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Colorectal Cancer Resection Via a Single Minimal Incision

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Smaller incisions may be the major reason for reduced invasiveness of laparotomy. The aim of this study was to clarify the feasibility and safety of a minimal skin incision for colorectal cancer resection. Between April 2005 and February 2008, 122 consecutive patients (56 women, 66 men) were enrolled in this prospective study and scheduled to undergo resection for colorectal cancer using a single minimal skin incision. All of the operations were performed by a single surgeon. The patients were grouped into "small-incision" (≤7 cm), "medium-incision" (>7 and ≤14 cm), and "large-incision" (>14 cm) for comparison. The small-incision, medium-incision, and large-incision groups included 64 (52.5%), 38 (31.1%) and 20 (16.4%) patients, respectively. The median length of laparotomy incision in the small-incision and medium-incision groups (102 patients) was 7 (interquartile range 7-10) cm. There was no operative mortality. The group with larger length of skin incision had longer operation time, greater operative blood loss, higher rate of postoperative complications and longer postoperative stay. Failure of the small-incision was significantly associated with tumor location (splenic flexure/rectum) and tumor characteristics (adhesion/invasion of tumor into adjacent organs, and/or tumor diameter ≥6.0 cm). This experience suggests that the majority of colorectal cancer resection can be safely accomplished via a median length of skin incision of 7 (interquartile range 7-10) cm.

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Introduction

One of the most exciting technologies that have been introduced by colorectal surgeons is minimally invasive surgery.[1] Although introduced over a decade ago, the acceptance of laparoscopic surgery in the field of colorectal cancer resection has been slower as compared with other areas of general surgery.[2,3] Several technical and oncological problems have played a role in this development.[2-4] One of the issues has been the necessity of laparotomy (small skin incision in most circumstances) to perform bowel anastomosis and to remove the resected tumor specimen.[1,2] The use of smaller abdominal skin incisions may be associated with an early recovery of patients.[5,6] Recent studies reported that a small skin incision approach, without handport or laparoscope, was technically feasible in selected patients with colorectal cancer.[7-12] However, there have been few prospective studies on the minimal skin incision approach in consecutive patients. The aim of this study was to clarify the feasibility and safety of a minimal skin incision approach for colorectal cancer resection.

Patients and Methods

Patient selection

Between April 2005 and February 2008, 122 consecutive patients (56 women, 66 men; median age 72 (range 36-94) years) were enrolled in this prospective study after obtaining written informed consent and scheduled to undergo elective surgery for resection of primary colorectal cancer using a single minimal skin incision. Excluded from the study were patients with only the creation of a stoma.

Operation

All of the operations were performed by a single surgeon (T.N.). At the beginning of the operation, a small skin incision (≤ 7 cm in length)[10] was made in all patients. When such a small skin incision approach was unsuccessful because of intraoperative problems (e.g., anatomical problems, technical problems, and/or problems with the primary tumor[10]), minimal elongations of the skin incisions were made. During the operation, we made specific efforts to minimize the incision lengths to accomplish the resection of colorectal

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Table 1. Comparison of clinicopathological features between the three groups

Variable	No. of patients (%)			*P*
	Small-incision (n=64)	Medium-incision (n=38)	Large-incision (n=20)	
Age (years)*	71.5 (64-78)	72.0 (62-77)	72.5 (65-80)	0.71
Gender				0.12‡
Female (n=56)	35 (54.7)	14 (36.8)	7 (35.0)	
Male (n=66)	29 (45.3)	24 (63.2)	13 (65.0)	
Overweight/obesity				0.10‡
No (n=93)	53 (82.8)	28 (73.7)	12 (60.0)	
Yes (n=29)	11 (17.2)	10 (26.3)	8 (40.0)	
Previous laparotomy				0.84‡
No (n=98)	51 (79.7)	30 (79.0)	17 (85.0)	
Yes (n=22)	13 (20.3)	8 (21.0)	3 (15.0)	
Operating time (min)*	157 (127-184)	220 (191-265)	278 (231-343)	<0.0001
Operative blood loss (ml)*	50 (30-80)	125 (70-250)	255 (155-405)	<0.0001
Postoperative hospital stay (days)*	21 (15-25)	25 (20-43)	35 (24-62)	<0.0001
Level of lymph node dissection†				0.33‡
D1 (n=17)	12 (18.8)	3 (7.9)	2 (10.0)	
D2 (n=49)	22 (34.4)	16 (42.1)	11 (55.0)	
D3 (n=56)	30 (46.9)	19 (50.0)	7 (35.0)	
Concurrent resection for other site organ/ other site of the colon§				0.37‡
No (n=112)	58 (90.6)	34 (89.5)	20 (100)	
Yes (n=10)	6 (9.4)	4 (10.5)	0 (0)	
Postoperative complication				0.040‡
No (n=111)	62 (96.9)	33 (86.8)	16 (80.0)	
Yes (n=11)	2 (3.1)	5 (13.2)	4 (20.0)	
Tumor location*				<0.0001‡
Right colon (n=43)	32 (50.0)	9 (23.7)	2 (10.0)	
Splenic flexure (n=7)	1 (1.6)	2 (5.3)	4 (20.0)	
Left colon (n=41)	27 (42.2)	10 (26.3)	4 (20.0)	
Rectum (n=31)	4 (6.2)	17 (44.7)	10 (50.0)	
Adhesion or invasion of tumor into adjacent organ				0.0034‡
No (n=111)	63 (98.4)	33 (86.8)	15 (75.0)	
Yes (n=11)	1 (1.6)	5 (13.2)	5 (25.0)	
Tumor diameter				0.0033‡
<6.0 cm (n=83)	52 (81.0)	19 (50.0)	12 (60.0)	
≥6.0 cm (n=39)	12 (19.0)	19 (50.0)	8 (40.0)	
Dukes stage during surgery**				0.068‡
A (n=38)	25 (39.1)	8 (21.1)	5 (25.0)	
B (n=24)	16 (25.0)	5 (13.2)	3 (15.0)	
C (n=48)	20 (31.2)	20 (52.6)	8 (40.0)	
D (n=12)	3 (4.7)	5 (13.2)	4 (20.0)	

*Values are median (IQR). Statistical analyses were conducted by Kruskal-Wallis test.
‡Chi-square test. †Level of lymph node dissection.[10] §See "Patients and Methods".
**Dukes stage defined by findings during surgery, including findings based on histopathological explorations. Preoperative clinical findings were also referred to.[10]

cancer. The operative procedures were reported previously.[10,13-15] No hand-port or laparoscope was used in this series.

There were 21 ileocecal resections, 14 right hemicolectomies, 8 transverse colectomies, 6 left partial colectomies, 27 sigmoidectomies, 34 anterior resections, 10 abdominoperineal resections, and 2 Hartmann's procedures. Curative and non-curative resection was performed in 110 and 12 patients, respectively.

Twenty-one patients underwent combined resections concurrent with surgery via a single laparotomy wound. Of the 21 patients, 11 underwent combined resections of involved adjacent organs (three

abdominal walls, two urinary bladders, two stomachs, two seminal vesicles, one vagina, one colon, one uterus, and one ileum) because of adhesion or invasion of the primary tumor, and the remaining 10 underwent combined resections of other site organs or other site of the colon because of diseases such as gallstones, gastric cancer, colonic tumors, and tuberculosis of the ileum (five cholecystectomies, one gastrectomy, three colectomies/surgical polypectomies, and resection of the ileum, respectively).

Definition

Appendectomy was excluded as previous laparotomy. Tumor diameter was documented as the longest diameter of the tumor on gross examination of the fresh resected specimens: the patients were classified into two groups based on the reference value of 6.0 cm.[10] The colorectal resection was classified as D1, D2, or D3 on the basis of lymph node dissection.[16] Overweight or obesity was defined as a body mass index (BMI) greater than 25.0 kg/m^2.[17]

In this study, we defined "small-incision" as completion of the operation employing the original small skin incision (≤ 7 cm in length).[10] "Large-incision" was defined as length of laparotomy > 14 cm in length. In addition, "medium-incision" was defined as length of laparotomy measuring > 7cm and ≤ 14cm in length. The patients were grouped into "small-incision", "medium-incision", and "large-incision" for comparison.

Statistical analysis

Statistical analyses were performed using STATISTICA™ (StatSoft, Tulsa, OK, USA). Numerical values are given as medians (interquartile range (IQR)). Continuous and categorical data were analyzed with Kruskal-Wallis test with multiple comparison post test and chi-square test, respectively. All tests were two tailed and P <0.05 was considered significant.

Results

Feasibility

Of the 122 patients who were scheduled to undergo resection for colorectal cancer using a minimal skin incision, success of the small-incision was achieved in 64 patients (52.5%). The medium-incision and large-incision were performed in 38 (31.1%) and 20 (16.4%) patients, respectively (Figure 1). There were no intraoperative complications such as massive bleeding, bowel perforation, or problems with the anastomosis.

The median length of the laparotomy incision in the 122 patients included in the study was 7.0 (IQR 7.0-12.0) cm. In addition, the median length of laparotomy incision in the small-incision and medium-incision groups (102 patients) was 7 (IQR 7-10) cm (average 8.1 [standard deviation 2.5] cm).

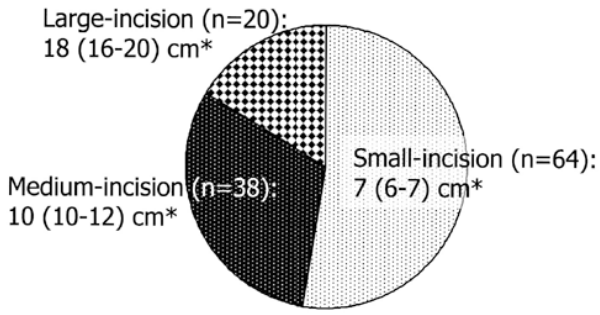

Figure 1. Of the 122 patients included in this study, the number (%) of patients in the small-incision, medium-incision, and large-incision groups were 64 (52.5%), 38 (31.2%) and 20 (16.4%), respectively. *Values denote median (IQR) length of abdominal skin incision.

Comparison of clinicopathological features between the three (small-incision, medium-incision, and large-incision) groups

There was no difference in six variables (age, gender, overweight/obesity, previous laparotomy, level of lymph node dissection, concurrent resection for other site organ/other site of the colon, and Dukes stage during surgery) between three groups.

The groups with longer skin incisions had longer operation time, greater operative blood loss, and longer postoperative stay: these differences were significant. In addition, the multiple comparison post test demonstrated significant differences in these variables between the small-incision and medium-incision groups (P<0.0001, P<0.0001, and P=0.0095, respectively), and between the small-incision and large-incision groups (P<0.0001, P<0.0001, and P= 0.0001, respectively). However, there was no difference in such variables between the medium-incision and large-incision groups.

There was no operative mortality. Two (3.1%) of 64 patients with successful small-incisions developed intestinal obstruction (one patient) and intra-abdominal abscess (one patient). Five (13.2%) of 38 patients in the medium-incision group developed wound infection (one patient), intra-abdominal abscess (one patient), anastomotic leakage (two patients), and myocardial infarction (one patient). Four (20.0%) of 19 patients in the large-incision group developed wound infection (one patient), intra-abdominal abscess (two patients), pneumonia (one patient), and intestinal obstruction (one patient). The frequency of postoperative complications between the three groups differed significantly: groups with larger length of skin incision had higher rates.

The proportion of tumor location, adhesion or invasion of tumor into adjacent organ, and tumor diameter differed significantly. Failure of the small-incision was significantly associated with tumor location (splenic flexure/rectum) and tumor characteristics (adhesion/invasion of tumor into adjacent organs, and/or tumor diameter ≥6.0 cm).

Discussion

Feasibility of the less invasive, small skin incision approach,

without hand-port and laparoscope, for resection of colorectal cancer has been reported.[7-12] This is a suitable technique in most patients; however, not all are candidates for resection via such a small incision. Fürstenberg et al. reported that patients with right-sided colonic carcinomas cannot be resected via a small incision (median incision length, 6 (range, 5-9.5) cm); approximately one-fourth of our patients required a conventional approach.[8] Nakagoe et al reported that the small skin incision approach (≤ 7 cm in length) was unsuccessful in 14% of colonic cancer patients and 10% of rectal cancer patients.[10,14] In addition, excluded from the study for resection of colonic cancer[10] were patients with tumors larger than 6 cm or a tumor infiltrating adjacent organs, those who had intestinal obstruction or perforation, those with synchronous cancers or familial adenomatous polyposis, and patients who had Dukes' D cancers. Furthermore, excluded from the study for resection of rectal cancer were patients who were overweight or obese. In this study, the median length of laparotomy incision in 102 (83.6%) of 122 consecutive patients who underwent elective surgery was 7 (IQR 7-10) cm (average 8.1 (standard deviation 2.5) cm).[14] The majority of colorectal resections can be performed through a smaller incision than is generally believed.

Several studies reported that the most common reasons for failure of the small skin incision approach were problems associated with the tumor characteristics: tumor size and growth of the tumor into adjacent organs.[8,10,11] The current study showed similar results. Although advances in surgical skills and minimally invasive equipment have allowed a broad application of laparoscopic surgery, the size of the specimen is now the limiting factor in the size of the incision required for an operation. Furthermore, laparoscopic resection of adjacent involved organs or the abdominal wall compounds the technical problems.[3] Therefore, in the small skin incision approach, as well as in the laparoscopic approach, en bloc resection for tumor with growth into adjacent organs and/or bulky tumors may be possible only in a limited number of patients.

The small skin incision approach may be best suited for straightforward simple resection of the colon.[7] On the other hand, patients who need a full view of the abdomen or who require mobilization of distant structures may be best approached by laparoscopy.[7] Therefore, laparoscopic resection of the rectum or the splenic flexure might be suitable. However, a significant higher risk factor for conversion to conventional laparotomy has been found to be associated with resection of the rectum.[18] These patients had high complication rates, in-hospital mortality, and requirements for transfusion. In addition, half of experts do not recommended laparoscopic resections of the splenic flexure, because mobilization of a tumor at the splenic flexure can be very demanding.[19] Almost all surgeons seem to consider that mobilization of a tumor at the splenic flexure is difficult with the small skin incision approach.[10-12] We believe that resection of cancer at the rectum and the splenic flexure, by small skin incision approach as well as laparoscopic approach, may be an alternative only for highly selected patients.

In this study, the groups with longer skin incisions had a tendency to include higher rate of overweight/obesity patients. Obesity is not an absolute contraindication for minimally invasive laparoscopic or minilaparotomy approach.[1,2,10-12,19] However, many surgeons seem to consider that obesity reduces the technical feasibility of such approaches.[10-12,19] Therefore, it may be appropriate to select patients with lower BMIs for less experienced surgeons.

The current study revealed that failure of smaller skin incision may be associated with greater invasiveness of surgery (longer operating time, greater operative blood loss, higher rate of postoperative complications and longer postoperative hospital stay). Fleshman et al. reported that the postoperative early recovery seemed to correlate with incision length, whether after minilaparotomy approach or after laparoscopic approach.[7] In addition, the impact of incision length seems to be directly reflected in the length of hospital stay after surgery. We believe that smaller skin incisions may be the major reason for the reduced invasiveness of laparotomy.[5,6] Therefore, during the operation, surgeons should make specific efforts to minimize the incision lengths to accomplish the resection of colorectal cancer.

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