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Safety and Feasibility of Single-port Surgery for Colon Cancer in Octogenarians

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Abstract. *Background/Aim: The use of single-port surgery (SPS) in elderly patients with colon cancer remains controversial. The aim of this study was to evaluate the clinical outcomes of elderly patients who underwent SPS. Patients and Methods: Consecutive patients >80 years old of age who underwent SPS (n=86) or multi-port surgery (MPS) (n=40) for colon cancer from January 2008 to December 2014 were analyzed. Short-term and long-term outcomes were compared between groups. Results: The morbidity rate in the SPS was significantly lower than that in the MPS (p=0.027). Length of hospital stay in the SPS was significantly shorter than that in the MPS (p=0.016). Similar oncological outcomes were observed in the groups. The 3-year disease-free survival rate, the 5-year overall survival rate and the 5-year cancer-specific survival rate did not differ significantly between groups. Conclusion: SPS is safe and can provide clinical outcomes comparable to those of MPS in octogenarians with colon cancer.*

Recently, the number of surgeries for elderly patients with colorectal cancer has been increasing in Japan. Surgery is the most effective treatment for colorectal cancer, but tends to be associated with higher morbidity and mortality rates in elderly compared to younger patients. Several studies have shown that laparoscopic surgery is superior to open surgery in terms of postoperative outcomes, including reduction of pain, earlier intestinal peristaltic recovery, shortening of postoperative stay, and cosmetic advantage (1-7), and can provide long-term oncological outcomes comparable to those of open surgery in elderly patients with colorectal cancer (8). The frequency of laparoscopic surgery for colorectal cancer was 46.8% in 2011 according to the 11th Nationwide Survey of Endoscopic Surgery in Japan (9), and it is expected that the number of patients who undergo laparoscopic surgery will increase in the future.

Single-port surgery (SPS) is a recent advance in minimally invasive techniques. The first SPS was described for right colectomy in 2008 (10), and the benefits included better cosmetic outcomes, less postoperative pain, faster postoperative recovery, and earlier hospital discharge (11-13). Additionally, several reports have found that SPS is feasible and safe for colorectal cancer in terms of short-term and long-term oncological outcomes (14-18).

Less invasive procedures for colorectal cancer surgery are becoming increasingly popular because they achieve better short-term postoperative results. However, the effect of less invasive surgery in elderly patients with colon cancer is unknown. Therefore, the aim of this study was to evaluate the clinical outcomes of SPS in elderly patients with colon cancer and to compare these outcomes with those of patients with colon cancer who underwent multi-port surgery (MPS).

Materials and Methods

Patient profiles. In our Department, the first case of SPS for colon cancer was carried out in May, 2009. Before April 2012, SPS was performed only for early colon cancer, but the indication was expanded gradually to include advanced colorectal cancer. Currently, SPS is considered a reasonable alternative approach for colon cancer in our department. Exclusion criteria were obstruction or perforation that required emergent surgery, massive invasion of cancer into adjacent organs that could not be resected laparoscopically, and withdrawal of informed consent. Patients received written information describing the differences between SPS and MPS. In addition, they received a thorough explanation of each operative procedure. All of the patients agreed to receive SPS and to provide written informed consent.

Between January 2008 and December 2014, a total of 182 consecutive patients >80 years of age underwent colectomy for colon carcinoma. Of these, 19 patients had a diagnosis of Stage IV disease. Of these, 19 patients underwent emergency surgery. Of these, 18 patients underwent open surgery. In total, our series was composed of 86 patients who underwent SPS and 40 who underwent MPS (Figure 1).

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Key Words: Single-incision laparoscopic surgery, single-port surgery, elderly, octogenarians, colon cancer.

Age, gender, tumor location, body mass index (BMI), American Society of Anesthesiologists (ASA) score, performance status (PS), Charlson risk index (19), comorbidities, management of preoperative anticoagulation, past history of previous abdominal surgery, operative procedure, stoma creation, operative time, blood loss, extent of lymph node dissection, conversion to open surgery, postoperative complications, oncologic resection, histopathological TNM staging, and long-term outcomes were obtained from the medical records. The extent of lymph node dissection was defined by the Japanese Classification of Colorectal Carcinoma (20). Postoperative complications were classified according to the Clavien-Dindo Classification (21). Operative mortality was defined as death on the same admission or within 30 days of surgery. All patients were followed for at least 30 days after surgery.

Statistical methods. Continuous data are expressed as median (range), unless specifically noted. Statistical analyses were performed with the JMP 11.0 software (SAS Institute Inc., Cary, NC). All group data were reported as median values. Differences in age, BMI, operative time, blood loss, length of hospital stay, tumor size and number of harvested lymph nodes were analyzed by Mann-Whitney's *U*-test. Other variables were analyzed by Fischer's exact probability test. The disease-free survival, overall survival and cancer-specific survival were determined with Kaplan-Meier analysis with a log-rank test. Statistical significance was established at $p<0.05$.

Results

Data from 126 patients (51 males and 75 females) >80 years of age who underwent laparoscopic surgery for colon cancer at our department were analyzed. Table I lists the patient profiles analyzed in both groups. The number of patients with management of perioperative anticoagulation was significantly higher in the SPS group than in the MPS group ($p=0.006$). The other factors did not differ significantly between groups (Table I).

Table II shows the operative details of the two groups. There were no significant differences between groups in terms of operative procedure, the rate of stoma creation, operative time, blood loss and extent of lymph node dissection. Two patients who underwent right hemicolectomy in the SPS group required an additional port. One patient who underwent sigmoidectomy in the MPS group was converted to open surgery. The reason was difficulty of development of an operative field due to a severe adhesion. None of the patients in either group had intraoperative complications (Table II).

Table III summarizes the postoperative complications that occurred in each group. Anastomotic leakage occurred in 1 patient who underwent right hemicolectomy in the SPS group. The incidence of postoperative delirium was significantly lower in the SPS group than in the MPS group (SPS, n=12, 14.0% *vs.* MPS, n=14, 35.0%, $p=0.009$). Reoperation was performed in two patients in each group

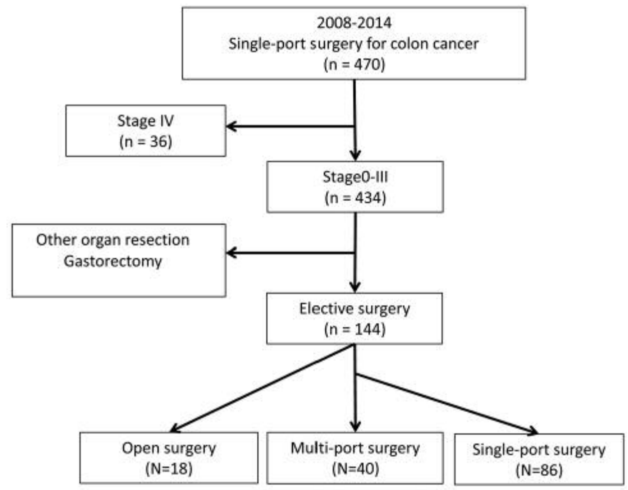

Figure 1. *Flowchart of SPS and MPS in elderly patients with colon cancer.*

($p=0.591$). Four of the patients in the MPS group experienced perioperative death (pneumoniae in two and disseminated intravascular coagulation in two). The overall postoperative complication rate was significantly lower in the SPS group than in the MPS group (SPS, n=26, 30.2% *vs.* MPS, n=20, 50.0%, $p=0.027$). The incidence of bleeding, wound infection, abdominal abscess, pneumonia, and bowel obstruction did not differ significantly between groups. The median length of hospital stay was significantly shorter in the SPS group than that in the MPS group (9 *vs.* 10 days, respectively; $p=0.016$). Hospital readmission within 30 days after surgery occurred for one patient in the SPS group. An 86-year-old man who had undergone a SPS transverse colectomy experienced a diverticulum bleeding of the right colon and required vascular embolization on postoperative day 14 (Table III).

Table IV summarizes the oncological resection and pathological features of the two groups. The median tumor size did not differ between groups (40 mm in the SPS group *vs.* 47mm in the MPS group, respectively $p=0.208$). The median number of harvested lymph nodes was similar in both groups (22 *vs.* 27, respectively $p=0.060$). There were no significant differences between groups in terms of tumor differentiation, depth of tumor invasion and lymph node metastasis (Table IV).

Table V lists the details of TNM stage and cancer recurrence in both groups. TNM stage, adjuvant chemotherapy and recurrence rate did not differ significantly between groups. The median follow-up period was 49 (range=7-70 months) months in the SPS group and 61 (range=1-77 months) months in the MPS group ($p<0.001$). This difference was expected, because almost all MPS cases

Table I. *Patient demographics*.

	SPS group (n=86)	MPS group (n=40)	*p*-Value
Age (years)	83 (80-93)	84 (80-93)	0.213
Gender, n (%)			0.560
Male	33 (38.4)	18 (45.0)	
Female	53 (61.6)	22 (55.0)	
Tumor location, n (%)			0.444
Right colon	47 (54.7)	25 (62.5)	
Left colon	39 (45.3)	15 (37.5)	
BMI	22.1 (15.4-31.2)	20.6 (12.8-39.9)	0.052
ASA score, n (%)			0.554
1 or 2	52 (60.5)	27 (67.5)	
≥3	34 (39.5)	13 (32.5)	
Performance status, n (%)			0.585
0 or 1	75 (87.2)	33 (82.5)	
≥2	11 (12.8)	7 (17.5)	
Charlson risk index			0.826
3<	64 (74.4)	31 (77.5)	
≥3	22 (25.6)	9 (22.5)	
Comorbidities, n (%)			
Cerebrovascular disease*	15 (17.4)	9 (22.5)	0.626
Cardiac disease*	33 (38.4)	12 (30.0)	0.427
Pulmonary disease*	13 (15.1)	2 (5.0)	0.142
Diabetes	12 (14.0)	9 (22.5)	0.304
Management of perioperative anticoagulation, n (%)	31 (36.0)	5 (12.5)	0.006
Previous abdominal surgery, n (%)	31 (36.0)	10 (25.0)	0.307

Data are number of patients and (percentage). ASA score: American Society of Anesthesiology Score; BMI: body mass index; SPS: single-port surgery; MPS: multi-port surgery. *Cerebrovascular disease: history of transient ischemic attacks and cerebrovascular event with or without neurological deficit; *Cardiac disease: ischemic disease, chronic heart failure and cardiomyopathy, excluded hypertension; *Pulmonary disease: asthma, chronic obstructive pulmonary disease, and interstitial pneumonia.

Table II. *Operative detail*.

	SPS group (n=86)	MPS group (n=40)	*p*-Value
Operative procedure, n (%)			0.472
Ileocecal resection	31 (5.5)	13 (18.5)	
Right hemicolectomy	16 (17.8)	12 (20.2)	
Left hemicolectomy	2 (17.3)	1 (9.2)	
Sigmoidectomy	27 (3.4)	8 (27.7)	
High anterior resection	10 (35.2)	6 (16.8)	
Stoma creation, n (%)	3 (3.5)	1 (2.5)	1.000
Median operative time, min (range)	176 (80-488)	183 (101-480)	0.155
Median blood loss, ml (range)	5 (5-560)	5 (5-650)	0.887
Extent of lymph node dissection, n (%)		0.838	
D2	26 (31.5)	13 (30.5)	
D3	60 (68.5)	27 (69.5)	
Conversion to open surgery, n (%)	0	1	-
Required additional port, n (%)	2	0	-

SPS: Single-port surgery; MPS: multi-port surgery.

Table III. *Postoperative complications*.

Complication, n (%)	SPS group (n=86)	MPS group (n=40)	*p*-Value
Bleeding	0	1 (2.5)	0.316
Anastomotic leakage	1 (1.2)	0	1.000
Wound infection	8 (9.3)	3 (7.5)	1.000
Abdominal abscess	5 (5.8)	3 (7.5)	0.708
Pneumonia	2 (2.4)	4 (10.0)	0.080
Bowel obstruction	6 (7.0)	4 (10.0)	0.724
Postoperative delirium	12 (14.0)	14 (35.0)	0.009
Perioperative death	0	4 (10.0)	0.001
Reoperation	2 (2.4)	2 (5.0)	0.591
Overall complication	26 (13.4)	20 (50.0)	0.027
Length of hospital stay, days (range)	9 (7-64)	10 (7-68)	0.016
Readmission within 30 days	1 (0.5)	0	1.000

SPS: Single-port surgery; MPS: multi-port surgery.

predated those in the SPS group. In the SPS group, nine patients had distant metastases (liver, n=4, lung, n=3, distant lymph node, n=2, and peritoneum, n=2). In the MPS group, six patients had distant metastases (liver, n=1, lung, n=1, distant lymph node, n=3, and peritoneum, n=3) (Table V). The disease-free survival rate at 3 years did not differ significantly between groups (89.3% in the SPS group *vs*. 85.7% in the MPS group, p=0.433) (Figure 2). The overall survival rate at 5 years did not differ significantly between groups (77.5% in the SPS group *vs*. 60.9% in the MPS group, p=0.126) (Figure 3). The cancer-specific survival rate at 5 years did not differ significantly between groups (89.6% in the SPS group *vs*. 82.7% in the MPS group, p=0.405) (Figure 4).

Discussion

Based on our previous experience, we reported that SPS for colon cancer is similar to MPS in terms of short-term surgical results and oncological clearance (18, 22), and in addition, we believe that SPS is superior in terms of port-site related complications, cosmetic advantage and patient satisfaction. In our study, SPS was performed successfully

Table IV. *Oncological resection and pathological features.*

	SPS group (n=86)	MPS group (n=40)	*p*-Value
Tumor size, mm (range)	40 (8-140)	45 (7-100)	0.208
Median number of harvested lymph nodes (range)	22 (4-54)	27 (5-71)	0.060
Tumor differentiation, n (%)			0.489
Well	23 (26.7)	6 (15.0)	
Moderate	50 (58.1)	26 (65.0)	
Poor	4 (4.7)	4 (10.0)	
Mutinous	7 (8.1)	3 (7.5)	
Sig	2 (2.3)	1 (2.5)	
Depth of tumor invasion, n (%)			0.196
T1	17 (19.8)	5 (12.5)	
T2	6 (7.0)	2 (5.0)	
T3	48 (55.8)	19 (47.5)	
T4	15 (19.8)	14 (35.0)	
Lymph node metastasis, n (%)			0.843
Negative	56 (65.1)	25 (62.5)	
Positive	30 (34.9)	15 (37.5)	

SPS: Single-port surgery; MPS: multi-port surgery; Well: well differentiated adenocarcinoma; Moderate: moderate differentiated adenocarcinoma; Poor: poorly differentiated adenocarcinoma; Mutinous: mutinous adenocarcinoma; Sig: signet ring cell carcinoma.

Table V. *TNM stage and recurrence.*

	SPS group (n=86)	MPS group (n=40)	*p*-Value
TNM stage, n (%)			0.309
I	19 (22.1)	6 (15.0)	
II	37 (43.0)	19 (47.5)	
III	30 (34.9)	15 (37.5)	
Adjuvant chemotherapy (stage III), n (%)			0.645
Yes	4 (13.3)	1 (6.7)	
No	26 (82.7)	14 (93.3)	
Median follow-up time, month, (range)	49 (7-70)	61 (1-77)	<0.001
Recurrence, n (%)			
Liver	4 (4.7)	1 (2.5)	
Lung	3 (3.5)	1 (2.5)	
Distant lymph nodes	2 (2.3)	3 (7.5)	
Peritoneum	2 (2.3)	3 (7.5)	

SPS: Single-port surgery; MPS: multi-port surgery.

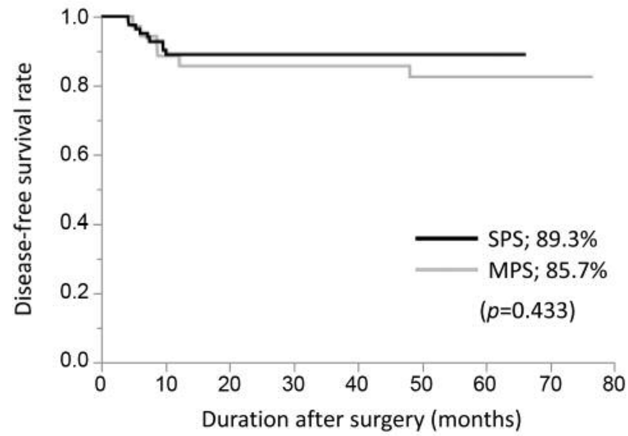

Figure 2. *Kaplan–Meier analysis of disease-free survival at 3 years in the SPS and MPS group.*

in 97.8% of patients, including 31 patients who had a history of previous abdominal surgery. Previous studies have reported that the operative time for SPS ranged from 135 to 178 minutes (12, 14-18), and the conversion rate from MPS to open surgery ranged from 1.5 to 10.9% (12, 14-18). In this study, almost all MPS cases predated those in the SPS group. Additionally, we have experienced 800 single-port laparoscopic colorectal surgeries to date. Though this study analyzed 126 consecutive patients retrospectively, our results with SPS had high reliability in terms of operative time, blood loss, extent of lymph node dissection and a successful completion rate for colon cancer in elderly patients.

Also, the overall postoperative complication rate was significantly lower in the SPS group than in the MPS group (13.4% *vs*. 50.0%, respectively; *p*=0.027). In particular, the incidence of postoperative delirium was significantly lower in the SPS group than in the MPS group (14.0 *vs*. 35.0%, respectively, *p*=0.009). We have reported that the risk of postoperative delirium is associated with operative approach (23).Operation-specific risk factors for the development of postoperative delirium are based on the degree of operative stress. Although it is controversial whether SPS is less invasive than MPS in elderly patients, we believe that the degree of operative stress with SPS is less than that with MPS. In this study, the overall postoperative complication rate in the MPS group was higher compared with other reports (14-17). In our study, minor complications that might have little or no influence on the length of hospital stay were counted. Nevertheless, the complication rate is within an acceptable range. The median length of hospital stay in the SPS group was shorter than that in the MPS group (9 *vs*. 10 days, respectively; *p*=0.016). Regarding the length of hospital stay, recent studies in Western countries indicate a median or mean postoperative hospital stay of 6 to 8 days (24-26), whereas the median hospital stay was 9 days in the SPS group and 10 days in the MPS group in this study. The reason for the longer hospital stay in Japan is that the Japanese health insurance system, maintains low medical costs, and has influenced this result.

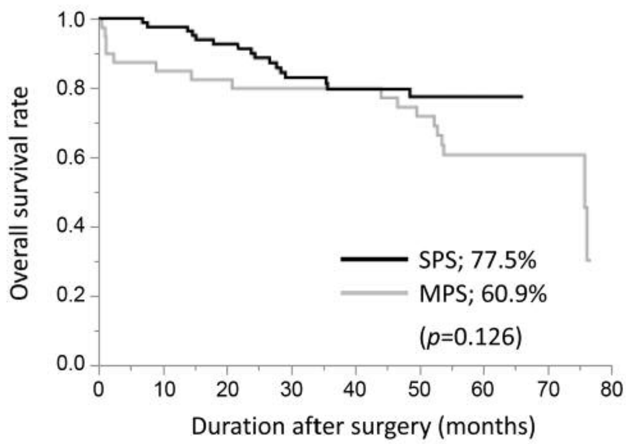

Figure 3. *Kaplan–Meier analysis of overall survival at 5 years in the SPS and MPS group.*

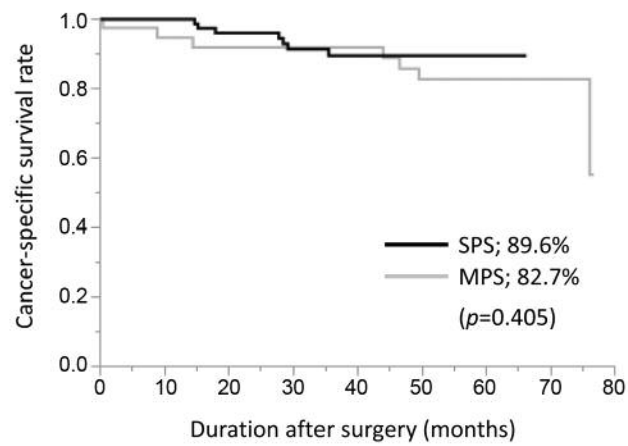

Figure 4. *Kaplan–Meier analysis of cancer-specific survival at 5 years in the SPS and MPS group.*

Maintenance of the surgical oncologic safety is the most important factor. High vascular ligation and a non-touch technique were maintained in this series. No gross or microscopic positive resection margins were observed in either group. In this study, the 3-year disease-free survival rate did not differ significantly between groups (89.3% in the SPS group *vs*. 85.7% in the MPS group, p=0.433). The 5-year overall survival rate tended to be higher in the SPS group than in the MPS group (77.5% in the SPS group *vs*. 60.9% in the MPS group, p=0.126). However, the 5-year cancer-specific survival rate did not differ significantly between groups (89.6% in the SPS group *vs*. 82.7% in the MPS group, p=0.405). She *et al*. reported that the 5-year overall survival rate and the 5-year disease-specific survival rate was 52.8% and 68.9%, respectively (27). Otsuka *et al*. reported that the 5-year overall survival rate and the 5-year disease-specific survival rate was 64.8% and 91%, respectively (28). Our results indicated that SPS can provide short-term oncological outcomes comparable to those of MPS in octogenarians with colon cancer.

The main limitations of this study were that it was carried out at a single institution, it had a small sample size, it was retrospective in nature, and it seemed to be biased toward the surgical approach. In addition, our total patient population may be typical for Japan, but may not be applicable to the average European or United States population. It is difficult to demonstrate the true clinical significance of differences between SPS and MPS in octogenarians with colon cancer in this study. However, it seems that SPS has no adverse effects on clinical outcomes in octogenarians with colon cancer.

Conclusion

This is the first report describing that SPS can provide clinical outcomes comparable to those of MPS in elderly patients with colon cancer. More studies of SPS and large, prospective randomized trials are needed to validate the benefits of SPS, including both short- and long-term oncological outcomes compared to MPS in elderly patients with colon cancer.

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