation; y, years; M, male; F, female; DM, diabetes mellitus; HT, hypertension; HL, hyperlipemia; EF, ejection fraction; BMI, body mass index; B1, Billroth I; B2, Billroth II; R-Y, Roux-en-Y; v, venous invasion; ly, lymphatic invasion; CEA, carcinoembryonic antigen; CA19-9, carbohydrate antigen 19-9; BNP, brain natriuretic peptide; CRP, C-reactive protein; Cr, creatinine; ALB, albumin; WBC, white blood cell; PNI, prognostic nutritional index; NLR, neutrophil to lymphocyte ratio; PLR, platelet to lymphocyte ratio; LMR, lymphocyte to monocyte ratio

Next, for each factor that showed a significant difference in the univariate analysis, we performed multivariate analysis using the stepwise method. As a result, only high preoperative CRP level was an independent risk factor for complications of CD classification class 2 or higher ($p = 0.0472$). We then evaluated the correlation between complications of CD classification class ≥2 and clinicopathological features of dialysis patients. Based on the curve analysis, we created an ROC curve for CRP and set the cutoff value to 2.34, and as shown in Figure 4, pooled ORs showed that a CRP level ≥2.34 was significantly associated with complications of CD classification class ≥2 (univariate: OR, 18.667; 95% CI, 1.5–23.229; $p = .0098$, multivariate: OR, 12.663; 95% CI, 1.772–23.755; $p = .0063$).

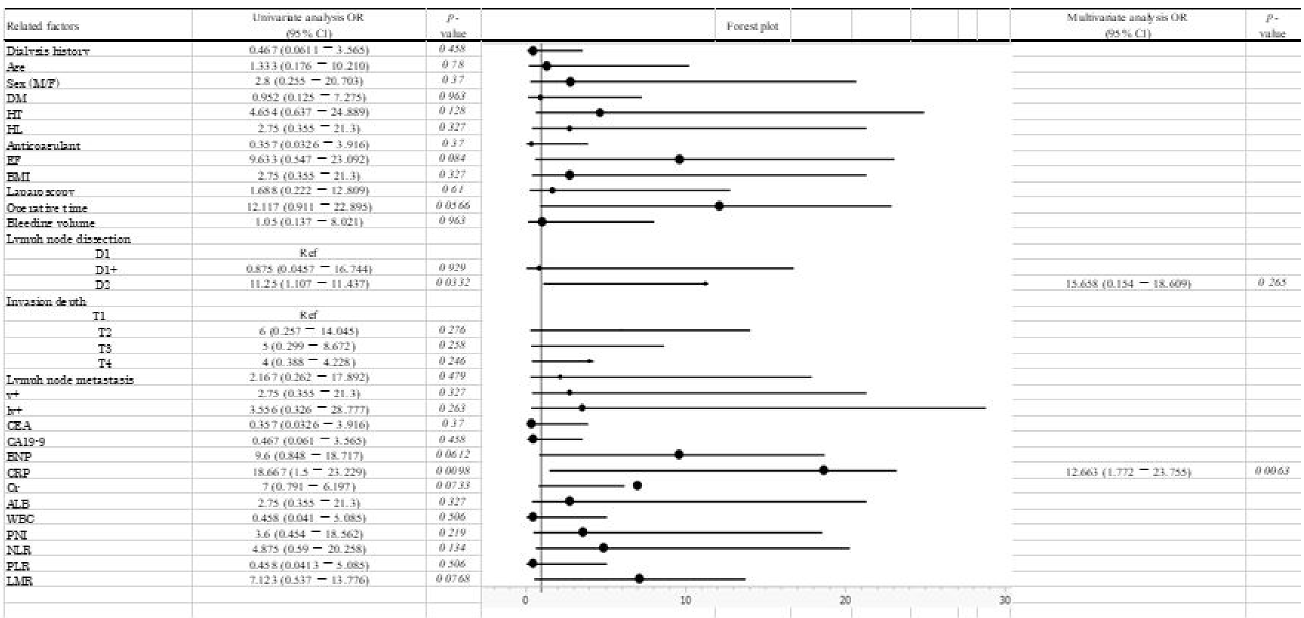


Figure 4: Pooled odds ratios of each risk factor to Clavien–Dindo classification ≥2

OR, odds ratio; CI, confidence interval; M, male; F, female; DM, diabetes mellitus; HT, hypertension; HL, hyperlipemia; EF, ejection fraction; BMI, body mass index; v, venous invasion; ly, lymphatic invasion; CEA, carcinoembryonic antigen; CA19-9, carbohydrate antigen 19-9; BNP, brain natriuretic peptide; CRP, C-reactive protein; Cr, creatinine; ALB, albumin; WBC, white blood cell; PNI, prognostic nutritional index; NLR, neutrophil to lymphocyte ratio; PLR, platelet to lymphocyte ratio; LMR, lymphocyte to monocyte ratio

Discussion

Based on the results presented in Table 1, no significant difference was found in any of the short-term results, such as postoperative course or complication rate, between the dialysis group and the nondialysis group. Although dialysis patients had significantly higher BNP levels, they had chronically higher BNP levels that were not directly linked to cardiac function or postoperative heart-related complications. Next, we limited the cases to laparoscopic surgery and compared them between the dialysis patient group and the nondialysis patient group, but we found no significant difference in the short-term postoperative results. We also compared the two groups in terms of CD classification class ≥2 only in laparoscopic cases, but no significant difference was observed in terms of the presence of dialysis history. From the above results, we considered that dialysis patients can achieve the same results, even if they undergo the same surgery as nondialysis patients, regardless of laparotomy or laparoscopic surgery. In the case of laparoscopic surgery, the operation time was longer in the complication group, so we thought that shortening the operation time, aside from the reconstruction method and degree of dissection, could lead to postoperative results. This point is controversial, as there are few reports of laparoscopic surgery for gastrointestinal cancer, especially gastric cancer, for dialysis patients. However, in a study by Higashino et al. of laparoscopic colorectal cancer surgery for dialysis patients, the authors found no clear significant difference between the dialysis patient group and the nondialysis patient group in terms of short-term postoperative results [7].

We also evaluated the preoperative nutritional status to some extent but found no direct effect on the postoperative course. In their gastric cancer surgery report of dialysis patients, Otani et al. found that PNI was significantly lower in dialysis patients, similar to our results [8]. In their report, the complication rate of CD classification ≥3 was also significantly higher in the dialysis group. It seems that there is no dispute that dialysis patients are poorly nourished and have a high rate of severe complications, but further cases must be accumulated to determine the causal relationship between such preoperative evaluation and the onset of complications. In this study, we also focused on NLR, PLR, and LMR. Generally, these items are associated with the long-term prognosis of gastrointestinal cancer [9-13]. On the other hand, some studies have recently reported that they are also related to short-term prognosis [12]. However, the results of our examination results cannot determine the relationship between these items and the short-term results. It is not clear whether dialysis patients are involved in the reason, but this is one of the subjects of this study. Patients with chronic renal failure have many serious complications, and once they have serious complications, they are at high risk of death [14-18]. It seems that some dialysis patients potentially have a high risk of short-term postoperative results, and to infer what is different from these high-risk cases, we performed the analysis only on dialysis patients. When dividing dialysis patients into two groups based on CD classification, the complication group had a significantly higher rate of D2 dissection and a significantly higher CRP level. All patients in this study were scheduled for surgery, and none had preoperative infections. In general, there are quite a few cases in which CRP is persistently high in long-term dialysis patients, but its medical significance remains unclear. It has been suggested that elevated CRP is closely associated with hypoalbuminemia, malnutrition, morbidity, and case fatality in dialysis patients and may be a predictor of atherosclerosis [19]. It has been reported that in dialysis patients, CRP >0.8 mg/dL increases overall mortality and cardiovascular mortality [20].

Taking this into consideration, our study suggests that among dialysis patients, those with a high preoperative CRP may reflect systemic inflammation related to the dialysis itself, which might contribute to short-term results after gastric cancer surgery. Although it has been pointed out that preoperative CRP is related to long-term prognosis after gastric cancer surgery, there is no consensus on its relationship with short-term results, especially short-term results of dialysis patients [13]. Our research is the first to examine this point. According to the results of this study, the number of cases of serious complications with CD classification ≥3 is small, and it can only be interpreted that CRP is significantly higher in patients with mild complications mainly composed of CD classification 2. The short-term results showed a significant difference only in that the start of oral intake was delayed and did not show a significant difference in terms of mortality or extension of hospital stay. Therefore, to discuss the link between CRP and serious postoperative complications, further case accumulation may be needed.

Conclusion

In this study, when considering gastric cancer surgery for dialysis patients, laparoscopic surgery may not be a risk factor in terms of at least short-term postoperative results and may be considered as an option for surgery. However, for dialysis patients, those with high preoperative CRP, whether undergoing open or laparoscopic surgery, should be treated with consideration for the risk of postoperative complications. In addition, although this multivariate analysis could not identify a significant independent risk factor, we suggest that careful indications should be considered when performing D2 dissection for gastric cancer in dialysis patients.

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Conflicts of Interest

Authors declare no conflicts of interest for this article.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Human Rights Statement

The study and all described procedures were conducted in accordance with the Helsinki Declaration, and the protocol was approved by the Ethics Committee of Japan Community Health Care Organization Sendai Hospital.

References

1. Nitta K, Masakane I, Hanafusa N, Taniguchi M, Hasegawa T, Nakai S, et al. (2019) Annual dialysis data report 2017, JSDT Renal Data Registry. Renal Replacement Therapy 5: 53.

2. Huang MJ, Wei RB, Wang Y, Su TY, Di P, et al. (2017) Blood coagulation system in patients with chronic kidney disease: a prospective observational study. BMJ open 7: e014294.

3. Eleftheriadis T, Liakopoulos V, Leivaditis K, Antoniadi G, Stefanidis I (2011) Infections in hemodialysis: a concise review - Part 1: bacteremia and respiratory infections. Hippokratia 15: 12-17.

4. Maroz N, Simman R (2013) Wound Healing in Patients With Impaired Kidney Function. The journal of the American College of Clinical Wound Specialists 5: 2-7.

5. Shiraishi T, Tominaga T, Nonaka T, Hashimoto S, Hamada K, et al. (2022) Effect of hemodialysis on short-term outcomes after colon cancer surgery. PloS one 17: e0262531.

6. Kanaka S, Aoki Y, Yoshioka M, Kawano Y, Shimizu T, et al. (2021) Short-term Outcomes of Liver Resection in Patients With Hemodialysis. In vivo (Athens, Greece) 35: 2465-2468.

7. Higashino N, Matsuda T, Hasegawa H, Yamashita K, Sakamoto H, et al. (2020) Outcomes of Laparoscopic Surgery in Colorectal Cancer Patients With Dialysis. Anticancer research 40: 2165-2170.

8. Otani Y, Okabayashi T, Shima Y, Shibuya Y, Ozaki K, et al. (2017) Safety and Efficacy of the Surgical Management of Hemodialysis Patients with Gastric Cancer. Acta medica Okayama 71: 333-339.

9. Pan YC, Jia ZF, Cao DH, Wu YH, Jiang J, et al. (2018) Preoperative lymphocyte-to-monocyte ratio (LMR) could independently predict overall survival of resectable gastric cancer patients. Medicine 97: e13896.

10 . Li Z, Li S, Ying X, Zhang L, Shan F, et al. (2020) The clinical value and usage of inflammatory and nutritional markers in survival prediction for gastric cancer patients with neoadjuvant chemotherapy and D2 lymphadenectomy 23: 540-549.

11. Zhang X, Zhao W, Yu Y, Qi X, Song L, et al. (2020) Clinicopathological and prognostic significance of platelet-lymphocyte ratio (PLR) in gastric cancer: an updated meta-analysis 18: 191.

12. Miyamoto R, Inagawa S, Sano N, Tadano S, Adachi S, et al. (2018) The neutrophil-to-lymphocyte ratio (NLR) predicts short-term and long-term outcomes in gastric cancer patients. European journal of surgical oncology : the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology 44: 607-612.

13 . Guo J, Chen S, Chen Y, Li S, Xu D (2018) Combination of CRP and NLR: a better predictor of postoperative survival in patients with gastric cancer. Cancer management and research 10: 315-321.

14. Matsumoto S, Takayama T, Wakatsuki K, Tanaka T, Migita K, et al. (2014) Short-term and long-term outcomes after gastrectomy for gastric cancer in patients with chronic kidney disease. World journal of surgery 38: 1453-1460.

15. Hsu CM, Weiner DE, Aweh G, Miskulin DC, Manley HJ, et al. (2021) COVID-19 Among US Dialysis Patients: Risk Factors and Outcomes From a National Dialysis Provider. American journal of kidney diseases : the official journal of the National Kidney Foundation 77: 748-756.

16. Fu EL, Evans M, Carrero JJ, Putter H, Clase CM, et al. (2021) Timing of dialysis initiation to reduce mortality and cardiovascular events in advanced chronic kidney disease: nationwide cohort study. BMJ (Clinical research ed) 375: e066306.

17. Tiong MK, Ullah S, McDonald SP, Tan SJ, Lioufas NM, et al. (2021). Serum phosphate and mortality in incident dialysis patients in Australia and New Zealand. Nephrology (Carlton, Vic) 26: 814-823.

18. Giménez Francés C, Tamayo Rodríguez ME, Albarracín Marín-Blázquez A (2021) Non-oclusive mesenteric ischemia as a complication of dialysis. Revista espanola de enfermedades digestivas : organo oficial de la Sociedad Espanola de Patologia Digestiva 113: 731-732.

19. Pecoits-Filho R, Heimbürger O, Bárány P, Suliman M, Fehrman-Ekholm I, et al. (2003) Associations between circulating inflammatory markers and residual renal function in CRF

patients. American journal of kidney diseases : the official journal of the National Kidney Foundation 41: 1212-1218.

20. Zimmermann J, Herrlinger S, Pruy A, Metzger T, Wanner C (1999) Inflammation enhances cardiovascular risk and mortality in hemodialysis patients. Kidney international 55: 648-658.