Original

[J Tokyo Wom Med Univ 84 (Extra 3) E406～E416 (2014)]

Risk Factors for Early Postoperative Surgical Complications of Loop Ileostomy Closure

Takeshi IHARA[1], Michio ITABASHI[1,*], Satoru SHIMIZU[2] and Shingo KAMEOKA[1]

[1]Department of Surgery II, Tokyo Women's Medical University
[2]Medical Research Institute, Tokyo Women's Medical University
*corresponding author

(Accepted September 24, 2014)

Introduction: A recent systematic review has revealed a complication rate associated with this procedure of 17.3% (3-38.5%). As this is a significant percentage, it is necessary to identify the risk factor, however, there is no unanimity of opinion as yet. In view of this, we conducted this study in an attempt to clarify the risk factors by using a method different from that employed in previously reported studies. The data of patients were analyzed objectively by multivariate analysis of candidate variables via model selection using a set of information criteria. **Materials and Methods:** We conducted a retrospective study of the 147 cases of LI closure in our department during the past 10 years and we conducted our study by using AIC score and statistical analysis. The outcomes were morbidity rate, mortality rate, reoperation rate and length of stay. **Results:** The morbidity rate after LI closure was 27%, and Small bowel obstruction (SBO) and Surgical Site Infection (SSI) were the most frequent complications. The only significant risk factor was intraoperative blood loss ≥50 ml (OR 2.76, 95%CI 1.15-6.61). It was also a significant risk factor for SBO (OR3.71, 95%CI 1.39-9.85), and diabetes (OR 5.36, 95%CI 1.19-24.06) and renal dysfunction (OR 8.85, 95%CI 1.15-81.75) were significant risk factors for SSI. **Conclusion:** Efforts should be made to reduce surgical complications with these risk factors taken into account.

Key Words: stoma closure, postoperative complication, risk factor, AIC, loop ileostomy

Introduction

It has become rather common in recent years to perform enteric anastomosis at a lower position in the pelvic cavity in the surgical treatment of lower rectal cancer or ulcerative colitis. Therefore, there seems to be a growing need for temporary ileostomy and its subsequent closure in order to secure rest for the site of anastomosis. In regard to the creation of a temporary stoma, comparisons have been made between loop colostomy and loop ileostomy (LI)[1)~3)]. Although no conclusion has been reached yet as to which procedure might be superior or preferred, it seems that LI is chosen more frequently on account of the lesser frequency of its prolapse and also the greater ease of performance of this procedure. A recent systematic review of studies dealing with LI closure (LIC) has revealed a complication rate associated with this procedure of 17.3% (3-38.5%)[4)]. As this is a significant percentage, it is necessary to identify the risk factors and institute effective measures to reduce the incidence of complications. There have been a number of reports concerning the risk factors for complications associated with this procedure[5)~22)], however, there is no unanimity of opinion as yet. In view of this, we conducted this study in an attempt to clarify the risk factors by using a method different from that employed in previously reported studies. The data of patients who had undergone LIC at this department during the past decade were reviewed retrospectively and analyzed objectively for risk factors by multivariate analysis of candidate variables via model selection using a set of information criteria.

Table 1 Patient and surgical characteristics

Patient factors (30 variables)	
1. age (years: median (min-max))	52 (15-83)
2. sex (male, female)	90, 57
3. BMI (median (min-max))	20 (14-31)
underweight (~18.4)	43
normal (18.5~24.9)	83
overweight (25~)	21
4. ASA classification (Class 1, Class 2, Class 3)	44, 93, 10
5. number of laparotomies (median (min-max))	1 (1-6)
6. Interval (day: median (min-max))	168 (26-1610)
7. Operation period (first half: second half)	61, 86
8. underlying disease	
rectal cancer	64
UC	60
FAP	5
peritonitis	9
other	9
9. operation of underlying disease (open: laparoscopy)※	117 : 30
10. cardiovascular disease (+, −)	13, 134
11. plumonary dysfunction (+, −)	15 : 132
12. renal dysfunction (+, −)	8, 139
13. hepatic dysfunction (+, −)	9, 138
14. cerebral disease (+, −)	6, 141
15. hypertension (+, −)	28, 119
16. diabetes (+, −)	15, 132
17. anemia (+, −)	4, 143
18. smoking habit (+, −)	11, 136
19. radiation therapy (+, −)	0, 147
20. cancer chemotherapy (+, −)	11, 136
21. corticosteroid therapy (+, −)	21, 126
22. immunosuppressant therapy (+, −)	1, 146
23. antipletelet drug therapy (+, −)	8, 139
24. oral anticoagulant therapy (+, −)	12, 135
25. postoperative heprin therapy (+, −)	18, 129
26. leukocyte count (median (min-max))	5,670 (2,460-17,230)
27. neutrophil count (median (min-max))	3,350 (1,353-15,714)
28. lymphocyte count (median (min-max))	1,482 (699-3,472)
29. total protein level (median (min-max))	6.9 (5.4-8.0)
30. albumin level (median (min-max))	4.2 (2.9-5.3)
Surgical factors (9 variables)	
1. mechanical bowel preparation (+, −)	98 : 49
2. chemical preparation (+, −)	0 : 147
3. intravenous antibiotic administration (+, −)	147 : 0
4. subcutaneous darinage (+, −)	2 : 145
5. intraperitoneal drainage (+, −)	1 : 146
6. suturing technique (hand sewn, stapled sutures)	14 : 132 (unknown 1)
7. surgeon's experience (resident, trainee, consultant)	53 : 38 : 56
8. duration of surgery (min: median (min-max))	121 (67-251)
9. intraoperative blood loss (ml: median (min-max))	25 (0-170)

※ Laparoscopy group includes 21 cases of hand assist laparscopic surgery (HALS).

Materials and Methods

Between January 2004 and October 2013, a total of 231 stoma closure operations were performed in our institution, and LI closure was performed in 164 of them. After excluding the 9 cases with missing data and 16 cases in which another operation was performed at the same time, the remaining 147 patients were adopted as the subjects of this study

(Table 1).

We included patients with different underlying diseases (rectal cancer, ulcerative colitis (UC), familial adenomatous polyposis (FAP), peritonitis, and others) to ensure elimination of the influence of the underlying disease on the risk of complications.

This study was conducted with the approval of the Ethics Review Board of the Ethics Committee of Tokyo Women's Medical University.

1. Patient factors and surgical factors

The patient factors evaluated were: age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, number of laparotomies (one time/≥2 times), time interval between the primary operation and stoma closure (interval), operation period (first half: 2004-2008/second half: 2009-2013), underlying disease, primary surgical approach (open/laparoscopy), preoperative complications (cardiovascular disease, pulmonary dysfunction, renal dysfunction, hepatic dysfunction, cranial nerve disease, hypertension, diabetes, anemia), smoking habit, preoperative treatment for underlying disease (radiation therapy, cancer chemotherapy, corticosteroid therapy, immunosuppressant therapy, antiplatelet drug therapy, oral anticoagulant therapy), postoperative heparin therapy, and preoperative peripheral blood data (leukocyte count, neutrophil count, lymphocyte count, total protein level, albumin level). A total of 30 patient variables were evaluated.

The surgical factors evaluated were: mechanical preparation, chemical preparation, intravenous antibiotics administration, subcutaneous drainage, intraperitoneal drainage, suturing technique (hand sewn, stapled sutures), surgeon's experience (resident, trainee, consultant), duration of surgery (minutes), and intraoperative blood loss (ml). A total of 9 surgical variables were evaluated (Table 1). Every patient received intravenous infusion of antibiotics from just prior to entry into the operating room until day 3 post-operation. The antibiotic was Flomoxef sodium in 92% of the cases. Mechanical preparation was performed at the discretion of the operating surgeon, and chemical preparation was not performed in every case. When hair removal was necessary, it was removed with a clipper in the operating room just before the operation.

The surgical procedure consisted of disinfecting around the stoma, making an incision around its entire circumference, and temporarily suturing the stoma closed. It was then disinfected again. Around the bowel was dissected, and the abdominal cavity was reached. A short segment of the bowel was resected, and an end-to-end anastomosis was made using either a stapler or hand suturing (Albert-Lembert or layer-to-layer or Gambee). The anastomosis was reinforced by adding serosa-muscle layer sutures in some cases. The wound was closed in two layers. Dermal suturing was performed at the body surface, and primary closure was performed. Open or closed drains systems were used if necessary.

2. Preoperative complications

With the follow-up duration confined to the period of postoperative hospitalization, each case was checked for the development of any of the above-defined postoperative complications by retrospective reference to the relevant medical records kept by the attending surgeon.

1) Cardiovascular disease: Recorded as present when a patient had ischemic heart disease, heart valve disease, or a severe arrhythmia that required treatment.

2) Pulmonary dysfunction: Recorded as present when a patient had a past history of pulmonary disease and reduced pulmonary function (% vital capacity ≤80% or forced expiratory volume 1 second (FEV1) ≤70%.

3) Renal dysfunction: Recorded as present when the patient was found to have a single kidney or chronic kidney disease and the serum creatinine level exceeded the normal range.

4) Hepatic dysfunction: Recorded as present when the patient was found to be under treatment for liver disease, or the blood transaminase level exceeded the normal range.

5) Cerebral disease: Recorded as present when the patient was diagnosed as having a sequela of a cerebral infarction.

6) Hypertension: Recorded as present when sys-

tolic blood pressure was ≥140 mmHg on admission or the patient was treated with oral antihypertensive drugs.

7) Diabetes: Recorded as present when the patient was being treated for diabetes or the HbA1c value was over the normal range.

8) Anemia: Recorded as present when the blood hemoglobin concentration was ≤10.0 g/dL.

3. Early postoperative surgical complications

We defined complications that developed during the postoperative hospital stay by reference to the U.S. National Cancer Institute's Common Terminology Criteria for Adverse Events (CTCAE) version 4.0.[23] and the Clavien-Dindo Classification[24].

1) Surgical site infection (SSI): Localized infection at the surgical site, or infection requiring local intervention, and infections at the surgical site requiring treatment by intravenous administration of antimicrobial agents. SSIs are classified into superficial SSIs, deep SSIs, and organ SSIs which include anastomotic leakages.

2) Anastomotic leakage: Breakdown of the connection and subsequent leakage from an anastomosis, regardless whether or not any treatments were required.

3) Small bowel obstruction (SBO): A disorder characterized by blockage of the normal flow of the intestinal contents in the ileum, or failure of the ileum to transport intestinal contents. SBOs include both bowel obstruction and prolonged ileus.

4) Postoperative hemorrhage: Finding of bleeding occurring after a surgical procedure, including subcutaneous hemorrhage requiring no treatment.

5) Wound dehiscence: A finding of separation of the approximated margins of a surgical wound, irrespective of depth of the wound.

6) Incisional hernia: Organ prolapse when pressure was exerted on the abdomen, or in hernia detected by diagnostic imaging.

7) Enterocutaneous fistula: A disorder characterized by an abnormal communication between the ileum and another organ or anatomic site.

4. Surgical outcomes

The morbidity rate, mortality rate, reoperation rate, and postoperative length of stay were evaluated as the surgical outcomes.

Morbidity rate: Defined as the percentage of patients who suffered from early postoperative surgical complications during the period of postoperative hospitalization.

Mortality rate: Defined as the percentage of patients who died during the period of postoperative hospitalization.

Reoperation rate: Defined as the percentage of patients who required reoperation during the period of postoperative hospitalization.

Length of stay: Defined as number of days from the day of operation until the day of discharge.

5. Statistical analysis

To objectively select possible risk factors for early postoperative surgical complications from the patient factors and surgical factors, we calculated the AIC (Akaike information criterion) score of each variable by using the CATDAP-02 software program (CATegorical Data Analysis Program). AIC scores are information criteria for evaluating the goodness of descriptive variable models, and smaller values are said to mean better models. The CATDAP-02 program was developed by the Institute of Statistical Mathematics (Ministry of Education, Culture, Sports, Science and Technology of Japan).

The merit of CATDAP lies in its applicability to both categorical data and continuous variables. Further, continuous variables are transformed into the best suited categorical data. That is, candidate cutoff values for the continuous variables are automatically calculated. By referring to the results of the calculation, we set down handy, clinically valid values as cutoff points, then transformed the continuous variables into categorical data, and calculated the AIC for each variable. A model selected via the AIC was subjected to logistic regression analysis by the stepwise method using the minimal AIC. The variables identified thus were selected as the risk factors for the development of complications. Strictly for reference, univariate analysis was also performed with the model selected via the AIC, using the chi-square test or Fisher's exact test. Risk factors for SSI and SBO were also assessed indi-

Table 2 Early postoperative surgical complications of LI closure

Complications	(−) n = 107	(+) n = 40
SSI	−	16 (11%)
SBO	−	22 (15%)
anastomiotic leakage	−	0
postoperative hemorrhage	−	3 (2%)
wound dehiscence	−	0
incisional hernia	−	0
fistula	−	0
colonic perforation	−	1 (0.7%)*
total	−	40 (27%)
reoperation	−	1 (0.7%)
mortality	−	0
postoperative hospital stay (days)**	12 (6-24)	17 (10-72)

*reoperation case, **median (min-max).

vidually by the same procedures. P values < 0.05 were considered evidence of statistical significance. The JMP 11.0 software program (2013 SAS Institute Inc.) was used to perform the statistical analysis.

Results

1. Mortality and Morbidity

Results of the follow-up are presented in Table 2. The early postoperative complications morbidity rate was 27% (40 cases), and morbidity rates for individual complications were: SBO 15.0% (22 cases), SSI 11% (16 cases), postoperative hemorrhage 2.0% (3 cases), and colonic perforation 0.7% (1 case). The reoperation rate was 0.7% (1 case), and the mortality rate was 0%. The patient who required reoperation had a colonic perforation affected by compression of intraperitoneal drainage. The median postoperative hospital stay was 12 (10-13) days in the complication-free group, 17 (12-25) days in the complication group, and the difference was statistically significant ($p < 0.0001$). There were no cases of anastomotic leakage, wound dehiscence, incisional hernia, or enterocutaneous fistula.

2. Identification of risk factors

Since no radiation therapy or chemical preparation had been performed, and all of the patients had received perioperative intravenous antibiotics, we calculated the AIC scores of just the other 35 variables (Table 3). The low-score AIC variables were: intraoperative blood loss (−4.68), ASA (−4.39), diabetes (−3.15), age (−3.15), antiplatelet drug therapy (−2.63), and cardiovascular disease (−2.55), and these 6 variables were subjected to the univariate analysis and multivariate analysis. Significant risk factors according to the univariate analysis were: intraoperative blood loss ≥50 ml, AS class 2/3, diabetes positive, age ≥75 y, antiplatelet drug therapy positive, and cardiovascular disease positive (Table 4). Only intraoperative blood loss ≥50 ml was identified as a significant risk factor in the multivariate analysis ($p = 0.0219$) (Table 5).

3. Identification of risk factors for SSI and SBO

We attempted to identify risk factors for SSI and SBO, which had particularly high incidences among the postoperative complications. First, we calculated the AIC scores of the 35 variables in relation to SSI and SBO (Table 6). The low-score AIC variables associated with SSI were: diabetes (−4.34), sex (−4.03), number of laparotomies (−2.34), and renal dysfunction (−2.23). The low-score AIC variables associated with SBO were: intraoperative blood loss (−4.90), and ASA (−1.71). Significant risk factors for SSI according to the univariate analysis were: diabetes positive, male sex, and renal dysfunction positive. Significant risk factors for SSI according to the multivariate analysis were diabetes positive ($p = 0.0253$) and renal dysfunction positive ($p = 0.0352$) (Table 7). The only significant risk factor for SBO according to the univariate analysis was in-

Table 3 AIC score for variables associated with complications

Factor (36 variables)	AIC score
intraoperative blood loss	−4.68
ASA classification	−4.39
diabetes	−3.15
age	−3.15
antiplatelet drug therapy	−2.63
cardiovascular disease	−2.55
subcutaneous drainage	−1.47
hypertension	−0.41
smoking habit	−0.40
interval	−0.27
renal dysfunction	0.02
postoperative heparin therapy	0.67
intraperitoneal drainage	0.74
neutrophil count	0.86
mechanical bowel preparation	0.92
leukocyte count	0.96
anemia	0.99
sex	1.07
duration of surgery	1.14
total protein level	1.69
plumonary dysfunction	1.70
operation period	1.72
oral anticoagulant therapy	1.76
number of laparotomies	1.84
albumin level	1.86
hepatic dysfunction	1.87
cerebral disesase	1.89
corticosteroid therapy	1.98
suturing technique	1.99
lymphocyte count	1.99
operation of underlying disease (open or laparoscopy)	1.99
immunosuppressant therapy	2.00
cancer chemotherapy	2.00
BMI	2.97
surgeon's experience	3.67
underlying disease	3.76

Table 4 Univariate analysis of risk factors of postoperative early complications after LI closure

Variables	Complication (−)	Complication (+)	p-value
intraoperative blood loss (<50 ml, ≥50 ml)	89, 18	25, 15	0.0097
ASA classification (class 1, class 2/3)	38, 69	6, 34	0.0156
diabetes (+, −)	7, 100	8, 32	0.0164
age (75 year>, 75 year<)	100, 7	32, 8	0.0164
antiplatelet drug therapy (+, −)	3, 104	5, 35	0.0211
cardiovascular disease (+, −)	6, 101	7, 33	0.0238

traoperative blood loss ≥50 ml. The only significant risk factor for SBO in the multivariate analysis was intraoperative blood loss ≥50 ml (p = 0.0080) (Table 8).

Discussion

Because the morbidity rate of LI closure operations is known to be high[4], there have been many reports on postoperative complications, and studies have been conducted on risk factors.

The following are risk factors for complications after stoma closure that have been reported in the

Table 5 Multivariate analysis of risk factors of postoperative early complications after LI closure

Variables	p-value	Odds ratio	95%CI
intraoperative blood loss ≥50 ml	0.0219	2.76	1.15-6.61
ASA class 2/3	0.0997	2.34	0.89-6.98
age≥75 year	0.2874	1.94	0.55-6.69
diabetes positive	0.4060	1.72	0.46-6.13
cardiovascular disease positive	0.4684	1.70	0.37-7.13
antiplatelet drug therapy positive	0.6749	1.49	0.22-9.90

※CI=confidence interval.

Table 6 AIC score for variables associated with SBO and SSI

AIC score for variables associated with SBO		AIC score for variables associated with SSI	
Factor (36 variables)	AIC score	Factor (36 variables)	AIC score
intraoperative blood loss	−4.90	diabetes	−4.34
ASA classification	−1.71	sex	−4.03
antiplatelet drug therapy	−0.62	number of laparotomies	−2.34
BMI	−0.49	renal dysfunction	−2.23
albumin level	−0.33	hypertension	−1.40
cardiovascular disease	−0.32	leukocyte count	−0.78
underlying disease	−0.31	mechanical bowel preparation	−0.13
interval	0.07	operation period	0.42
cancer chemotherapy	0.14	BMI	0.52
subcutaneous drainage	0.62	albumin level	0.54
cerebral disesase	0.67	neutrophil count	0.70
operation of underlying disease (open or laparoscopy)	1.21	operation of underlying disease (open or laparoscopy)	0.82
neutrophil count	1.22	ASA classification	0.84
postoperative heparin therapy	1.23	smoking habit	0.98
duration of surgery	1.29	interval	1.51
mechanical bowel preparation	1.35	corticosteroid therapy	1.73
smoking habit	1.64	cardiovascular disease	1.73
plumonary dysfunction	1.69	intraperitoneal drainage	1.74
age	1.69	immunosuppressant therapy	1.74
anemia	1.82	suturing technique	1.75
operation period	1.83	cerebral disesase	1.77
intraperitoneal drainage	1.88	total protein level	1.80
immunosuppressant therapy	1.88	duration of surgery	1.90
hepatic dysfunction	1.88	plumonary dysfunction	1.90
leukocyte count	1.92	age	1.90
sex	1.94	oral anticoagulant therapy	1.91
number of laparotomies	1.94	intraoperative blood loss	1.93
renal dysfunction	1.96	subcutaneous drainage	1.96
diabetes	1.96	cancer chemotherapy	1.96
oral anticoagulant therapy	1.97	anemia	1.96
hypertension	1.99	lymphocyte count	1.98
corticosteroid therapy	1.99	antiplatelet drug therapy	1.98
suturing technique	1.99	postoperative heparin therapy	2.00
total protein level	2.00	hepatic dysfunction	2.00
lymphocyte count	2.00	underlying disease	3.13
surgeon's experience	3.00	surgeon's experience	3.48

literature: age[5], no preoperative systemic antibiotic administration[5], corticosteroid therapy[6], preoperative hypoalbuminemia[6], surgeon's experience[7)8)], underlying disease[5)9)19)], stoma site[5)10)], operative technique[11)20)~22)], interval between primary operation and stoma closure[8)12)~15)22)], postoperative hypoalbu-

Table 7 Univariate analysis and Multivariate analysis of SSI

Univariate analysis

Variables	Complication (−)	Complication (+)	p-value
diabetes (+, −)	10, 121	5, 11	0.0032
renal dysfunction (+, −)	5, 126	3, 13	0.0129
sex (male, female)	76, 55	14, 2	0.0223
number of laparotomies (1 time, ≥2 times)	95, 36	15, 1	0.0647

Multivariate analysis

Variables	p-value	Odds ratio	95%CI
diabetes positive	0.0253	5.36	1.19-24.06
renal dysfunction positive	0.0352	8.85	1.15-81.75
male sex	0.1986	2.87	0.68-19.93
number of laparotomies 1 time	0.0500	14.38	1.63-425.55

※CI = confidence interval.

Table 8 Univariate analysis and Multivariate analysis of SBO

Univariate analysis

Variables	Complication (−)	Complication (+)	p-value
intraoperative blood loss (<50 ml, ≥50 ml)	102, 23	12, 10	0.0050
ASA (class 1, class 2/3)	41, 84	3, 19	0.0703

Multivariate analysis

Variables	p-value	Odds ratio	95%CI
intraoperative blood loss ≥50 ml	0.0080	3.71	1.39-9.85
ASA class 2/3	0.0866	3.11	0.96-14.01

※CI = confidence interval.

minemia[18], and ASA[16)17)].

Thus, the risk factors vary among reports, and no unanimity of opinion exists. In view of this, we sought risk factors using a method different from that used in previous studies, by taking note of the statistical analysis methods. In previous studies, it was common practice to initially carry out univariate analysis for each variable, and then, any variable found to be statistically significant was subjected to multivariate analysis to extract the independent risk factors. Eventually, variables to be entered into the multivariate analysis were selected based on the p-values. However, p-values are unsuited to comparisons, and it is considered desirable to employ relevant information criteria for comparing multiple variables. In the present study we extracted risk factors objectively by using the AIC, which is a statistical information criterion, the first time that this method has been used in the study of stoma closure. The attempt to separately identify risk factors for postoperative complications with particularly high incidences, i.e., SBO and SSI, yielded new findings.

The morbidity rates in earlier reports have varied, and differences in observation periods and definitions of complications appear to be the reasons for the variation. We restricted the observation period in our own cases to the postoperative hospital stay, and we restricted the complications to the surgical one. The report by Andre et al contains the largest number of cases in this area of research in recent years[4]. They conducted a systematic review of LI closure in 48 studies, 6,107 cases, during the 1980-2008 period and reported morbidity in 17.3%, a mortality rate of 0.4%, an SBO incidence of 7.2%, SSI incidence of 5.0%, and prolonged ileus in 3.8%. The

reason for the high complication rate among our own cases may have been that we included both bowel obstruction and prolonged ileus in the definition of SBO. SBO was the most common complication in the literature including the systematic review[4)17)25)]. As well, the incidence of SSI was also found to be high. Thus it is imperatives to find ways of reducing the events of both SBO and SSI.

In our study intraoperative blood loss ≥50 ml was found to be a risk factor for postoperative surgical complications of LI closure, and ours is the first study to report this finding. Intraoperative blood loss per se seems not to be the cause of complications. Rather, the difficulty of surgery may be the confounder of the association because the standardized operative technique of LI closure in our department resulted in little blood loss in many patients.

Not all of the previously recognized risk factors were included in our own cases, but we observed significant differences in regard to age and ASA classification in the univariate analysis.

The factor intraoperative blood loss ≥50 ml was also associated with SBO. Again, the association may be confounded with difficulty of surgery. The causes of SBO have reported to be small bowel torsion, adhesions, edema, or anastomotic stricture[17)26)27)]. Thus, it might be possible to reduce the incidence by performing careful dissection of adhesions, maneuvers that restore the bowel to its proper position, and use of laparoscopic procedure for initial surgery and of adhesion-preventing materials. Moreover, the methods of anastomosis have been often debated in regard to SBO. Some investigators claimed that SBO was less common when stapling was used instead of hand sewing[28)], while others indicated that the two method were equivalent[26)29)]. However, the reports expressing the latter opinion include a report of a meta-analysis by Terry et al[26)] and a report of a multicenter randomized trial by Loffler et al[29)], and both of them report that using staple reduces operation time. No significant difference in anastomosis methods was observed among our own cases, but mechanical anastomosis had been performed in 90% of them. The primary approach in our present series was evaluated separately for laparoscopic surgery and laparotomic procedures, but this variable failed to be selected as a risk factor for SBO. This result could be attributable to a large proportion of patients having been treated by hand-assisted laparoscopic surgery (HALS) (21 pts.) among the 30 patients who underwent laparoscopic surgery.

Diabetes and renal dysfunction were risk factors for SSI. SSI seems to be more common as a postoperative complication of stoma closure after colostomy than after ileostomy[1)], but the incidence of SSI after LI closure is not very low. Wound closure methods are often debated in regard to reducing SSIs. There are reports of studies that compared primary closure and secondary intention[30)], delayed closure and packing[31)], and purse-string wound closure[19)32)33)], and many of them reported that one of these methods, purse-string wound closure, in particular, was better[19)30)32)33)]. A conclusion has yet to be reached, but purse-string wound closure may reduce SSIs, particularly in cases with risk factors for SSI.

Kim et al conducted a study focused on nutritional status, and it is very interesting that they reported finding that even though the difference in preoperative blood albumin values was not significant, postoperative hypoalbuminemia and an decrease in albumin concentration between before and after surgery (1.3 mg/dl or more) were significant risk factors for SSI.

Because this was a retrospective study, there were various biases that it was impossible to eliminate. This study had several limitations. First, the design of this study, which was a retrospective investigation rather than a randomized controlled study, was not suitable for verification of the causal relationships between the risk factors and the complications. Secondly, some selection bias may have existed, insomuch as the present study population consisted of patients who had undergone LIC at this department. Thirdly, the relationship between surgical blood loss and the complication rate is considered to be confounded by the presence of adhesions, yet quantification of adhesions is difficult, so that

such parameters cannot be controlled for.

In order to make LI closure a safer operation that is less stressful for patients, in the future it will be necessary to conduct further assessments of risk factors and to continue improving surgery for patients who have risk factors and improving their perioperative management.

Conclusion

There was a high morbidity rate after LI closure (27%), and SBO and SSI were the most frequent complications. The only significant risk factor for early postoperative surgical complications after LI closure was intraoperative blood loss ≥50 ml. An effort to decrease blood loss will be necessary to reduce complications. Intraoperative blood loss ≥50 ml was also a significant risk factor for SBO, and diabetes and renal dysfunction were significant risk factors for SSI. Efforts should be made to reduce surgical complications with these risk factors taken into account.

The authors indicated no conflicts of interest.

References

1) **Chen J, Zhang Y, Zhou SJ et al**: Temporary ileostomy versus colostomy for colorectal anastomosis: evidence from 12 studies. Scand J Gastroenterol **48**: 556–562, 2013
2) **Rondelli F, Reboldi P, Noya G et al**: Loop ileostomy versus loop colostomy for fecal diversion after colorectal or coloanal anastomosis: a meta-analysis. Int J Colorectal Dis **24**: 479–488, 2009
3) **Güenaga KF, Lustosa SAS, Matos D et al**: Ileostomy or colostomy for temporary decompression of colorectal anastomosis. Cochrane Database Syst Rev **24** (1): 2008
4) **Chow A, Tilney HS, Purkayastha S**: The morbidity surrounding reversal of defunctioning ileostomies: a systematic review of 48 studies including 6,107 cases. Int J Colorectal Dis **24**: 711–723, 2009
5) **Garber HI, Morris DM, Annous MO et al**: Factors influencing the morbidity of colostomy closure. Dis Colon Rectum **25** (5): 464–470, 1982
6) **Mileski WJ, Rege RV, Nahrwold DL et al**: Rates of morbidity and mortality after closure of loop and end colostomy. Surg Gynecol Obstet **171**: 17–21, 1990
7) **Riesener KP, Lehnen W, Schumpelick V et al**: Morbidity of ileostomy and colostomy closure: Impact of surgical technique and perioperative treatment. World J Surg **21**: 103–108, 1997
8) **Demetriades D, Pezikis A, Pickles G et al**: Factors influencing the morbidity of colostomy closure. Am J Surg **155** (4): 594–596, 1988
9) **Rosen L, Friedman I**: Morbidity and mortality following intraperitoneal closure of transverse loop colostomy. Dis Colon Rectum **23**: 508–512, 1980
10) **Pittman DM, Smith LE**: Complications of colostomy closure. Dis Colon Rectum **28**: 836–843, 1985
11) **Kohler A, Athanasiadis S, Nafe M et al**: Postoperative ergebnisse nach colostomie- und Ileostomieruckverlegung. Chirurg **65**: 529–532, 1994
12) **Salley RK, Bucher RM, Rodning CB**: Colostomy closure: morbidity reduction employing a semi-standardized protocol. Dis Colon Rectum **26**: 319–322, 1983
13) **Parks SE, Hastings PR**: Complications of colostomy closure. Am J Surg **149**: 672–675, 1985
14) **Freund HR, Raniel J, Muggia SM**: Factors affecting the morbidity of colostomy closure: a retrospective study. Dis Colon Rectum **25**: 712–715, 1982
15) **Knox AJ, Birkett FD, Collins CD**: Closure of colostomy. Br J Surg **58**: 669–672, 1971
16) **Cipe G, Erkek B, Gecim E et al**: Morbidity and mortality after the closure of a protective loop ileostomy: analysis of possible predictors. Hepatogastroenterology **59**: 2168–2172, 2012
17) **van Westreenen HL, Visser A, Bemelman WA**: Morbidity related to defunctioning ileostomy closure after ileal pouch-anal anastomosis and low colonic anastomosis. Int J Colorectal Dis **27**: 49–54, 2012
18) **Kim MS, Kim HK, Ju JK et al**: The influence of nutritional assessment on the outcome of ostomy takedown. J Korean Soc Coloproctol **28**: 145–151, 2012
19) **Camacho-Mauries D, Rodriguez-Díaz JL, Vergara-Fernández O**: Randomized clinical trial of ostomy takedown comparing purstring wound closure vs conventional closure to eliminate the risk of wound infection. Dis Colon Rectum **56**: 205–211, 2013
20) **Pokorny H, Herkner H, Herbst F et al**: Predictors for complications after loop stoma closure in patients with rectal cancer. World J Surg **30**: 1488–1493, 2006
21) **Pokorny H, Herkner H, Herbst F et al**: Mortality and complications after stoma closure. Arch Surg **140**: 956–960, 2005
22) **Freund HR, Raniel J, Muggia-Sulam M**: Factors affecting the morbidity of colostomy closure. Dis Colon Rectum **25**: 712–715, 1982
23) U.S. Department of Health and Human Services: Common Terminology Criteria for Adverse Events (CTCAE) version 4.0. National Cancer Institute, National Institutes of Health (2009)
24) **Pierre AC, Jeffrey B, Masatoshi M et al**: The Clavien-Dindo classification of surgical complications. Five-year experience. Ann Surg **250**: 187–196, 2009
25) **Monica MB, Jose AGM, Jose LAA et al**: Proctective ileostomy: complications and mortality associated with its closure. Rev Esp Enferm Dig **104**: 350–354, 2012

26) **Terry TWL, Anthony RM, Elijah D et al**: Comparison of stapled versus handsewn loop ileostomy closure: A meta-analysis. J Gastrointest Surg **12**: 939–944, 2008
27) **Gooszen AW, Geelkerken RH, Gooszen HG et al**: Temporary decompression after colorectal surgery. Br J Surg **85** (1): 76–79, 1998
28) **Shelygin YA, Chernyshov SV, Rybakov EG et al**: Stapled ileostomy closure results in reduction of postoperative morbidity. Tech Coloproctol **14**: 19–23, 2010
29) **Loffler T, Rossion I, Weitz J et al**: Hand suture versus stapling for closure of loop ileostomy (HASTA Trial): results of a multicenter randomized trial (DRKS00000040). Ann Surg **256**: 828–835, 2012
30) **Vermulst N, Vermeulen J, van der Harst E et al**: Primary closure of the skin after stoma closure. Dig Surg **23**: 255–258, 2006
31) **Harold DM, Johnson EK, Steele SR et al**: Primary closure of stoma site wounds after ostomy takedown. Am J Surg **199**: 621–624, 2010
32) **Reid K, Pockney P, Pollitt T et al**: Randomized clinical trial of short-term outcomes following purse-string versus conventional closure of ileostomy wounds. Br J Surg **97**: 1511–1517, 2010
33) **Camacho-Mauries D, Rodriguez-Diaz JL, Salgado-Nesme N et al**: Randomized clinical trial of intestinal ostomy takedown comparing purse-string wound closure vs conventional closure to eliminate the risk of wound infection. Dis Colon Rectum **56**: 205–211, 2013

回腸双孔式人工肛門閉鎖術後の外科的短期合併症のリスク因子に関する検討

[1]東京女子医科大学医学部外科学（第2）講座（主任：亀岡信悟教授，指導：板橋道朗准教授）
[2]東京女子医科大学総合研究所
井原（イハラ） 健（タケシ）[1]・板橋（イタバシ） 道朗（ミチオ）[1]・清水（シミズ） 悟（サトル）[2]・亀岡（カメオカ） 信悟（シンゴ）[1]

〔緒言〕近年，下部直腸癌や潰瘍性大腸炎において骨盤内の低い位置での吻合が行われるようになり，吻合部の安静を保つため一時的な loop ileostomy (LI) の造設術とその閉鎖術の必要性は高まっていると考えられる．しかし，LI 閉鎖術の合併症率は 17.3% (3-38.5%) であり少なくない．そのためリスク因子の検討が行われているが一定した見解は得られていない．そこで従来とは異なる方法でリスク因子を求めることを目的とし，情報基準を用いたモデル選択から多変量解析を行う方法で検討を行った．〔対象と方法〕2004 年から 2013 年までに原疾患を問わず当科で経験した LI 閉鎖術 147 例を対象とした．術後入院期間中の合併症率，再手術率，死亡率，術後在院日数をアウトカムとし解析を行った．また，年齢，性別，BMI，原疾患，原疾患に対する前治療，術前併存症，血液検査などの患者因子と術中出血量，手術時間，吻合方法などの手術因子の各因子に対し AIC (Akaike information criterion) を用いて客観的にモデル選択を行い，多変量解析を行って合併症のリスク因子を同定した．〔結果〕術後早期の外科的合併症は 40 例（27%）に認められた．術後合併症の内訳は腸閉塞 22 例（15%），創感染 16 例（10.9%），術後出血 3 例（2%），結腸穿孔 1 例（0.7%）であった．患者因子と手術因子の AIC を計算し，AIC が低い因子に対して多変量解析を行った．その結果，術中出血量 50 ml 以上 ($p=0.0219$, OR 2.76, 95%CI 1.15-6.61) が術後早期の外科的合併症のリスク因子であった．同様の方法で腸閉塞と創感染の解析を行い，腸閉塞は術中出血量 50 ml 以上 ($p=0.0080$, OR3.71, 95%CI 1.39-9.85) が，創感染は糖尿病 ($p=0.0253$, OR 5.36, 95%CI 1.19-24.06)，腎障害 ($p=0.0352$, OR 8.85, 95%CI 1.15-81.75) がリスク因子であった．〔結論〕術後早期の外科的合併症のリスク因子は術中出血量 50 ml 以上であり，合併症減少のためには出血量を減らす努力が必要である．合併症毎でみると腸閉塞については術中出血量 50 ml 以上が，SSI については糖尿病と腎障害を有することがリスク因子であった．このようなリスク因子を考慮し合併症の低減に努めるべきである．