Evaluation of a Transumbilical Incision as an Approach for Organ Removal in Laparoscopy-assisted Colectomy

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Abstract. *Aim: To investigate the risk factors of transumbilical incision for organ removal in laparoscopy-assisted colectomy (LAC). Patients and Methods: We enrolled 348 consecutive patients who underwent LAC at our hospital between 2010 and 2013. The occurrence of superficial surgical site infection (SSI) and hernia at the transumbilical port site were recorded. Results: SSI was observed in 15 patients (4.31%); there were no obvious associated risk factors. Hernia occurred in 23 patients (6.61%); multivariate analysis revealed that female sex [odds ratio (OR)=4.736, 95% confidence interval (CI)=1.058 to 24.362; p=0.042] and diabetes mellitus (OR=4.655, 95% CI=1.520 to 13.585; p=0.004) were significantly associated with the risk of hernia. Anastomotic method and the anastomotic site (inside and outside the body) did not contribute to the occurrence of complications. Conclusion: Female sex and diabetes mellitus are independent risk factors for hernia formation in patients undergoing transumbilical incision for organ removal in laparoscopy-assisted colectomy.*

In laparoscopic surgery, a transumbilical incision is often used for anastomosis and organ removal. In our Department, we have been performing transumbilical incisions to remove resected organs since shortly after the introduction of laparoscopic surgery. We vertically extend the umbilical wound corresponding to the size of the specimen and anastomose extracorporeally. We have already reported that surgical site infection (SSI) and hernia occurred at a significantly higher rate in colorectal resection than in gastric

resection in laparoscopic surgery. Additionally, we showed that female sex and diabetes mellitus (DM) were independent risk factors in relation to hernia (1).

The present study aimed to evaluate the complication rates and risk factors associated with transumbilical incisions in laparoscopy-assisted colectomy (LAC).

Patients and Methods

This study included a cohort of 417 consecutive patients who underwent LAC for colorectal cancer at the Division of Gastroenterological and General Surgery, Department of Surgery, Showa University Hospital, Japan, between January 2010 and December 2013. The exclusion criteria were as follows: reoperation in the early postoperative period, follow-up by other hospitals from the early postoperative period, conversion to laparotomy, multiple simultaneous procedures, and unknown details regarding the anastomosis. Of the 417 patients, 69 were excluded. The study protocol was approved by the Showa University Institutional Review Board (approval number: 1917), University Hospital Medical Information Network (UMIN) ID: 000021651.

Patient data, including sex, age, height, weight, body mass index (BMI), history of DM, type of anastomosis [functional end-to-end anastomosis (FEEA), double-staple technique (DST), and hand-sewn end-to-end anastomosis (HEEA)], anastomotic point (extracorporeal and intracorporeal), type of surgery, surgical duration, amount of blood loss, maximum tumor diameter, intraoperative accident, SSI, umbilical wound port-site hernia, and length of postoperative hospital stay, were collected from the hospital database. Additionally, we retrospectively examined transumbilical wound SSI, hernia rate and risk factors associated with transumbilical incision.

SSI was defined according to the criteria of the American College of Surgeons National Surgical Quality Improvement Program (2). Wound hernia was defined according to the definition by Tonouchi *et al*. (3). We followed-up patients every 3 months in the first postoperative year and yearly thereafter for 3 years. SSIs were monitored by the Infection Control Team of our hospital, and umbilical port-site hernias were routinely assessed according to computed tomography (CT) and clinical findings. Patients with DM were allowed to undergo diabetes assessments preoperatively and were operated on under glycemic control.

In all cases, preoperative mechanical bowel preparation was performed, and a second-generation cephalosporin was administered intravenously 30 minutes before surgery. Additionally, wound

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closure methods and covering methods were performed following a standardized protocol at our Department. We cut the skin in a craniocaudal direction from the center of the navel and inserted the first 12-mm port *via* the closed method (Figure 1a).

The umbilical wound was extended in the craniocaudal direction to account for the size of the resected organ (approximately 3-5 cm) (Figure 1b), and a wound protector was attached to extract the specimen (Figure 1c and d). An appropriate anastomosis method was selected based on the type of operation. FEEA was carried out using an automatic suture instrument, and HEEA was performed using the Gambee anastomosis method with a 3-0 absorbable thread. An automatic anastomotic device was used for DST.

The anterior and posterior laminae of the rectal sheath on the wound were continuously sutured with a monofilament absorbable suture material. All wounds were washed with 50 ml saline, and buried interrupted dermal sutures were performed using a 4-0 monofilament absorbable suture material. We used silver and hydrocolloid dressing to prevent superficial SSI, and the wound was sealed for 48 hours postoperatively (Figure 1e and f).

Data are presented as mean±standard deviation (SD) unless otherwise specified. Risk factors were investigated using univariate analyses, including the chi-squared test, Fisher's exact test, Wilcoxon rank-sum test, Wilcoxon signed-rank test, and univariate logistic regression. Significant variables were then analyzed using multivariate logistic regression analysis. All analyses were performed using JMP 12 (SAS Institute Inc., Cary, NC, USA). Statistical assessments were two-sided, and a *p*-value of less than 0.05 was considered to indicate significance.

Results

Of the total 348 patients, 200 were male (57.5%) and 148 were female (42.5%), with a mean±SD age of 69.09±11.71 years (median, 71 years; range, 22-91 years). The details of anastomosis for each procedure are shown in Table I.

SSI was observed in 15 patients (4.31%). In the univariate analysis comparing groups with and without SSI, there were no significant differences, except for the duration of postoperative hospital stay, which, as would be expected, was significantly longer in patients with SSI (Table II).

An umbilical wound hernia was observed in 23 patients (6.61%). The median time to hernia development was 12 months (range=3-24 months). On comparing the groups with and without umbilical wound hernia, there were significant differences in weight (*p*=0.014), BMI (*p*<0.001), DM (*p*=0.004), and blood loss (*p*=0.002), whereas there was no significant difference in sex (*p*=0.081) (Table III). In multivariate analysis, female sex [odds ratio (OR)=4.736, 95% confidence interval (CI)=1.058 to 24.362; *p*=0.042] and DM (OR=4.655, 95% CI=1.520 to 13.585; *p*=0.004) were significantly associated with increased risk of hernia (Table IV).

Discussion

An umbilical incision has been commonly used in laparoscopic surgery recently. Although a transumbilical incision is generally avoided because of the possibility of SSI and postoperative

Table I. *Surgical procedure and anastomotic methods used in transumbilical incision approach for laparoscopy-assisted colectomy.*

Procedure	Number of patients	Anastomosis: FEEA/HEEA/DST
Ileocecal resection	29	29/0/0
Right colon resection	60	60/0/0
Right hemicolectomy	32	32/0/0
Transverse partial resection	15	13/2/0
Left hemicolectomy	1	1/0/0
Left colon resection	24	20/3/1
Sigmoid colectomy	81	25/2/54
High anterior resection	35	0/0/35
Low anterior resection	71	0/0/71
Total	348	

FEEA, Functional end-to-end anastomosis; HEEA, hand-sewn end-to-end anastomosis; DST, double-staple technique.

adhesion, it was shown not to be associated with complications (4). In our Department, we have used a transumbilical incision routinely in all abdominal surgeries considering it to have the following advantages: (a) better cosmetic outcomes and ease of extension, (b) ability to minimize the skin incision, and (c) ability to reach the abdominal cavity safely and securely *via* the shortest anatomical distance.

With regard to wound extension, if fasciotomy is carried out completely, it is possible to extract large specimens by utilizing the extensibility of the skin in the umbilicus, without excessive skin incision. Thus, it is considered that a transumbilical incision is rational and provides an excellent esthetic outcome.

We have already reported that we found SSI to occur at a significantly higher rate in colorectal resection than in gastric resection (1), and the most likely cause is bacterial contamination at extracorporeal manipulation for resection and anastomosis. In this study, we limited the procedure to LAC and included the anastomotic method (FEEA, HEEA, and DST) and anastomotic site (inside and outside the body) as evaluated variables. Additionally, we investigated the usefulness of the wound for organ removal and examined the risk factors for complications. The anastomotic methods differed as FEEA and HEEA were extra-abdominal procedures, and DST was an intra-abdominal procedure.

Umbilical port-site SSI has been reported to occur at rates of 1.06-25.9% (5-9). Laparoscopic procedures were found to reduce the incidence of port-site infections and other wound-related complications (10). The risk factors for SSI limited to laparoscopic colon resection have been reported to include increased BMI and a history of DM (11-13). Wound retractors can prevent infection after laparoscopic colorectal procedures, indicating that the methods and instruments used are important (14, 15). In our department, the incidence of
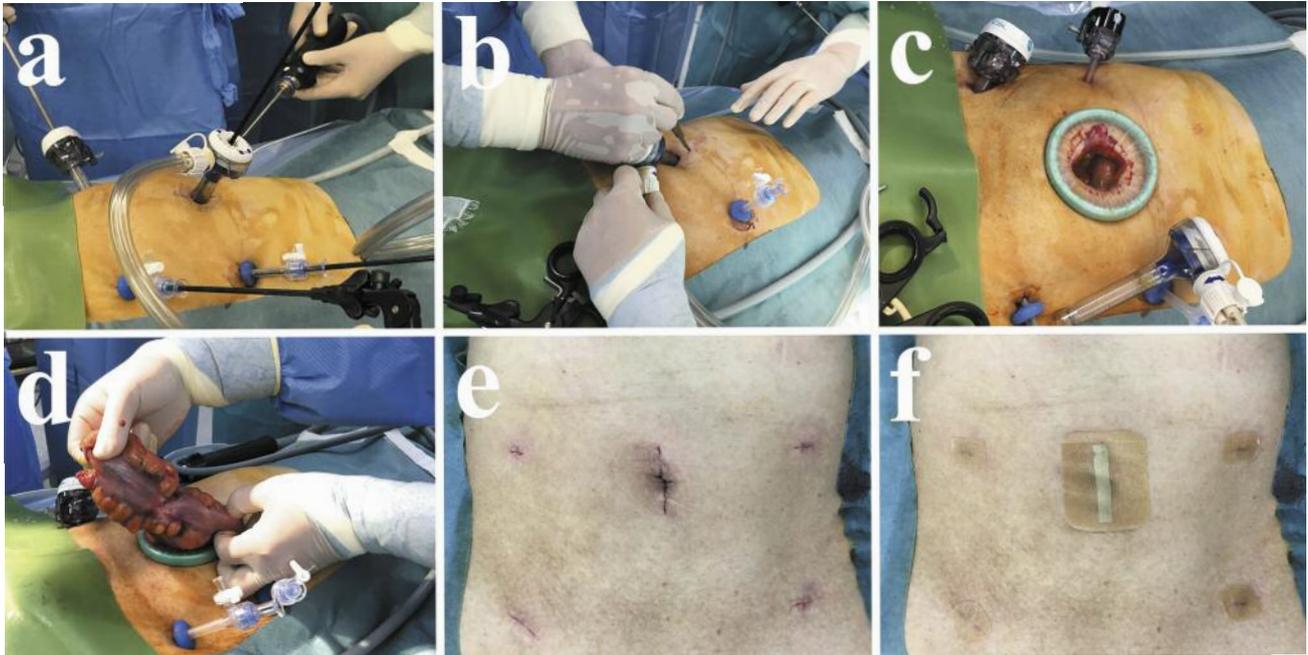
Figure 1. *Transumbilical wound. a: Intraoperative insertion of a 12-mm port through the transumbilical wound. b: The wound is cut and extended to enable removal of the organ. c: The wound protector is attached. d: The resected specimen is removed. e: The wound after closure. f: The wound is covered with silver ion and hydrocolloid dressing.*

Table II. *Demographic data of patients with and without transumbilical wound surgical site infection (SSI) after laparoscopy-assisted colectomy with transumbilical incision approach.*

Variable		No SSI (n=333)	SSI (n=15)	*p*-Value
Age (years)	Mean±SD	69.18±11.59	67.60±13.85	0.863
Gender	Male:female	191:142	9:6	>0.999
Height (cm)	Mean±SD	159.29±9.60	159.73±8.20	0.780
Weight (kg)	Mean±SD	57.46±11.54	57.46±11.20	0.661
BMI (kg/m^2)	Mean±SD	22.53±3.54	21.97±3.50	0.579
DM	N (%)	34 (10.21%)	1 (6.67%)	>0.999
Anastomosis method	FEEA/DST/HEEA	171/156/6	9/5/1	0.292
Anastomotic point	Intra/extra	158/175	5/10	0.306
Operative time (min)	Mean±SD	173.53±67.54	175.00±58.52	0.712
Blood loss (g)	Mean±SD	38.88±115.12	111.00±213.26	0.209
Tumor major axis (mm)	Mean±SD	38.44±22.32	41.93±29.72	0.780
Intraoperative accident	N (%)	4 (1.20%)	0 (0%)	>0.999
Postoperative complication	N (%)	35 (10.51%)	3 (20.00%)	0.218
Hospital stay (days)	Mean ±SD	13.86±11.89	18.60±7.74	<0.001

BMI: Body mass index; DM: diabetes mellitus; FEEA/DST/HEEA: functional end-to-end anastomosis/ double staple teqnique/ hand-sewn end-to-end anastomosis; SSI: surgical site infection.

transumbilical wound SSI in LAC was 4.3% (15/348). There were no significant differences between the groups with and without SSI, and there were no obvious risk factors observed in the present study.

The incidence of a port-site hernia has been reported, with rates of 0-5.2% (6), 0.4% (5), 1.06% (8), 1.4% (7), and 25.9% (9). Nassar *et al.* observed that extension of the umbilical wound was the most significant risk factor (16). In

Table III. *Demographic data of patients with and without a transumbilical wound hernia after laparoscopy-assisted colectomy with transumbilical incision approach.*

Variable		No wound hernia (n=325)	Wound hernia (n=23)	p-Value
Age (years)	Mean±SD	69.21±11.69	67.87±12.07	0.522
Gender	Male:female	191:134	9:14	0.081
Height (cm)	Mean±SD	159.43±9.53	157.30±9.65	0.249
Weight (kg)	Mean±SD	56.96±11.44	63.27±11.19	0.014
BMI (kg/m^2)	Mean±SD	22.28±3.45	25.49±3.33	<0.001
DM	N (%)	28 (8.62%)	7 (30.43 %)	0.004
Anastomosis method	FEEA/DST/HEEA	170/149/6	10/12/1	0.555
Anastomotic point	Intra/extra	151/174	12/11	0.668
SSI	N (%)	14 (4.31%)	1 (4.35%)	1.000
Operative time (min)	Mean±SD	172.83±67.50	184.34±61.56	0.170
Blood loss (g)	Mean±SD	39.89±122.31	71.70±104.88	0.002
Tumor major axis (mm)	N (%)	38.62±22.92	38.26±19.12	0.853
Intraprocedure events	N (%)	4 (1.23%)	0 (0%)	1.000
Postoperative complication	N (%)	37 (11.38%)	1 (4.35%)	0.491

BMI: Body mass index; DM: diabetes mellitus; FEEA/DST/HEEA: functional end-to-end anastomosis/ double staple technique/ hand-sewn end-to-end anastomosis; SSI: surgical site infection.

addition, Comajuncosas *et al.* pointed out that DM, SSI, wound size, and higher BMI were risk factors for hernia formation, although their research was limited to cholecystectomies (9).

In the present study, an umbilical port-site hernia was noted in 23 out of 348 patients (6.61%). Univariate analysis for port-site hernia indicated a greater risk was associated with increased weight ($p=0.014$), increased BMI ($p<0.001$), a history of DM ($p=0.004$), and increased blood loss ($p=0.002$). The female count was high in the hernia group; however, no significant result was obtained ($p=0.081$). As female sex was identified as a risk factor in our previous study, multivariate analysis was performed. The multivariate analysis revealed that female sex (OR=4.736) and DM (OR=4.655) contributed to the risk of developing a hernia.

We had previously reported that there were no obvious risk factors for SSI and that female sex (OR=5.410) and DM (OR=4.437) were believed to be risk factors for developing a hernia (1). Owing to the richness of subcutaneous fat in women, suturing a transumbilical wound can be difficult. Thus, technical factors are involved. With regard to the influence of BMI as an index of obesity, we compared the BMI in women with and without hernias, and the BMIs were 25.32±3.27 and 22.38±3.50 kg/m^2, respectively ($p=0.0023$). However, the direct relationship between subcutaneous fat and BMI remains unknown, and we look forward to a further study to evaluate this relationship. In the present study, female sex and DM were identified as risk factors for a transumbilical wound hernia in multivariate analysis, regardless of the surgical procedure.

Conversely, in order to consider the influence of contaminating bacteria and other factors, anastomotic

Table IV. *Multivariate ambos of risk of transumbilical wound hernia after laparoscopy-assisted colectomy with transumbilical incision approach.*

Variable		OR	95% CI	p-Value
Gender	Female *vs.* male	4.736	1.058-24.362	0.042
Weight	Per kg increase	1.032	0.882-1.063	0.495
BMI	Per kg/m^2 increase	1.147	0.680-1.109	0.264
DM	With *vs.* without	4.655	1.520-13.585	0.008
Blood loss	Per g increase	1.001	0.996-1.002	0.234

CI, Confidence interval; DM: diabetes mellitus; OR, odds ratio.

method and anastomotic site were added to the evaluation; however, no significant difference was observed. Based on the above findings and our previous report, it would seem that colorectal resection itself might be a risk factor for transumbilical wound complications.

The main features of this research are as follows. Firstly, the focus of this study was transumbilical incision as a site for organ removal rather than just a port wound. All specimens were removed through the transumbilical incision, and we extended the wound craniocaudally as necessary. Thus, a further incision for organ removal was not required. Furthermore, we believe that these research findings might suggest the utility of this type of incision in any laparoscopic surgery for all organs. Secondly, we examined and limited LAC to patients with malignant diseases. We routinely performed the operation with lymphadenectomy for

colorectal malignant disease, regardless of the disease stage. The surgeons had at least 5 years of postgraduate experience, with the possibility of minimal selection bias by the surgeons. Owing to the strict postoperative follow-up, there was minimal loss of data. Thirdly, all procedures from transumbilical incision to wound coating, including all methods of colectomy and perioperative management, were standardized at our Department through an operation manual, thereby minimizing variation and bias.

The present study has several limitations. Firstly, this was a retrospective study. The wound length in each case was unknown, and there was bias in variable settings. Secondly, the low incidence of and a small number of adverse events indicate that we cannot exclude the possibility of a type 2 error. Thirdly, our Institution shifted to laparoscopic surgery in 2010; therefore, we were unable to perform a comparison with open surgery.

In conclusion, female sex and DM are independent risk factors for hernia formation after transumbilical incision approach for LAC. Additionally, anastomosis methods and the anastomotic site (intra/extra-abdominal) did not contribute to the occurrence of complications. In modern laparoscopic surgery, our approach using transumbilical incision with organ removal, including wound closure and covering methods, can be considered a feasible and safe approach with good tolerability and rationality.

Compliance with Ethical Standards

Informed consent: Informed consent was obtained from all individual participants included in the study. The Authors thank the patients for allowing us to publish this study.

Conflicts of Interest

None of the Authors has any conflict of interest to declare in regard to this study.

Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol was approved by the Showa University Institutional Review Board (Approval number: 1917). University Hospital Medical Information Network (UMIN) ID: 000021651.

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