Selective use of prophylactic drainage after gastrectomy

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ABSTRACT

Selective use of prophylactic drainage after gastrectomy for gastric cancer

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Introduction: Although our previous randomized controlled trial showed that there was no difference in postoperative complications after gastric cancer surgery between patients with and without a prophylactic drains (PDs), PDs are commonly used by most surgeons and at most institutions. However, these results have not yet been validated elsewhere. The purpose of this study is to analyze the incidence, characteristics, and risk factors for a postoperative percutaneous catheter drainage (PCD) procedure after gastric cancer surgery when PDs were not used.

Methods: We reviewed data from 1989 patients who underwent gastrectomy with lymphadenectomy for gastric cancer with curative intent from January 2012 to December 2013.

Results: The incidence of PCD in the abdomen was 1.8% (22/1249) and 9.1% (67/740) in patients with and without PD, respectively. In the without PD group, age (odds ratio [OR], 1.032; p=.013), male gender (OR for female, 0.38; p=.005), open surgery (OR for minimally invasive surgery, 0.16; p=.013), and longer operative time (OR, 1.01; p<.001) were independent risk factors for postoperative PCD in the abdomen. In the without PD group, no microbes were detected in the peritoneal fluid

obtained by PCD in 72.1% (44/61) of patients who underwent PCD, and the most commonly identified organisms were *Escherichia coli* and *Candida albicans*.

Conclusion: The risk of PCD postoperatively was increased by not using a PD, but no microbes in peritoneal fluid were detected in the most patients. Selective use of PD in patients during gastric cancer surgery by risk factor analysis using a nomogram would be possible. Especially, most of patients with probability value below 0.09807 should not require PD after gastric cancer surgery (NPV : 96.3%).

Key words : external drainage, prophylactic intra-peritoneal drainage, percutaneous catheter drainage, gastric cancer, gastrectomy

Selective use of prophylactic drainage after gastrectomy for gastric cancer

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I. INTRODUCTION

Prophylactic intra-peritoneal drainage (PD) has been widely used during major abdominal surgery[1,2] because of its possible advantages. These advantages include removing intra-peritoneal fluids, such as ascites, blood, and chyle, which can be a source of infection, fever, and abdominal pain after surgery[3, 4], and assisting the early detection of postoperative hemorrhage and/or leak[3-5]. However, PD can produce discomfort and pain, which may limit early ambulation and postoperative recovery[6]; infection at the insertion site; and ascending infection, caused by migration of bacteria.[7, 8] Despites of its potential disadvantages, PD is commonly used for gastric cancer surgery by most surgeons and at most institutions.

Our previous randomized controlled trial showed no difference in postoperative complications after gastric cancer surgery between patients treated with and without PD.[9] Based on this result, PD has no longer beenused routinely for gastric cancer surgery in our institution for several years. Although some surgeons in our institution have abandoned using PD in an attempt to decrease patient discomfort, improve quality of life during early recovery, and promote early ambulation, other surgeons continue to use PD. Surgeons favorable using PD thought that early diagnosis and treatment for some critical postoperative complications such as intra-abdominal bleeding,

abscess, and anastomotic leakage would be simultaneously possible by using PD.

In our recent prospective cohort study of postoperative complications after gastrectomy for gastric cancer[10], we noticed that the incidence of a postoperative intra-peritoneal drainage procedure was higher than expected. Because of this observation and because the results of our randomized controlled trial have not yet been validated at another institution, we conducted the following study to review and analyze the incidence, characteristics, and risk factors for requiring a postoperative intra-peritoneal drainage procedure after gastric cancer surgery in patients with and without intraoperative PD.

II. MATERIALS AND METHODS

1. Participants

This study was approved by the Institutional Review Board of Yonsei University Severance Hospital (#4-2014-0504). We analyzed data from 1989 patients who underwent gastrectomy for primary gastric cancer with curative intent at Yonsei University Severance Hospital between January 2012 and December 2013. Patients with cancer in a remnant stomach, a history of preoperative chemotherapy, a stage IV tumor (e.g. with peritoneal seeding or distant metastasis), or an R1 resection were excluded. Patients who underwent wedge resection with sentinel lymph node navigationas part of a clinical trial were also excluded.

2. Surgery and evaluations

Distal gastrectomy was performed when the tumor was located in the mid or lower body of the stomach and it was possible to save the proximal stomach while achieving sufficient tumor margins. When the tumor was located in the upper body of the stomach, total gastrectomy was performed.

We performed gastrectomy with D1+ lymph node dissection for clinically early gastric cancer and D2 lymph node dissection for clinically advanced gastric cancer, in accordance with the recent Japanese Gastric Cancer Guidelines.[11] The decision to use PD was left to the discretion of each surgeon. In our institution, some surgeons routinely use PD and others do not. In the PD group, the prophylactic drain was positioned in the sub-hepatic and/or left sub-phrenic area except pelvic cavity. Pathologic T and N stage was followed according to American Joint Committee on Cancer (AJCC) 7th edition[12].

3. Patient follow-up and definition of a PCD event

The patients were routinely followed at our outpatient clinic at 1–2 weeks after hospital discharge. When a patient developed fever, abdominal distention, abdominal pain, or dyspnea during the follow-up period, a complete blood cell count and computed tomography scan were obtained at the surgeons' discretion. When the fluid collection in the intra-abdominal and/or pleural cavity was small and symptoms were minimal, the patient was treated conservatively. However, if the fluid collection was large and symptoms were severe or sustained, a catheter was inserted postoperatively into the intra-abdominal and/or pleural cavity. These catheters were inserted percutaneously under ultrasonographic guidance in the interventional radiology department in all instances. For most patients, the fluid flowing out through the catheter was cultured to determine the type of micro-organism. When a patient required a postoperative intra-peritoneal and/or pleural drainage procedure within 30 days after gastrectomy, the event was defined as percutaneous catheter drainage (PCD).

4. Statistical Analyses

Risk factors for PCD were analyzed with odds ratios (ORs) and their 95%

confidence intervals (CIs) using a binary logistic regression model and a multivariable model was selected using the forward likelihood ratio method. A nomogram was created using the finally selected multivariable logistic regression model, and the repetition for its calibration plot was set at 200 (B=200). A receiver operating characteristics (ROC) curve was constructed of the probability of the final multivariable model and the event (PCD insertion in the abdomen), and the optimal cutoff point was determined using the *Youden* method. The statistical analyses were performed with IBM SPSS 20.0 software (SPSS Inc., Chicago, IL, USA) and R software version 2.9.1 using the "Design" package for creating the nomogram with its calibration plot, and version 3.0.1 using the "pROC" and "Optimal Cutpoints" packages for the ROC curve, area under the curve (AUC), and optimal cutoff point (including its sensitivity, specificity, positive predictive value, and negative predictive value). A *p*-value less than 0.05 was considered statistically significant.

III. RESULTS

1. Baseline characteristics

Among the 1989 patients enrolled in this study, 740 (37.2%) were in the without PD group and 1249 (62.8%) were in the with PD group (Supplement figure 1). Baseline characteristics of the patients are shown in Table 1. The mean age was 57.8 years and 59.4 years in the without and with PD groups, respectively. In both groups, the proportion of males was over 60% and the mean BMI was approximately 23. The tumor characteristics were similar to those noted in our previous report.[13] The mean blood loss was approximately 90 mL in both groups, and the mean operative time was 189.5 minutes in the with PD group and 166.1 minutes in the without PD group.

Table 1. Baseline characteristics of with and without prophylactic intra-peritoneal drainage group.

	Without PD (n=740)	**With PD (n=1249)**
Age	57.8 ± 12.0 (58.0, 28-86) †	59.4 ± 12.1 (60.0, 23-86) †
Sex		
Male	457 (61.8%)	809 (64.8%)
Female	283 (38.2%)	440 (35.2%)
BMI	22.9 ± 2.7 (22.9, 16.0-34.5) †	23.5 ± 3.1 (23.3, 14.5-40.0) †
ASA score		
I	264 (35.7%)	414 (33.1%)
II	396 (53.5%)	629 (50.4%)
III	77 (10.4%)	187 (15.0%)
IV	3 (0.4%)	19 (1.5%)
Previous abdominal surgery		
No	552 (74.6%)	946 (75.7%)
Yes	188 (25.4%)	303 (24.3%)
Modality		
Open	579 (78.2%)	434 (34.7%)
MIS (laparoscopy/robot)	161 (21.8%, 96/65)	815 (65.3%, 637/178)
Extent of gastrectomy		
Subtotal	582 (78.6%)	950 (76.1%)
Total	158 (21.4%)	299 (23.9%)
Extent of LND		
D1 +	190 (25.7%)	610 (48.8%)
D2	550 (74.3%)	639 (51.2%)
Combined resection		
No	670 (90.5%)	1079 (86.4%)
Gallbladder only	47 (6.4%)	86 (6.9%)
Spleen and/or pancreas and/or liver	13 (1.8%)	40 (3.2%)
Others*	10 (1.4%)	44 (3.5%)
Sizes (mm)	31.3 ± 23.2 (25.0, 2-200) †	35.6 ± 28.1 (28.0, 2-250) †
Depth of tumor		
mucosa	259 (35.0%)	388 (31.1%)

submucosa	225 (30.4%)	383 (30.7%)
proper muscle	91 (12.3%)	120 (9.6%)
subserosa	60 (8.1%)	143 (11.4%)
serosa	101 (13.6%)	210 (16.8%)
adjacent organ invasion	4 (0.5%)	5 (0.4%)
pNstage		
pN0	547 (73.9%)	884 (70.8%)
pN1 (1~2)	66 (8.9%)	141 (11.3%)
pN2 (3~6)	74 (10.0%)	84 (6.7%)
pN3a (7~15)	37 (5.0%)	88 (7.0%)
pN3b (>15)	16 (2.2%)	52 (4.2%)
Number of retrieved LNs	35.7 ± 12.6 (34.0, 9-90) †	35.8 ± 13.8 (28.0 6-99) †
Histology		
Differentiate	281 (38.0%)	501 (40.1%)
Undifferentiate	448 (60.5%)	719 (57.6%)
Others°	11 (1.5%)	29 (2.3%)
Lauren		
Intestinal	335 (45.3%)	603 (48.3%)
Diffuse	346 (46.8%)	541 (43.3%)
Others‡	59 (7.9%)	105 (8.4%)
Blood loss (g)	93.3 ± 106.2 (60, 10-850) †	91.0 ± 135.9 (50.5, 10-2610) †
Operative time (min.)	166.1 ± 44.0 (160.0, 79-360) †	189.5 ± 63.2 (180.0, 78-660) †

*including combined resection of colon, ovary, uterus, esophagectomy, small intestine, appendix, diverticulum, nephrectomy, and adrenalectomy

† median and range

° lymphoepithelioma like carcinoma

‡ mixed type and indeterminate type

PD; prophylactic intra-peritoneal drainage

ASA; American Society of Anesthesiologists

MIS; minimally invasive surgery

LND; lymph node dissection

LN; lymph nodes

2. Patients requiring postoperative PCD

PCD in the intra-abdominal and/or pleural cavity was required postoperatively in 2.3% of patients in the with PD group and 9.7% of patients in the without PD group; this difference was statistically significant (Chi-square test, $p<.001$). In the with PD group, 1.8% of patients (22/1249) required PCD in the abdomen postoperatively, and 8 of these patients had leakage. In the without PD group, 9.1% of patients (67/740) required PCD in the abdomen postoperatively, and 4 of these patients had leakage. The incidence of leakage was not statistically different between the with and without PD groups (Fisher's exact test, $p=.519$).

3. Time of postoperative PCD insertion in the abdomen

Figure 1 shows the number of patients who required PCD insertion in the abdomen overtime after surgery. In the without PD group patients who required PCD in the abdomen, PCD was performed at 3 to 27 days postoperatively; 90% of these were performed within the first 2 weeks after surgery (Figure 1-A), and four patients in this group had leakage. In the with PD group patients who required PCD in the abdomen, PCD was performed at 5 to 31 days after gastrectomy; PCD was performed evenly throughout this time period (Figure 1-B). Eight patients experienced leakage. Three of these patients required PCD after the PD tube was removed, and for the other five PD group patients with leakage, PCD was performed while their PD tube was still in place. No intestinal or vessel injury occurred in those patients undergoing PCD.

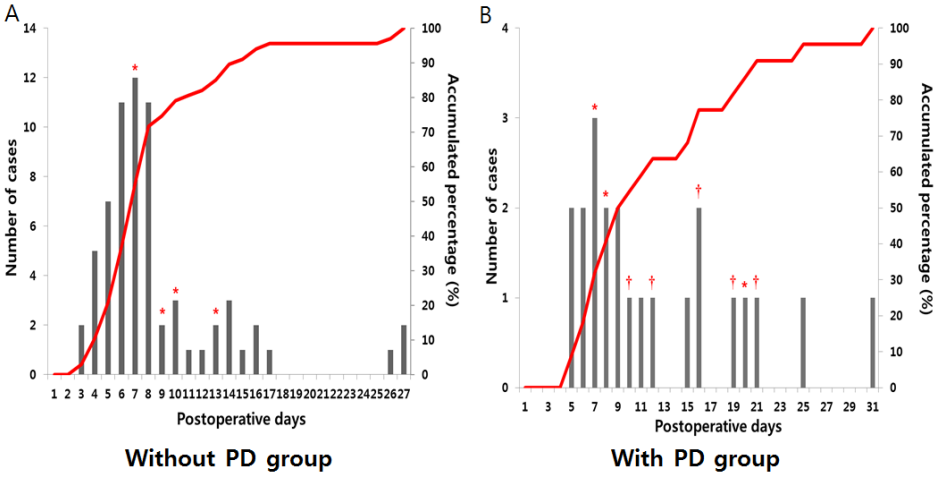

Figure 1. Bar graph and ogive graph of the number of patients who required postoperative PCD in the abdomen over time. A) Without prophylactic intra-peritoneal drainage group; B) with prophylactic intra-peritoneal drainage group. (* and † represent patients with leakage; * PD was not in place when PCD was performed, † PD was in place when PCD was performed)
PD; prophylactic intra-peritoneal drainage, PCD; percutaneous catheter drainage

4. Risk factors for postoperative PCD

Table 2 shows the risk factors for postoperative intra-abdominal PCD in the without and with PD groups. In the without PD group, univariable analysis indicated that the following were risk factors for postoperative PCD insertion: old age, male gender, no previous abdominal surgery, open surgery (compared to MIS surgery), total gastrectomy, D2 lymph node dissection (compared to D1+ dissection), combined resection, aggressive tumor characteristics (large size, deep invasion, and with lymph node metastasis), greater blood loss, and longer operative time. During multivariable analysis, age (OR, 1.032; p=.013), male gender (OR for females, 0.38; p=.005), open surgery (OR for MIS, 0.16; p=.013), and longer operative time (OR, 1.01;

p<.001) were identified as independent risk factors.

In the with PD group, univariable analysis indicated that the following were risk factors for postoperative PCD: open surgery (compared to MIS surgery), larger tumor size, advanced gastric cancer, presence of lymph node metastasis, greater blood loss, and longer operative time. During multivariable analysis, only the tumor depth (OR of AGC, 4.27; *p*=.003) and operative time (OR, 1.007; *p*=.003) were identified as independent risk factors in the with PD group.

5. Prediction model for selective inserting PD for gastric cancer surgery

A nomogram was constructed for predicting postoperative PCD in the abdomen when prophylactic PD was not used for gastric cancer surgery (Figure 2-A). Risk factors selected by the prediction model (multivariable analysis of the without PD group in Table 2) were used for the nomogram. These factors included gender, surgical modality, age, and operative time. The actual probability of the event (PCD in the abdomen) correlated closely with the predicted probability, and the mean absolute error was 0.008 for the calibration plot (Supplement Figure 2), there by indicating that the nomogram was acceptable. The ROC curve (Figure 2-B) of the probability of the prediction model and the event (PCD in the abdomen) showed that the AUC was 0.753 and the optimal cutoff point for the probability of predicting PCD was 0.09807. The sensitivity of this prediction model was 74.6%, specificity was 66.6%, positive predictive value was 18.2%, and negative predictive value was 96.3%.

Table 2. Risk factors for postoperative intra-abdominal percutaneous catheter drainage in without and with prophylactic intra-peritoneal drainage group.

	Without PD				**With PD**			
	Univariable		**Multivariable**		**Univariable**		**Multivariable**	
	OR (95% CI)	***p*-value**	**OR (95% CI)**	***p*-value**	**OR (95% CI)**	***p*-value**	**OR (95% CI)**	***p*-value**
Age	**1.038 (1.015-1.061)**	**.001**	**1.032 (1.007-1.058)**	**.013**	1.035 (0.997-1.075)	.069		
Sex		**<.001**		**.005**		.223		
Male	1		1		1			
Female	**0.29 (0.15-0.56)**		**0.38 (0.19-0.74)**		0.58 (0.23-1.45)			
BMI		.306				.255		
<18.5	0.75 (0.17-3.31)				3.60 (0.72-17.80)			
18.5~22.9	1				1			
23~25	1.50 (0.85-2.63)				1.86 (0.67-5.17)			
25~28	0.61 (0.26-1.42)				0.57 (0.12-2.77)			
>28	1.13 (0.33-3.93)				2.30 (0.58-9.05)			
ASA score		.706				.226		
I	1				1			
II	1.23 (0.70-2.14)				1.99 (0.64-6.22)			
III/IV	1.29 (0.55-3.03)				3.08 (0.89-11.02)			
Previous abdominal surgery		**.021**				.866		

No	1				1	
Yes	**0.43 (0.21-0.88)**				0.92 (0.34-2.51)	
Modality		**<.001**		**.013**		**.007**
Open	1		1		1	
MIS (laparoscopy/robot)	**0.10 (0.02-0.41)**		**0.16 (0.04-0.68)**		**0.30 (0.12-0.72)**	
Extent of gastrectomy		**<.001**				.067
Subtotal	1				1	
Total	**2.80 (1.65-4.72)**				2.24 (0.95-5.29)	
Extent of LND		**.004**				.115
D1 +	1				1	
D2	**3.20 (1.44-7.13)**				2.07 (0.84-5.11)	
Combined resection		**.043**				.085
No	1				1	
Gallbladder	**2.70 (1.24-5.88)**				3.45 (1.12-10.64)	
Spleen and/or pancreas and/or liver	**2.07 (0.45-9.60)**				3.73 (0.82-16.88)	
Others	**2.85 (0.59-13.77)**				1.65 (0.21-12.75)	
Sizes (mm)		**.006**				**.045**
<30	1				1	
>31	**2.04 (1.23-3.38)**				**2.45 (1.02-5.89)**	

Depth of tumor		**.002**				**.002**		**.003**
EGC	1				1		1	
AGC	**2.24 (1.35-3.71)**				**4.42 (1.72-11.36)**		**4.27 (1.65-11.04)**	
LNM		**.030**				**.004**		
LN negative	1				1			
LN positive	**1.79 (1.06-3.03)**				**3.59 (1.52-8.48)**			
Histology		**.023**				.694		
Differentiate	1				1			
Undifferentiate	**0.60 (0.36-1.01)**				0.69 (0.30-1.61)			
Others°	**2.92 (0.74-11.56)**				NA			
Lauren		.146				.802		
Intestinal	1				1			
Diffuse	0.61 (0.36-1.03)				0.74 (0.30-1.82)			
Others‡	0.57 (0.20-1.66)				0.96 (0.21-4.34)			
Blood loss (g)	**1.002 (1.000-1.004)**	**.025**			**1.002 (1.000-1.003)**	**.026**		
Operative time (min.)	**1.012 (1.007-1.018)**	**<.001**	**1.01 (1.005-1.016)**	**<.001**	**1.007 (1.003-1.012)**	**.002**	**1.007 (1.002-1.012)**	**.003**

*including combined resection of colon, ovary, uterus, esophagectomy, small intestine, appendix, diverticulum, nephrectomy, and adrenalectomy

° lymphoepithelioma like carcinoma

‡ mixed type and indeterminate type

OR; odds ratio

PD; prophylactic intra-peritoneal drainage

ASA; American Society of Anesthesiologists

MIS; minimally invasive surgery

LND; lymph node dissection

LN; lymph nodes

6. Microbes in fluid obtained by PCD

Table 3 shows the microbial culture results of the fluids obtained by postoperative PCD in the abdomen and/or pleural cavity. In the without PD group, peritoneal fluid was obtained for culture in 91% of the patients (61/67) who underwent PCD in the abdomen; no microbes were detected in 72.1% of these patients (44/61). Two patients experienced leakage and the Escherichia coli and Enterococcus faecium was detected in the peritoneal fluid obtained by PCD.

In the with PD group, peritoneal fluid was obtained for culture in 72.7% of the patients (16/22) who underwent PCD in the abdomen; no microorganisms were detected in 43.8% of these patients (7/16). In most patients (88.2%) [15/17] of patients in the without PD group and 100% [8/8] of patients in the with PD group), no microbes were detected from the pleural fluid obtained by PCD

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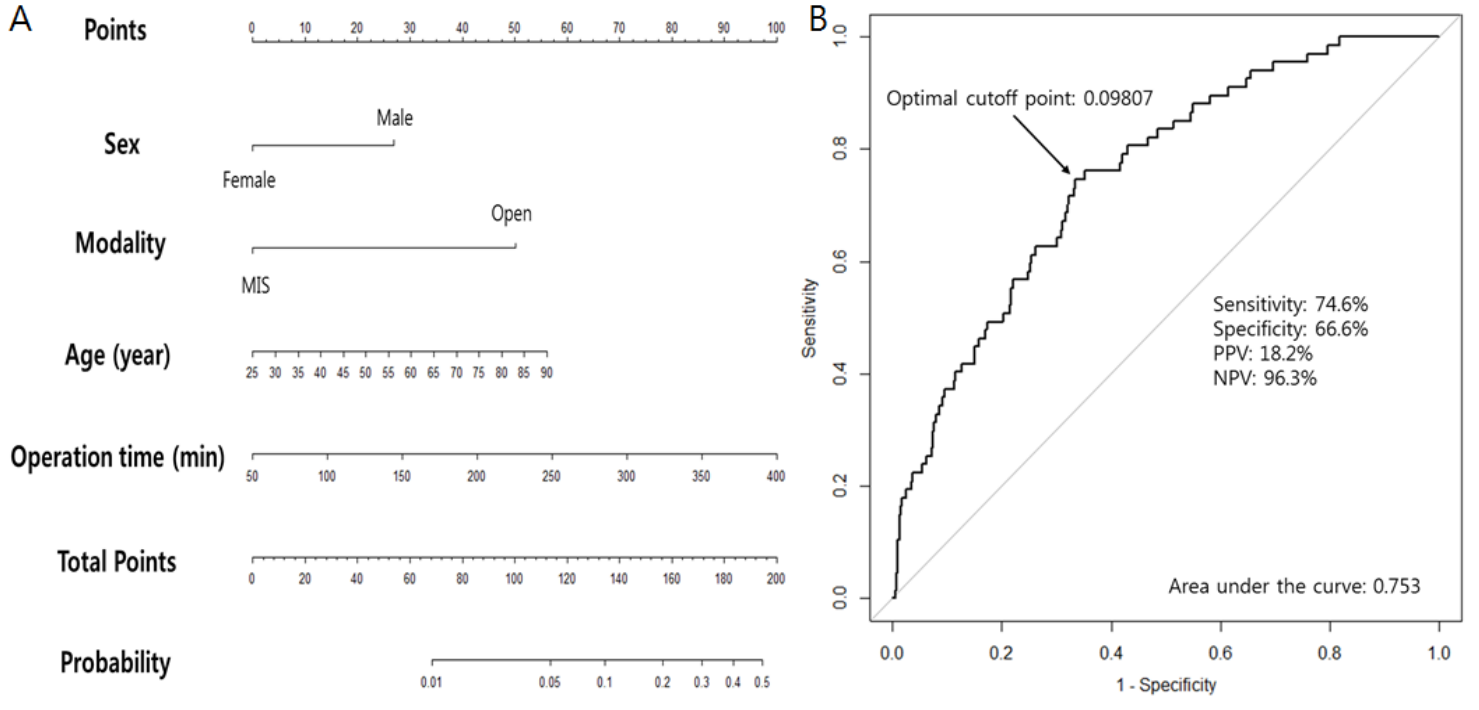

Figure 2. Nomogram and its receiver operating characteristics (ROC) curve for predicting postoperative PCD in the abdomen in the without prophylactic intra-peritoneal drainage group. A) nomogram from the final multivariable analysis of the binary logistic regression model, B) ROC curve and its diagnostic performance.

PCD; percutaneous catheter drainage

IV. DISCUSSION

The present study showed that the incidence of postoperative PCD after gastric cancer surgery was higher in the without PD group than the with PD group. However, over 90% of patients without a PD did not require postoperative drainage and no microbes were detected in over two-third (72.1%) of those who underwent PCD. Considering postoperative PCD relieved uncomfortable symptoms in patients with intra-abdominal fluid collections and most of the collections did not appear to be pathologic, routine use of PD during surgery in all patients would be overtreatment. Because most microbes cultured from peritoneal fluids obtained by PCD were commensal organisms from the small intestine, particular attention to avoiding contamination during the anastomosis may decrease the rate of peritoneal fluid infection.

Our results showed that the incidence of postoperative leakage in the with and without PD groups was similar, and most PCDs were performed within 2 weeks after surgery. Therefore, if we can identify patients with an increased risk for postoperative PCD, it will be possible to selectively insert a PD during surgery. During our risk factor analyses, male gender, older age, open surgery, and longer operative time were identified as independent risk factors for postoperative PCD in patients without a PD. Differences in fat distribution according to gender are well known. Women have a higher amount of body fat, especially in the gluteal-femoral area, whereas men have more visceral fat[14], and a greater quantity of visceral fat may result in more peritoneal fluid after gastric cancer surgery. Wound healing is known to differ between young and aged individuals because of delayed re-epithelialization, angiogenesis, secretion of growth factors, and collagen deposition with increasing age[15]. Thus, sealing of injured lymphatics during surgery could be delayed in older patients and thereby lead to the accumulation of more fluid in the peritoneal cavity. Open surgery was likely identified as an independent risk factor for

postoperative PCD because of the surgical devices used. In the present study, only an electro-cautery device (Bovie) was used during most of the open surgeries, whereas ultrasonic devices were always used for MIS. Several previous reports have indicated that ultrasonic devices are more effective than electro-cautery devices in reducing lymphatic fluid accumulation after surgery because of their sealing effects[16-18]. Finally, a longer operative time may represent more difficult and extensive surgery, such as a total gastrectomy, more extended lymph node dissection, or combined resection.

Our nomogram shows that it may be possible to selectively apply PD in gastric cancer surgery, as the nomogram can be used to predict a considerable need for PCD after surgery when PD is not used during surgery (AUC: 0.753). For example, if we did not apply PD in a patient with a probability below 0.09807, which was calculated by the nomogram at the end of the operation, the patient would have a 96.3% likelihood of not requiring PCD. It is also likely that the risk of PCD after gastric cancer surgery can be reduced by using ultrasonic devices during open surgery and by performing careful intraoperative manipulations to avoid contamination during the anastomosis. Although there were no PCD-related complications, such as bowel injury or bleeding, in the patients enrolled in this study, every interventional procedure has potential risks and may cause patient discomfort. Therefore, our nomogram should be helpful for identifying patients who would benefit from prophylactic PD during surgery.

One limitation of this study is that the decision regarding whether to insert a PD was left to the discretion of the surgeon (some surgeons routinely used PD, whereas others routinely did not); this non-random selection process may have influenced our results. Another limitation is the uncertainty whether this result can be reproducible in other centers and other countries especially where preoperative chemotherapy and/or radiotherapy or limited lymph node dissection is the standard of care. The other limitation is the design of this

study, retrospective cohort study. Thus we are going to perform randomized controlled trial to compare the outcomes between routinely used PD group and selectively used PD based on the present nomogram group. If it works in the trial, validation in other centers and other countries may be the next step.

V. CONCLUSION

The risk of PCD postoperatively was increased by not using PD during gastric cancer surgery, but no microbes in peritoneal fluid were detected in the most patients. Selective use of PD in patients during gastric cancer surgery by risk factor analysis using a nomogram would be possible. Especially, most of patients with probability value below 0.09807 should not require PD after gastric cancer surgery (NPV : 96.3%). Finally, on the basis of our result the clinical efficacy of this approach should be evaluated in further studies.

Table 3. The details of culture results from the fluids through postoperative percutaneous catheter drainage.

Abdomen	**Without PD (n=67)**	**Number of patient with leak**	**With PD (n=22)**	**Number of patient with leak**
Without culture	6 (9.0%)	0	6 (27.3%)	2
With culture	61 (91.0%)	4	16 (72.7%)	6
No growth	**44 (72.1%)**	2	7 (43.8%)	1
Gram positive				
Streptococcus intermedius	1 (1.6%)	0		
Enterococcus faecium	1 (1.6%)	1	1 (6.3%)	1
Streptococcus mitis			1 (6.3%)	1
Enterococcus faecalis	1 (1.6%)	0		
Streptococcus anginosus	2 (3.3%)	0		
Diphtheroids	1 (1.6%)	0		
Staphylococcus aureus			1 (6.3%)	0
Staphylococcus intermedius	1 (1.6%)	0		
Bacillus species			1 (6.3%)	1
Gram negative				
Pseudomonas aeroginosa			1 (6.3%)	1
Klebsiella pneumonia	2 (3.3%)	0		
Enterobacter cloacae	2 (3.3%)	0	1 (6.3%)	1
Enterobacter aerogene			2 (12.5%)	1
Escherichia coli	**3 (4.9%)**	1	2 (12.5%)	0
Bacteroides fragilis	2 (3.3%)	0		
Prevotella disiens	1 (1.6%)	0		
Proteus mirabilis			1 (6.3%)	0
Fungus				
Candida albicans	**3 (4.9%)**	0	1 (6.3%)	1
Pleura	**Without PD (n=18)**	**Number of patient with leak**	**With PD (n=10)**	**Number of patient with leak**

Without culture	1 (5.6%)	0	2 (20.0%)	0
With culture	17 (94.4%)	3	8 (80.0%)	0
No growth	**15 (88.2%)**	3	**8 (100%)**	0
Gram positive				
Streptococcus intermedius	1 (5.9%)			
Gram negative				
Bacteroides fragilis	1 (5.9%)			

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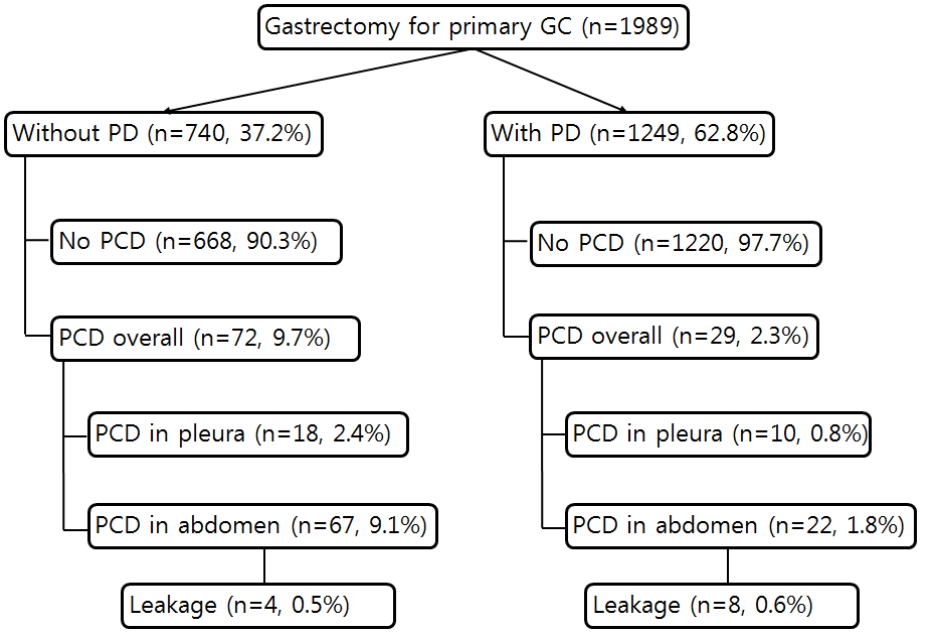
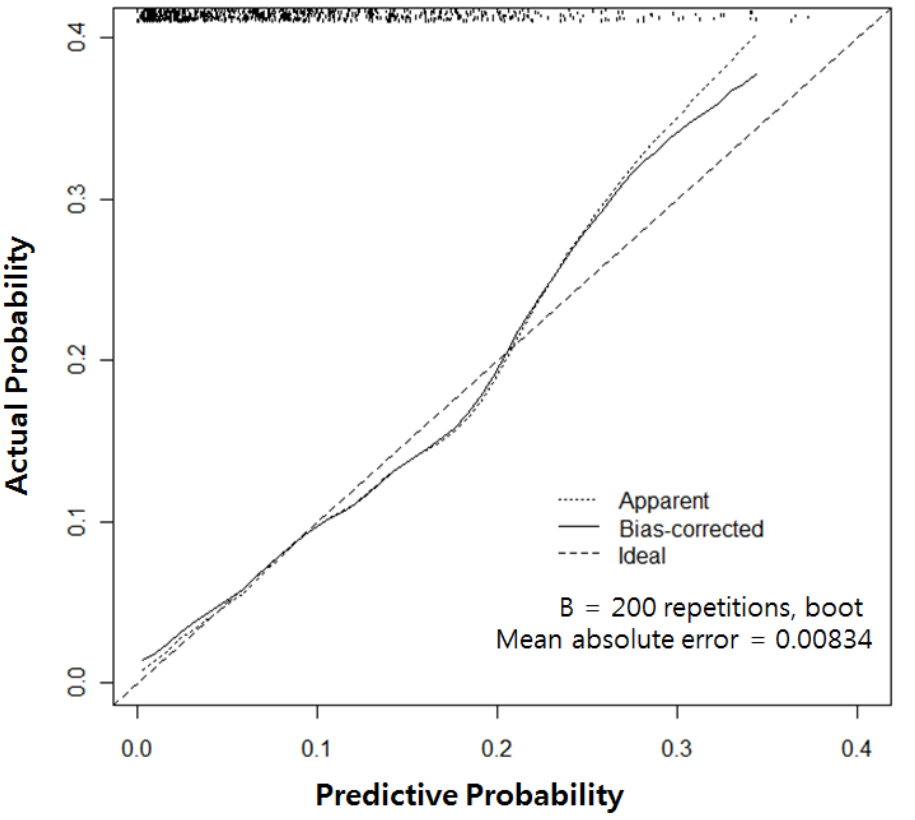
APPENDICES



Supplement Figure 1. Diagram of the number of patients in the groups with and without prophylactic intra-peritoneal drainage after gastrectomy for gastric cancer.



Supplement Figure 2. Calibration plot of the nomogram

ABSTRACT(IN KOREAN)

위암으로 이한 위절제술 시행 시 예방적 배액관의 선택적 삽입

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이 장 희

서론: 위암 수술에 있어서 예방적 배액관 삽입술의 시행 유무가 환자의 수술 후 합병증에 유의미한 차이가 없다는 우리 기관의 이전 연구 결과가 있었지만 현재도 대다수의 외과의사와 기관에서는 수술 시 예방적 배액관 삽입술을 시행하고 있다. 하지만 예방적 배액관 삽입의 유용성은 현재까지 증명된 바가 없다. 본 연구에서는 위암 수술 시 예방적 배액관 삽입술을 시행하지 않았던 환자를 대상으로 수술 후 복강 내 액체 저류로 인한 경피적 배액술을 시행했던 환자의 비율, 특성 및 위험인자를 분석하고자 하였다.

방법: 2012년 1월부터 2013년 12월까지 위암으로 위절제술 및 림프절 제술을 시행받은 1989명의 자료를 후향적으로 분석하여 연구를 진행하였다.

결과: 수술 후 배액관 삽입 시술을 받은 환자의 비율은 수술 시 예방적으로 배액관을 삽입했던 환자에서는 1.8%(22/1249), 삽입하지 않았던 환자에서는 9.1%(67/740) 이었다. 수술 후 배액관 삽입의 독립적인 위험인자로는 나이(odds ratio [OR], 1.032; p=.013), 남성(OR for 여성, 0.38; p=.005), 개복수술(OR for 최소침습수술, 0.16; p=.013), 수술 시간(OR, 1.01; p<.001)이 있었다. 또한 수술 후 배액관 삽입을 통해 채취한 복강 내 액체를 배양한 결과, 72.1%(44/61)에서 어떠한 세균도 동정되

지 않았으며 동정되었던 세균 중에서는 *Escherichia coli*와 *Candida albicans*이 가장 많은 비율을 차지하였다.

결론: 수술 시 예방적 배액관을 삽입하지 않는 것은 수술 후 배액관 삽입 시술의 가능성을 높이지만 복강 내 저류된 액체의 대부분에서 세균은 동정되지 않았다. 본 연구의수술 후 배액관 삽입 시술의 위험 인자 분석을 통하여 필요한 환자에게 선택적으로 예방적 배액관을 삽입하는 것이 가능할 것으로 생각된다. 특히 probability값이 0.09807미만의 환자의 대부분은 실제로 수술 후 예방적 배액관이 필요하지 않을 가능성이 높았다. (NPV : 96.3%)

핵심되는 말 : 체외 배액술, 예방적 복강내 배액관 삽입술, 경피적 배액술, 위암, 위절제술

PUBLICATION LIST

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