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Short-term outcomes of single-incision plus one-port laparoscopic versus conventional laparoscopic surgery for rectosigmoid cancer: a randomized controlled trial

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Abstract

Objective The objective of the study is to evaluate the short-term outcomes of single-incision plus one-port surgery (SILS + 1) compared with conventional laparoscopic surgery (CLS) for colonic cancer.

Background At present, single-incision laparoscopic colectomy remains technically challenging. The use of SILS + 1 as an alternative has gained increasing attention; however, its safety and efficacy remain controversial.

Methods and patients Between April 2014 and July 2016, 198 patients with clinical stage T1-4aN0-2 M0 rectosigmoid cancer were enrolled. The participants were randomly assigned to either SILS + 1 ($n = 99$) or CLS ($n = 99$). The morbidity and mortality within 30 days, operative and pathologic outcomes, postoperative recovery course, inflammation and immune responses, and pain intensity were compared.

Results There was no significant difference in overall complications between the two groups (17.2 vs. 16.3%, $P = 1.000$). The total operating time for the SILS + 1 group was significantly shorter (100.8 ± 30.4 vs. 116.6 ± 36.6, $P = 0.002$). Blood loss was significantly greater in the CLS group (20 vs. 50, $P < 0.001$). Thirteen patients (14%) in the CLS group required additional postoperative analgesics, which was significantly more than four patients in the SILS + 1 group. Notably, on postoperative day three, the visual analogue scale score of the CLS group was greater than that of the SILS + 1 group (1.3 ± 1.1 vs. 1.7 ± 1.3, $P = 0.023$). Tumor diameter, pathologic stage, length of the proximal and distal margins, and number of lymph nodes harvested were similar, other values were also similar between the two groups.

Conclusion Our findings suggest that SILS + 1 might be safe and feasible for rectosigmoid cancer when performed by experienced surgeons. It offers minimal invasiveness without compromising oncologic treatment principles. *Trial Registration* This trial was registered on ClinicalTrials.gov (NCT02117557).

Keywords Short-term outcomes · Single-incision plus one-port · Laparoscopic surgery · Rectosigmoid cancer · Randomized controlled trial

Colon cancer is one of the most commonly diagnosed cancers worldwide, and adequate surgical excision of the primary tumor remains the only curative treatment [1, 2]. The National Comprehensive Cancer Network (NCCN)'s colon cancer treatment guideline recommends conventional laparoscopic surgery (CLS) as an alternative to traditional open surgery for colon cancer. Because of the potential for further reductions in invasiveness, a number of small-scale retrospective studies have reported the safety and feasibility of single-incision laparoscopic colectomy (SILC) compared with CLS [3]. However, despite encouraging results, SILC is still technically challenging due to limitations in terms of instrument movement, loss of triangulation, and in-line viewing. These difficulties have become obstacles to the

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generalization of this technique [4–8]. To balance the gap between minimizing the abdominal trauma and reducing the technical difficulties, the application of single-incision plus one-port laparoscopic surgery (SILS + 1), which includes an additional port in the right lower quadrant when performing SILS for sigmoid and rectal cancer, has gained increasing attention from colorectal surgeons [9, 10]. An increasing number of studies have shown that SILS + 1 is safe and feasible for colorectal cancer and offers short-term outcomes comparable with those of CLS [11–15]. The findings of our previous retrospective study also suggested that SILS + 1 for rectosigmoid cancer could yield similar short- and long-term outcomes compared with CLS [16]. However, the above-mentioned studies have limitations, including retrospective designs, small sample sizes. The aim of this study was to determine the short-term outcomes of SILS + 1 compared with CLS for rectosigmoid cancer using a randomized controlled trial.

Methods

Study design and patients

This study was a single-center, open-labeled, non-inferiority, randomized controlled trial that was conducted in the Department of General Surgery, Nanfang Hospital, Southern Medical University, Guangzhou, China. The center performs over 700 laparoscopic colorectal cancer surgeries per year, including both CLS and SILS + 1. The trial was registered on ClinicalTrials.gov (NCT02117557). The protocol was approved by the Ethics Committee of Southern Medical University on March 19, 2014, (Reference number: NFEC-2014-026) and it was published previously [17]. All the patients received written informed consent before being enrolled in the study. The inclusion criteria, exclusion criteria, and withdrawal criteria were reported in our previous protocol [17].

Outcome measures

Primary endpoint

The primary endpoint was early morbidity, which included intraoperative and postoperative complications within 30 days after surgery. Early morbidity was assessed on postoperative day (POD) 30 and classified according to the Clavien–Dindo classification [18].

Secondary endpoints

Secondary endpoints included operative outcomes, pathological outcomes, postoperative inflammation and immune response, postoperative recovery, pain intensity, cosmetic results, 3-year disease-free survival (DFS), and 5-year overall survival (OS) [17].

Randomization and sample size

The patients were randomized at a 1:1 ratio to the SILS + 1 group or the CLS group. Simple random allocation sequences were computer generated using SPSS version 13.0 (SPSS, Inc., Chicago, IL, USA). A research coordinator gave the surgeon the patients' randomization numbers and group assignment in identical, opaque, sealed envelopes the day before surgery. The sample size was determined by the primary endpoint. According to the non-inferiority design, this analysis was based on an alpha of 0.025, a power of 80%, and a margin delta of 20%; a sample of at least 90 participants per group was calculated using the NCSS-PASS (11th edition, NCSS, LLC, Utah, USA). Assuming a drop-out rate of 10%, the total number of participants needed per group was 99.

Eligibility of surgeons

Surgery was performed by surgeons who had completed over 100 successful CLS cases and at least 10 successful SILS + 1 cases in accordance with our previous research regarding the SILS + 1 learning curve.

Surgical quality control

Surgical quality control was maintained by using mandatory intraoperative photographs that identified specific surgical fields, the resection margin of the specimen, and the abdominal incision. Five photos were required to verify the surgical quality, as follows: (1) high ligation in the root of inferior mesenteric artery (IMA) and inferior mesenteric vein (IMV), (2) the macroscopic quality of the complete mesocolic excision, and (3) proximal and distal margin lengths over 5 cm. These photos were reviewed, and feedback was regularly provided to the investigators.

Perioperative management

Polyethylene glycol electrolyte solution (2.5 L) was administered the day before surgery for bowel preparation. A single small dose of prophylactic antibiotics (second-generation cephalosporins) was given intravenously 30 min before surgery. Nasogastric tubes were not routinely applied. Postoperative patient-controlled opioid-based intravenous analgesia was routinely administered directly after surgery in the recovery room and discontinued on POD 2. Additional analgesics were allowed in cases of breakthrough pain as recommended by the World

Health Organization Analgesic Ladder and at the discretion of the treating ward physician. The drainage tube was removed at the surgeon's discretion and based on the amount of drainage and the properties of the drained fluid. Participants were discharged when they could tolerate a soft diet and ambulate independently.

Surgical technique

For the SILS + 1 procedure, an initial 5-cm periumbilical transverse incision was made. Then, a multiport device (SURGAID MEDICAL; XIAOMEN, CHINA) was placed at the umbilical incision (Fig. 1A). A 10-mm port was used for laparoscope insertion, and the other two ports were used for laparoscopic device insertion. A 12-mm trocar was placed in the right lower quadrant under laparoscopic view and served as the surgeon's dominant operating channel (Fig. 1B). After mobilization, the specimen was taken out through the primary incision where the SILS device was placed. After surgery, a drainage tube was placed through this trocar to drain the pelvic cavity of the patients who underwent anterior resection. The need for additional trocar(s) was defined as conversion to multiport surgery.

The CLS procedure was performed using five ports: a 12-mm port in the umbilical region; 5-mm ports in the upper right, left and lower left quadrants; and a 12-mm port in the lower right quadrant. A 12-mm umbilical trocar was used as a camera port for a rigid scope. After mobilization, the specimen was taken out by transversely extending the umbilical incision where laparoscopy was placed to 4–5 cm according to the tumor size. Once the length of the minilaparotomy exceeded 10 cm, laparoscopic surgery was considered an open conversion.

Statistical analysis

The statistical analysis was performed using SPSS version 13.0 (SPSS, Inc., Chicago, IL, USA). A two-sided $P < 0.05$ was considered significant. Descriptive statistics were applied for baseline characteristics analyses. For categorical variables, including the primary outcome, a χ^2 test or Fisher's exact test was applied. For continuous variables, Student's t test or the Mann–Whitney U test was applied.

Results

Patient recruitment

One hundred ninety-eight patients were enrolled and randomly assigned to either the SILS + 1 group or the CLS group between April 2014 and July 2016 (99 per group). After seven from the SILS + 1 group and six from the CLS group were excluded, ninety-two patients in the SILS + 1 group and ninety-three patients in the CLS group were analyzed (Fig. 2). The subjects' clinicopathologic characteristics are shown in Table 1. Baseline factors, including body mass indexes, comorbidities, tumor location, and surgical approaches, were well balanced between the groups.

Surgical and pathologic outcomes

The surgical and pathologic outcomes are presented in Tables 2 and 3. Conversion to open laparotomy, hospitalization expenses, and postoperative recovery were similar between the CLS and SILS + 1 groups. The total operating time in the SILS + 1 group was significantly shorter than that in the CLS group (100.8 ± 30.4 vs. 116.6 ± 36.6, $P = 0.002$), mainly due to the shorter intraperitoneal

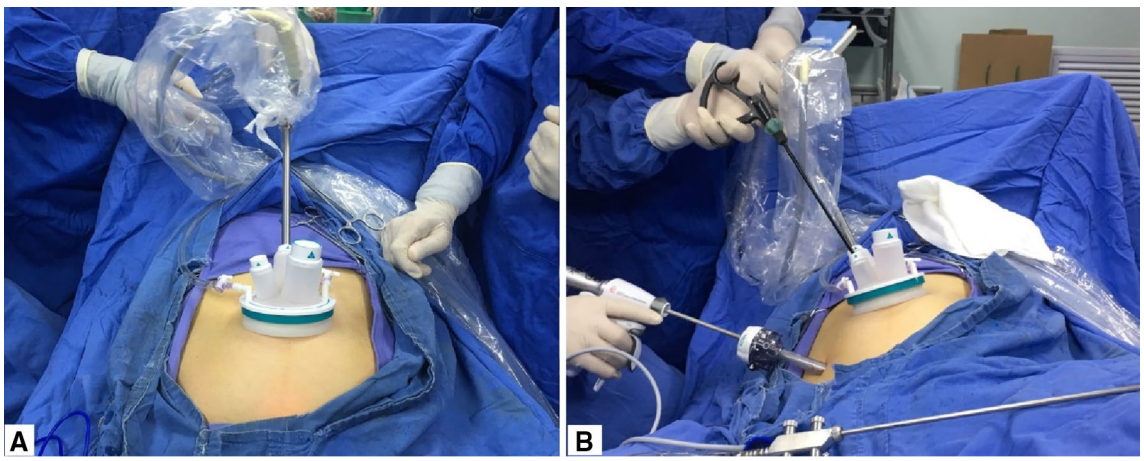

Fig. 1 **A** Multiport device placed at the umbilical incision. **B** 12-mm trocar placed in the right lower quadrant

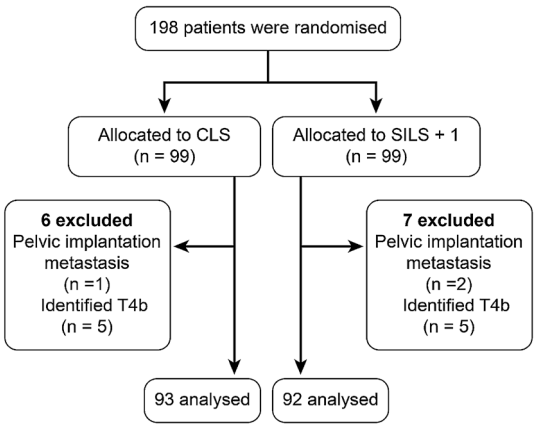

Fig. 2 Consort diagram

Table 1 Baseline clinical characteristics

	CLS ($n=93$)	SILS + 1 ($n=92$)	P
Age (years)	57.2 ± 11.7	56.9 ± 11.5	0.865
Gender			
Male	56 (60.2)	49 (53.3)	0.374
Female	37 (39.8)	43 (46.7)	
BMI (kg/m^2)	23.0 ± 3.1	22.8 ± 2.7	0.722
ECOG status			0.139
0	72 (77.4)	79 (85.9)	
1	21 (22.6)	13 (14.1)	
ASA grade			0.940
I	53 (57.0)	53 (57.6)	
II	35 (37.6)	34 (37.0)	
III	5 (5.4)	5 (5.4)	
Comorbidities	13 (14.0)	11 (11.8)	0.827
Tumor location from the anal verge (cm)	18.0 ± 5.3	19.4 ± 5.2	0.084
Tumor location			0.135
Sigmoid colon	17 (18.3)	28 (30.5)	0.061
Rectosigmoid	39 (41.9)	36 (39.1)	0.765
Superior rectum	37 (39.8)	28 (30.4)	0.218
Surgical approaches			0.432
Sigmoidectomy	58 (62.4)	64 (69.6)	
Anterior resection	32 (34.4)	24 (26.1)	
Left hemicolectomy	3 (3.2)	4 (4.3)	

CLS conventional laparoscopic surgery, *SILS + 1* single-incision plus one-port laparoscopic surgery, *BMI* body mass index, *ECOG* Eastern Cooperative Oncology Group, *ASA* American Society of Anesthesiologists, *CEA* carcinoembryonic antigen

operating time (66.2 ± 26.9 vs. 76.3 ± 28.2, $P=0.014$). Blood loss was significantly greater in the CLS group ($P<0.001$). Thirteen patients (14.0%) in the CLS group required additional postoperative analgesics, representing a greater proportion than the four patients (4.3%) in the SILS + 1 group ($P=0.039$). In the SILS + 1 group, eight patients (8.7%) required one to three additional 5-mm trocars for adherence separation or the mobilization of the splenic flexure and a low mesorectum. The umbilical minilaparotomy incision length did not differ significantly between the two groups. The total skin incision length in the SILS + 1 group was significantly shorter than that in the CLS group ($P<0.001$). Regarding the pathologic outcomes, the tumor diameter, pathologic stage, length of the proximal and distal margins, and number of lymph nodes harvested were similar for the two groups.

Postoperative complications

Morbidities and mortalities are shown in Table 4. There were no statistically significant differences in the overall intra- and postoperative complication rates in the CLS and the SILS + 1 groups (17.2 vs. 16.3%, $P=1.000$). One patient in the SILS + 1 group whose inferior epigastric artery had been injured by trocar had intraoperative bleeding and lost approximately 800 ml of blood. There were no deaths in either group ($P=1.000$). According to the Clavien–Dindo classification of surgical complications, one CLS patient with a trocar hernia and one CLS patient with anastomotic leakage required reoperation, and two SILS + 1 patients with anastomotic leakage required reoperation (2.2%, respectively; $P=1.000$). In the SILS + 1 group, one patient required re-admission because of ileus and was treated with conservative therapy.

Postoperative pain and inflammation

No significant difference was observed in the visual analogue scale (VAS) on POD 1–2 or in the discharge day between the SILS + 1 and CLS groups ($P=0.955$; 0.680; 0.392) (Fig. 3). On POD 3, the VAS was significantly higher in the CLS group than in the SILS + 1 groups ($P=0.023$). No significant differences were observed in the levels of inflammation, including white blood cell (WBC), C-reactive protein (CRP), interleukin-6 (IL-6), or tumor necrosis factor-a (TNF-a) between the two groups at each time point.

Quality of life and urinary function

QLQ-C30 scores showed similar patterns between the two groups. Urinary function was evaluated using the International Prostatic Symptom Score (IPSS), and no significant difference was observed between the groups. The groups both showed increasing trends at 1 month after surgery and decreasing trends at 3 months after surgery.

Table 2 Surgical outcomes

	CLS ($n=93$)	SILS + 1 ($n=92$)	P*
Operation time (min)			
Total time[a]	116.6 ± 36.6	100.8 ± 30.4	0.002
Intraperitoneal time[b]	76.3 ± 28.2	66.2 ± 26.9	0.014
Time for building trocars[c]	3.7 ± 1.9	5.0 ± 1.9	< 0.001
Closure time[d]	18.7 ± 7.8	16.8 ± 5.8	0.067
Blood loss (ml)[f]	50.0 (20.0, 50.0)	20.0 (20.0, 30.0)	< 0.001[f]
Additional trocar	0	8 (8.7)	–
Additional 1	–	1 (1.1)	–
Additional 2	–	2 (2.2)	–
Additional 3	–	5 (5.4)	–
Conversion to open surgery	0	1 (1.1)	0.497
Length of incision (cm)			
Minilaparotomy[e]	5.6 ± 1.2	5.5 ± 1.4	0.907
Total	8.4 ± 1.3	6.4 ± 1.1	< 0.001
Time to first flatus (h)	53.1 ± 23.9	55.5 ± 21.3	0.478
Time to first defecation (h)	80.6 ± 34.8	77.7 ± 26.8	0.526
Time to first oral intake (h)	67.8 ± 28.9	64.9 ± 26.6	0.418
Time to first ambulation (h)	65.8 ± 28.3	61.5 ± 30.3	0.319
Additional postoperative analgesics	13 (14.0)	4 (4.3)	0.039
Length of postoperative hospital stay (days)	7.6 ± 4.0	7.3 ± 3.0	0.522
Hospitalization expenses (yuan)	65,321 ± 13,622	65,190 ± 15,787	0.952

Values are presented as the number (%) or the mean ± standard deviation or the median and quartile range unless otherwise stated

CLS conventional laparoscopic surgery, *SILS + 1* single-incision plus one-port laparoscopic surgery

*χ^2 test

[a]Total operation time was measured from skin incision to skin closure

[b]Time from establishing pneumoperitoneum to the time the distal rectum was dissected by linear stapling device and the time from establishing pneumoperitoneum again after the specimen was removed to completing intraperitoneal end-to-end anastomosis

[c]Time for building trocars was measured from skin incision to when all trocars were built

[d]Closure time was the time for the abdominal incision closure

[e]The minilaparotomy was the incision made for specimen retrieval

[f]Values are presented as the median and quartile range. The Mann–Whitney *U* test was used

Cosmetic outcomes

The cosmetic outcomes were estimated using questionnaires that mainly evaluated satisfaction with a photo showing the scar and with the scar itself. Higher scores represented greater satisfaction. There was no significant difference observed between the groups; specifically, the satisfaction with photos gradually increased in both groups, while the satisfaction with the scar itself was better in the SILS + 1 group but not significantly different from that of the CLS group.

Discussion

During the past 20 years, laparoscopic surgery has been widely applied for the treatment of colorectal cancer. Increasing minimally invasive benefits, including less blood loss, less pain, faster recovery course, shorter hospital stays, have been obtained when surgeons strictly follow oncologic treatment principles [19–22]. For conventional laparoscopic colorectal cancer surgeries, 4–5 operating trocars and one incision for specimen removal were needed.

Table 3 Pathologic and oncologic outcomes

	CLS ($n=93$)	SILS + 1 ($n=92$)	P*
Tumor diameter	3.9 ± 1.6	3.9 ± 1.6	0.973
Pathologic TNM stage			0.148
0–I	18 (19.3)	20 (21.5)	
II	34 (36.6)	43 (46.7)	
III	41 (44.1)	29 (31.5)	
Differentiation			0.879
Good	10 (10.8)	11 (12.0)	
Moderate	76 (81.7)	72 (78.2)	
Poor/other	7 (7.5)	9 (9.8)	
Depth of invasion			0.839
Tis/T1	12 (12.9)	10 (10.9)	
T2	11 (11.8)	13 (14.1)	
T3	8 (8.6)	10 (10.9)	
T4a	62 (66.6)	59 (64.1)	
Harvested no. of LN	23.0 ± 11.2	20.9 ± 13.1	0.241
PRM (cm)	6.1 ± 3.5	6.1 ± 2.7	0.922
DRM (cm)	6.4 ± 3.5	6.4 ± 2.6	0.871

Continuous variables are described as the mean ± standard deviation (range); categorical variables are described as *n* (%)

TNM tumor-node-metastasis, *LN* lymph node, *PRM* proximal resection margin, *DRM* distal resection margin

With the rapid development of laparoscopic surgical devices and techniques, some experienced laparoscopic surgeons can complete the surgery with even fewer operating trocars or a smaller incision to further minimize the invasiveness of the procedure. These surgical techniques include SILS and NOTES. However, although it has been almost 10 years since Bucher et al. [23] and Remzi et al. [24] first reported the use of SILS for colorectal cancer in 2008, the procedure remains underdeveloped, and most studies of SILS have been single-center retrospective studies with a limited number of cases [25]. Only three single-center studies and one multicenter prospective study have been reported to date [26–29]. The main reason for the slow development of SILS might be the technical challenges, conflicts of surgical devices, and the lack of triangulation and in-line viewing. In the attempt to decrease these difficulties, some surgeons have added one operating port for device manipulation. Through this port, the abovementioned technical challenges could be better resolved while preserving the minimally invasive benefits of SILS. Thus, SILS + 1 surgery provides a more feasible option for laparoscopic colorectal surgeries [30, 31]. In our previous retrospective studies, we found that for colorectal cancer, SILS + 1 could greatly reduce surgical difficulties compared with pure SILS and that the operating time was even shorter than that of CLS. The postoperative cosmetic results and reduction in pain were similar to those of SILS; moreover, SILS + 1 only required two surgeons to finish the surgery [16]. Thus, we designed this single-center

Table 4 Postoperative morbidity and mortality

	CLS ($n=93$)	SILS + 1 ($n=92$)	P*
Perioperative complication	16 (17.2)	15 (16.3)	1.000
Intraoperative complication	1 (1.1)	0 (0)	1.000
Bleeding	1 (1.1)	0 (0)	1.000
Postoperative complication	15 (16.1)	15 (16.3)	1.000
Wound infection	0 (0)	2 (2.2)	0.246
Urinary retention	5 (5.4)	3 (3.3)	0.721
Anastomotic leakage	2 (2.2)	3 (3.3)	0.682
Anastomotic bleeding	3 (3.2)	1 (1.1)	0.315
Lymphorrhea	3 (3.2)	3 (3.3)	1.000
Ileus	2 (2.2)	1 (1.1)	1.000
Intra-abdominal bleeding	0 (0)	1 (1.1)	0.497
Trocar hernia	1 (1.1)	0 (0)	1.000
Clavien–Dindo classification			0.766
I	5 (5.4)	6 (6.5)	0.492
II	8 (8.6)	7 (7.6)	1.000
III	2 (2.2)	2 (2.2)	1.000
Reoperation	2 (2.2)	2 (2.2)	1.000
Re-admission within 30 days of surgery	0 (0)	1 (1.1)	0.497
Mortality within 30 days of surgery	0 (0)	0 (0)	–

Values are presented as *n* (%)

*χ^2 test

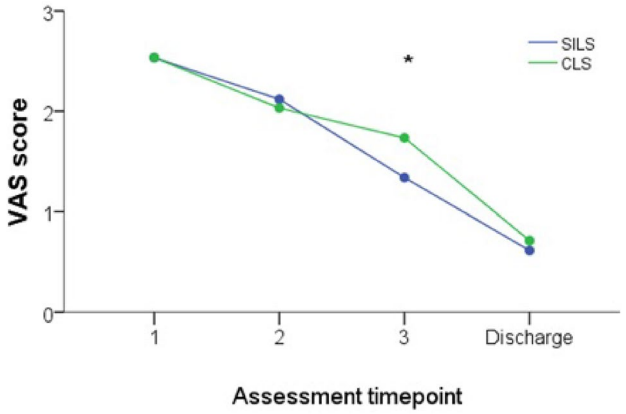

Fig. 3 Visual analogue scale on postoperative day 1–3 and discharge day. *$P<0.05$ (2.5 ± 1.6 vs. 2.5 ± 1.6, $P=0.995$; 2.1 ± 1.7 vs. 2.0 ± 1.3, $P=0.680$; 1.3 ± 1.1 vs. 1.7 ± 1.3, $P=0.023$; 0.6 ± 0.7 vs. 0.7 ± 0.8, $P=0.392$)

prospective study to further investigate the safety and feasibility of SILS + 1 for colorectal cancer. This is the first randomized controlled trial examining SILS + 1 for colorectal cancer.

To generalize the SILS + 1 technique, we enrolled patients with sigmoid colon and upper rectal cancer in the present study. Most of the enrolled patients did not require splenic flexure mobilization, and a sufficient distal resection margin could be easily obtained without excessive mobilization of the rectum outside the peritoneum reflection. Meanwhile, only the inferior mesenteric artery and vein required ligation for the lymph node dissection, making the procedure relatively easy to learn. The learning curve comprised only 14 SILS + 1 procedures for experienced laparoscopic surgeons, according to our previous study. In the present study, the surgery was completed in 83 patients; the exceptions included three cases with difficult splenic flexure mobilization, three cases with severe peritoneal adhesion, and two cases with anatomical variations that required additional operating port(s), and one case was converted to open surgery due to adhesion and anatomical variation. In addition to the technical difficulty, the population that is likely to benefit is another important factor we considered for the enrollment inclusion criteria. In our center, sigmoid colon and upper rectal cancer account for approximately 18% of the more than 700 colorectal cancer patients who require surgical treatment [32] and may benefit from the SILS + 1 technique.

Operating time is an important measure for evaluating surgical difficulties. Song et al. [12] retrospectively compared 32 patients who underwent two-port laparoscopic surgery for colorectal cancer with 217 CLS patients and found that two-port laparoscopic surgery required shorter operating times. A similar finding was also reported in Yu's study [13]. These authors believed that the reason for the shorter operating time was related to the smaller tumor sizes and relatively earlier-stage disease in the two-port groups. In our study, the prospective design allowed us to balance tumor size and stage between the SILS + 1 and CLS groups. Still, the operating time was shorter in the SILS + 1 group. Specifically, the intraperitoneal operating time was significantly shorter in the SILS + 1 group, although the operating platform establishment time was slightly longer than that of the CLS group, a finding similar to that of our previous retrospective study [16]. A possible contributor to this phenomenon might be that in our center, most of the laparoscopic assistants were less-experienced surgeons who lacked the fluent techniques during surgery, which was quite common in many Chinese high-volume centers, where the assistants were mostly visiting fellows. Thus, during surgery, the cooperation between the surgeon and assistants was not always smooth, which consumed the operating time. In contrast, during SILS + 1 surgery, the surgeon independently conducted the surgery without an assistant, which avoided the time spent adjusting and cooperating. Also, the laparoscopic surgical technique for sigmoid colon cancer and upper rectal cancer was not very demanding, and help coming from the assistants' exposure was relatively limited.

Surgical safety as the primary endpoint of this study was mainly measured in terms of intraoperative complications and postoperative morbidity and mortality. For intraoperative blood loss, past studies reported different findings when comparing SILS + 1 and CLS [12, 13, 15]. In our study, blood loss was significantly greater in the CLS group, mainly because in one case, the accidental injury of the inferior epigastric artery led to an 800-ml blood loss. A previous study suggested that the use of more trocars might increase the probability of trocar-related complications such as bleeding, hernia, organ injury, and infection [33]. In our study, one patient in the CLS group experienced a third-grade complication (trocar hernia) that required manipulation under general anesthesia. Other third-grade complications, one in the CLS group and two in the SILS + 1 group, were anastomotic leakages. However, the total number of complications did not differ between the groups, similar to previous reports [9–15]. Thus, the safety of SILS + 1 was comparable with that of CLS.

Since the surgical resection and lymph node dissection range was identical between the groups, the incisions for removing the specimen were similar. Postoperative inflammation and immune response, recovery course, hospitalization, and quality of life 3 months after surgery were not significantly different between groups. However, when we analyzed postoperative pain management, we found that 13 patients (14%) in the CLS group required additional analgesics, which was a significantly greater proportion than the 4 patients in the SILS + 1 group. Especially on POD three, the VAS scores of the patients in the CLS group were greater

than those of the patients in the SILS + 1 group. Song [12] and our retrospective studies [16] reported similar observations. We believe that the three additional 5-mm trocars used for the CLS group increased the patients' pain when they were encouraged to ambulate on POD3.

To analyze the cosmetic results, we measured the total length of the trocars and incisions. Although the total incision length of SILS + 1 group was smaller than that of the CLS group, there was no significant difference in the main incision length. Thus, the two groups did not differ in terms of postoperative cosmetic scales. This finding was identical to the findings of two meta-analyses published in 2016 [3, 34].

In cancer treatment, better cosmetic results and less-invasive approaches must not compromise oncological clearance. Therefore, the use of any new technique for colon cancer treatment must be considered carefully. As many other retrospective studies [9–13, 15] have reported regarding oncologic clearance, the mean number of harvested lymph nodes and proximal and distal resection margins did not differ significantly between the two groups. The 3-year disease-free survival (DFS) and 5-year overall survival (OS), as the secondary endpoints for this study, are still to be determined.

Conclusion

When performed by experienced laparoscopic surgeons, SILS + 1 for sigmoid colon and upper rectal cancer is safe and feasible and provides minimally invasive benefits, including shorter operation time and less postoperative pain, without compromising oncologic treatment principles. SILE + 1 might be a more practical alternative to pure SILS.

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Compliance with ethical standards

Disclosure Authors Yanan Wang, Haijun Deng, Tingyu Mou, Junmeng Li, Hao Liu, Haipeng Zhou, and Guoxin Li have no conflicts of interest or financial ties to disclose

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