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Comparison Between Transverse Mini-Incision and Longitudinal Mini-Incision for the Resection of Locally Advanced Colonic Cancer

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We performed a retrospective review of non-overweight (body mass index $\leq$ 25 kg/m^2) patients scheduled to undergo a curative resection of locally advanced colon cancer via a transverse mini-incision (n = 62) or a longitudinal mini-incision (skin incision $\leq$7 cm, n = 62), with the latter group of patients randomly selected as historical controls matched with the former group according to tumor location. Extension of the transverse mini-incision wound was necessary in 3 patients (5%). Both groups were largely equivalent in terms of demographic, clinicopathological, and surgical factors and frequency of postoperative complications. Postoperative analgesic was significantly less ($P = 0.04$) and postoperative length of the hospital stay was significantly shorter ($P < 0.01$) in the transverse mini-incision group. Concerning a mini-incision approach for locally advanced colonic cancer, a transverse incision seems to be advantageous with regard to minimal invasiveness and early recovery compared with a longitudinal incision.

Key words: Colonic cancer – Colectomy – Transverse incision – Mini-laparotomy

As a useful alternative to laparoscopic-assisted surgery, we have performed a longitudinal mini-incision (skin incision, <7 cm) for the resection of locally advanced colonic cancer in non-overweight (body mass index <25.0 kg/m^2) patients since 2000 and have demonstrated satisfactory outcomes in terms of technical feasibility and safety, minimal invasiveness, and oncological safety.[1–5] The "longitudinal short" or "transverse" incision has been proposed as part of an enhanced recovery after surgery (ERAS) clinical care protocol,[6] which was developed firstly and mainly for open colectomies. The use of such incision types is considered to reduce postoperative pain, leading to a more rapid return of patient mobility. However, a "transverse mini-incision" has rarely been evaluated, probably

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because many surgeons likely believe a curative colectomy via such an incision type would be difficult to perform. In April 2009, we began using a "transverse mini-incision" for the curative resection of locally advanced colonic cancer as an alternative approach to the previously used "longitudinal mini-incision." We herein report the results of a comparison between "transverse mini-incision" and "longitudinal mini-incision" for the resection of locally advanced colonic cancer in terms of technical feasibility and safety as well as minimal invasiveness.

Patients and Methods

This study was approved by the local ethics committee of Saitama Medical Center, Saitama medical University.

Patients

Data for 62 patients with locally advanced colonic cancer who were scheduled to undergo curative resection via a transverse mini-incision $\leq$7 cm (transverse mini-incision group) between April 2009 and March 2013 were evaluated retrospectively. In addition, 62 patients with locally advanced colonic cancer who were scheduled to undergo curative resection via a longitudinal (transrectus or midline) mini-incision ($\leq$7 cm, longitudinal mini-incision group) between September 2002 and March 2009 were randomly selected as a control group and were matched with the patients in the transverse mini-incision group according to the tumor location. Patients with peritoneal carcinomatosis at the time of laparotomy were excluded.

Indications for transverse mini-incision

The inclusion and exclusion criteria for a transverse mini-incision were the same as for a longitudinal mini-incision performed prior to the introduction of the transverse mini-incision[1–5]: the inclusion criteria were a body mass index $\leq$25.0 kg/m^2, and a tumor size $\leq$7 cm, while the exclusion criteria were suspected severe adhesive formation after major abdominal surgery as determined by a computed tomography scan, and tumors invading the adjacent organs. Tumors located within 10 cm orally or anally from the splenic flexure were also excluded since such tumors are resected using laparoscopically assisted procedures at our institution.

Surgical techniques via transverse mini-incision

To standardize the surgical techniques of either transverse mini-incision or longitudinal mini-incision, board-certified surgeons of the Japan Society of Surgery and/or the Japan Society of Coloproctology managed all the surgical techniques as an operating surgeon or a supervisor. Thus, senior residents were occasionally an operating surgeon under the supervision of the board certificated surgeons (data not shown), similarly in conventional open curative colectomy. Drs. HI or JS was the operating surgeon or supervisor in the transverse mini-incision group, while Drs. HI, MY, or HN was the operating surgeon or supervisor in the longitudinal mini-incision group.

All the surgical procedures via the transverse mini-incision were the same as those via the longitudinal mini-incision reported elsewhere,[1–5] except for the method of exposing the abdominal cavity. Each patient was positioned supine. A transverse incision $\leq$7 cm was placed in principle in the right lower abdomen for cecal or ascending colon cancers, in the lower abdomen for descending colon or sigmoid colon cancers, and in the epigastrium for transverse colon cancers (Fig. 1A). Following the skin incision, the anterior sheath of the rectus abdominis and the peritoneum were also incised transversely, without splitting the rectus muscle. A wound retractor (Alexis, medium size; Applied Medical, Rancho Santa Margarita, CA) was placed against the edge of the wound with the rectus muscle retracted laterally (Fig. 1B). If necessary, 1 to 4 gauze swabs were placed intraperitoneally to retract the small bowel and omentum away from the operative field. We did not use any specific instruments to obtain surgical field. Instead, an assistant slid the wound into position utilizing conventional retractors. Bowel resection along with mesocolic excision and high ligation of the regional vessels (D3-level lymph node dissection according to the Japanese guidelines[7,8]) was performed using a medial to lateral approach (Figs. 1C, 1D). All anastomoses were stapled extracorporeally.

Perioperative care

The perioperative care was almost similar between the two groups, even though the types of mechanical bowel preparation (use of polyethylene glycol or sennoside, or no bowel preparation) and the doses of intravenous antimicrobial prophylaxis

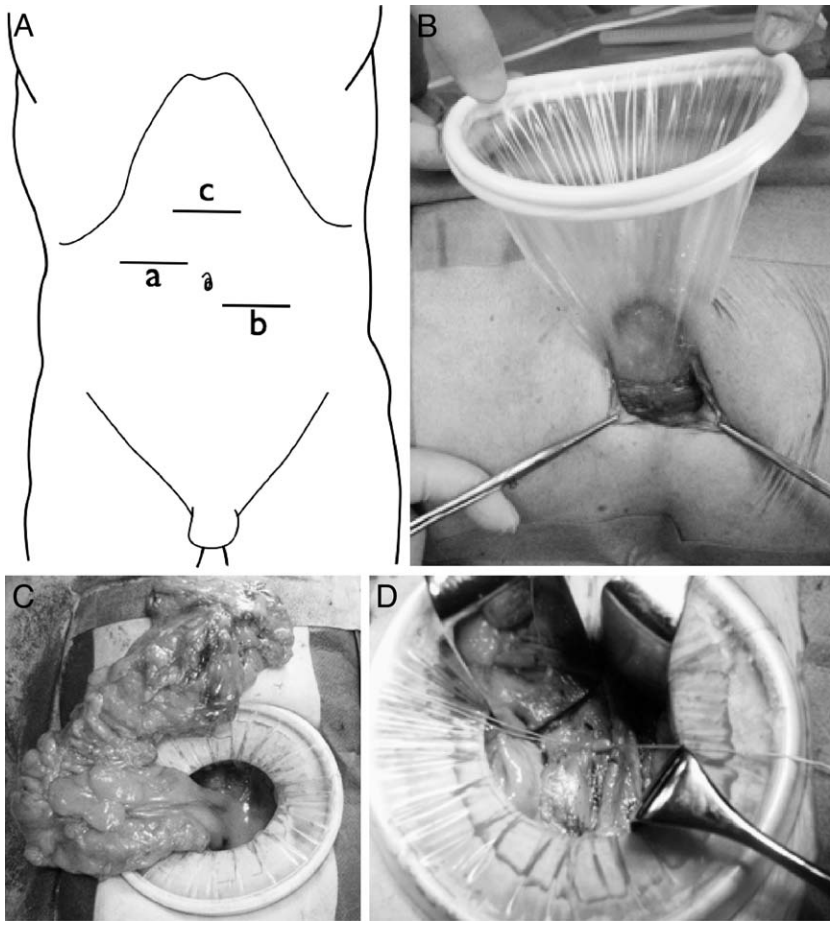

Fig. 1 (A) Schema showing transverse mini-incision according to the tumor site: (a) right-sided colon, (b) mid-transverse colon, and (c) left-sided colon. (B) Right-sided colon retracted through the wound. (C) Photograph showing a wound retractor attached to the edge of the transverse mini-incision in a patient with ascending colon cancer. (D) Exposed superior mesenteric vein and superior mesenteric artery during standard lymph node dissection for the ascending colon. The ileocolic artery being ligated just prior to dissection.

with second-generation cephalosporins (single or multiple) differed according to the study period. In patients in whom an epidural anesthesia was given intraoperatively, the anesthesia was continued for 48 hours postoperatively. All the patients were given patient-controlled analgesia (PCA) postoperatively until no longer needed and oral fluid and diet were given as tolerated. None of the patients were given oral painkillers. Patients were discharged when they were fully mobile with minimal pain, could tolerate a full diet and experience normal bowel function, and were willing to go home.

Factors evaluated

Data for both groups were collected prospectively and were recorded on the patients' medical charts. Demographic, clinicopathological, and surgical factors, as well as postoperative complications and parameters related to postoperative recovery, were compared between the two groups.

Statistical analysis

A statistical software package (StatFlex version 7.0; Artec, Osaka, Japan) running on a personal computer was used to conduct the analysis. Continuous data were expressed as the median and range and were compared using the Mann-Whitney test. Categorical data were compared using the χ^2 test or Fisher exact probability test where appropriate. All P values of less than 0.05 were denoted to be statistically significant. Since this study was performed on an intention-to-treat basis, patients with a failed mini-incision approach were included in the analysis.

Results

The site of tumor location was the cecum in 11 patients, the ascending colon in 24 patients, the transverse colon in 9 patients, the descending colon in 1 patient, and the sigmoid colon in 17 patients. Table 1 shows a comparison of the demographic,

Table 1 Comparison of demographics, clinicopathological and surgical factors between patients with transverse and those with longitudinal mini-incision

	Transverse mini-incision group (n = 62)	Longitudinal mini-incision group (n = 62)	*P* value
Age, years	70.5 (31–88)	71.5 (25–91)	0.92
Sex, male/female	31:31	30:32	>0.99
BMI, kg/m^2	21.6 (14.2–25.0)	21.6 (16.0–25.0)	0.53
Types of surgery			
Ileocecal resection	9	4	
Right (hemi) colectomy	29	34	
Transverse colectomy	6	5	
Left hemicolectomy	1	2	
Sigmoidectomy	17	17	0.60
Maximal tumor diameter, mm	40 (10–135)	35 (12–110)	0.36
Pathological stage			
I	9	11	
II	36	25	
III	17	26	0.13
Number of lymph nodes harvested	21 (4–67)	18 (5–59)	0.12
Duration of surgery, min	130 (60–210)	120 (72–255)	0.07
Blood loss, mL	50 (5–380)	70 (5–400)	0.12
Extension of wound	3 (5%)	2 (3%)	>0.99

clinicopathological, and surgical parameters between the two groups. Age ($P = 0.92$), sex ($P > 0.99$), BMI ($P = 0.53$), types of surgery ($P = 0.60$), maximal tumor diameter ($P = 0.36$), pathological stage according to the 7th edition of the TNM classification ($P = 0.13$), and estimated blood loss ($P = 0.12$) did not differ significantly between the two groups. The median number of lymph nodes harvested tended to be larger in the transverse mini-incision group (21 versus 18, $P = 0.12$). Duration of surgery tended to be longer in the transverse mini-incision group (130 min versus 120 min, $P = 0.07$). Concerning the success rate of the mini-incision, 3 patients (5%) in the transverse mini-incision group required extension of the wound up to 9 cm in length because of poor visualization of the surgical field, while 2 patients in the longitudinal mini-incision group required extension of the wound up to 15 cm because of poor visualization in one and severe intra-abdominal adhesions in one. The success rate of the mini-incision did not differ between the 2 groups (95% versus 97%, $P > 0.99$). Table 2 shows a comparison of the postoperative complications. One patient in the transverse mini-incision group underwent a second laparotomy for re-anastomosis as a result of stricture, while 1 patient in the longitudinal mini-incision group underwent a re-laparotomy because of intra-abdominal bleeding. The frequency of postoperative complications did not differ between the 2 groups (11% versus 8%, $P = 0.76$). Concerning various parameters related to postoperative recovery, the time to first passage of flatus ($P = 0.18$) and the time to first passage of stool ($P = 0.19$) did not significantly differ between the 2 groups. Postoperative analgesic use (pentazocine, 15 mg, intramuscularly) was significantly less in the transverse mini-incision group ($P = 0.04$), even though the use of epidural anesthesia tended to be less in the transverse mini-incision group ($P = 0.09$). Postoperative length of the hospital stay was

Table 2 Postoperative complications between patients with transverse and those with longitudinal mini-incision

	Transverse mini-incision group (n = 62)	Longitudinal mini-incision group (n = 62)	*P* value
Ileus	3	2	
Wound infection	1	1	
Anastomotic stricture	1	0	
Intra-abdominal bleeding	0	1	
Pneumonia/atelectasis	0	1	
Others	2	0	
Total, %	7 (11)	5 (8)	0.76

Table 3 Comparison of parameters related to postoperative recovery

	Transverse mini-incision group (n = 62)	Longitudinal mini-incision group (n = 62)	*P* value
First pass of flatus, d	1 (1–4)	2 (1–8)	0.18
First pass of stool, d	3 (1–7)	3 (1–9)	0.19
Use of epidural anesthesia, %	43 (69)	52 (82)	0.09
Number of intramuscular analgesic use	0 (0–4)	1 (0–3)	0.04
Length of postoperative hospital stay, d	8 (4–47)	10 (7–33)	<0.01

significantly shorter ($P < 0.01$) in the transverse mini-incision group than in the longitudinal mini-incision group (Table 3).

Discussion

This study has shown that the transverse mini-incision was equivalent to a longitudinal mini-incision in terms of technical feasibility and safety as well as postoperative complications, although 3 patients required extension of the wound and 1 patient required a second laparotomy for re-anastomosis in the transverse mini-incision group. The duration of surgery tended to be significantly longer in the transverse mini-incision group, but the difference between the 2 groups (median value, 10 minutes) seems to be of little significance in clinical practice. The number of lymph nodes harvested did not significantly differ between the 2 groups and the median number of lymph nodes seems to be oncologically satisfactory[9,10] in both groups. A longer follow-up period is needed to confirm the oncological safety of a transverse mini-incision approach, but we have already demonstrated that a longitudinal mini-incision had a similar oncological outcome, compared with a conventional open procedure. Thus, this approach seems to be acceptable if surgeons are familiar with a longitudinal mini-incision.[1–5,11–15] There may be a criticism regarding surgeons' experiences on the 2 study periods of different procedures. All the procedures throughout the 2 study periods were exclusively managed by the board-certified surgeons. In addition, surgical procedures related to colorectal surgery were standardized well in Japan according to the spread of the clinical guidelines[7] for the management of colorectal cancer. Thus, we believe that there might be little difference in surgeons' experiences in the 2 study periods.

More importantly, we should note that a transverse mini-incision resulted in less postoperative pain and a shorter hospital stay in agreement with numerous previous reports. Although this study was retrospective in nature, the preoperative care was similar throughout the study period except for the perioperative bowel preparation and antimicrobial prophylaxis, suggesting a minimal bias in perioperative care between the 2 groups.

The possible mechanisms explaining the lesser pain after a transverse mini-incision are 2-fold. First, our approach could potentially avoid cutaneous somatic nerve injuries. In addition, our approach did not divide the rectus abdominis muscle and retracted it laterally, also avoiding relevant nerve injuries. Second, compared with a longitudinal incision, a transverse incision might decrease the tension on the wound itself as demonstrated in human[16] and animal studies[17], leading to less pain.

Two systematic reviews or meta-analyses[18,19] combining several studies comparing "long longitudinal incisions" and "long transverse incisions" for gastrointestinal and abdominal aortic surgeries demonstrated that postoperative pulmonary complications were fewer, short- and long-term wound complications were fewer, and postoperative pain was lesser in the "long transverse incision" group.

Regarding colorectal surgery, to the best of our knowledge, 3 retrospective studies have compared transverse incision and midline incision, regardless of the length of the incision and with no clear definition for a mini-incision. Stipa *et al*[20] compared "transverse mini-incisions (n = 28)" and "midline incisions (n = 17)" for the curative resection of the right-sided colonic cancer. They reported that the recovery of postoperative bowel function tended to be faster and the postoperative hospital stay was significantly shorter in the "transverse mini-incision" group, though the actual lengths of the incision in both groups were not reported. Donati *et al*[21] compared a "limited transverse incision" (median length, 10 cm; n = 62) and a "traditional midline incision" (median length, 20 cm, n = 61) for the resection of right-sided colonic cancer and concluded that the "limited transverse incision" had a significantly shorter operative time, earlier recovery of bowel motility, earlier oral intake, and shorter postoperative stay. Kam *et al*[22] compared a "trans-

verse mini-incision" (median length, 13.5 cm; n = 140) and a "midline incision" (median length, 20 cm; n = 140) for the resection of left-side colonic cancer and concluded that a "transverse min-incision" had significantly shorter operating time, an earlier postoperative recovery, less pain, and a shorter postoperative stay. In addition to these 3 reports, Theodosopoulos *et al*[23] compared the results of right hemicolectomies for colonic cancer between a subcostal incision (median length, 10 cm; n = 113), and midline incision (median length, 12 cm; n = 100) and concluded that a subcostal incision, which might be a modification of a transverse incision, could achieve the same standards of tumor resection and surgical field accessibility as the midline approach, while reducing the time to postoperative recovery. Concerning a prospective randomized study, only 1 study[24] has compared right hemicolectomies between a transverse incision group (n = 14) and a midline incision group (n = 14), but the study did not demonstrate any important difference between the 2 groups because of the insufficient number of cases.

The advantages of mini-incisions include a lower cost, faster completion of the procedure, reduced bulkiness of equipment, less manpower, and the possibility of exploring the entire peritoneal cavity without a loss of tactile sensation,[1–5,11–15] compared with laparoscopic-assisted approach. We do not deny the utility of a laparoscopic-assisted approach, but a retrospective study,[25] comparing the effects of laparoscopic-assisted colectomies (average midline skin incision, 7.7 cm, n = 13) and open colectomies through a right transverse skin incision (average length, 10.3 cm, n = 20) for right-sided colon cancer, showed no significant differences between the 2 groups with regard to short-term surgical outcomes and oncological parameters, with longer operative time in the laparoscopic-assisted group.

This retrospective observational study with a small number of patients compared, possibly for the first time, a "transverse mini-incision" and a "longitudinal min-incision" for the resection of locally advanced colonic cancer with the same maximal incision (≤7cm) in both groups, which was shorter than those in previous reports describing "mini-incisions." In addition, the tumor site was matched between the 2 groups; thus, this study seems to be more credible than previously reported studies comparing incision methods (transverse or longitudinal) and patients' outcomes, although a prospective randomized study with a larger series is needed to conclude the superiority of either type of mini-incision.

This study excluded patients with a BMI >25kg/m^2, since we felt that a curative colectomy would be difficult to perform in overweight or obese patients. We previously reported that our "longitudinal mini-incision" would be suitable for most patients with colonic cancer in East Asian countries, since the incidence of overweight (BMI > 25.0 kg/m^2) or morbidly obese patients (BMI > 30.0 kg/m^2) in East Asian countries is lower than that in Western countries.[26] Thus, we should note that the merits of a "transverse mini-incision" also might be restricted to select patients, similar to the situation for "longitudinal mini-incision."

In conclusion, our preliminary case-match retrospective study demonstrated that a "transverse mini-incision" is similar to a "longitudinal mini-incision" in terms of technical feasibility and safety as well as postoperative morbidity for the surgical treatment of nonoverweight patients with locally advanced colonic cancer. In addition, some postoperative recovery-related parameters seemed to be more favorable in the "transverse mini-incision" group.

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