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Impact of single-port laparoscopic approach on scar assessment by patients and observers: a multicenter retrospective study

Sung Uk Bae[1], Kyeong Eui Kim[1], Chang-Woo Kim[2], Ji-Hoon Kim[3], Woon Kyung Jeong[1], Yoon-Suk Lee[3], Seong Kyu Baek[1], Suk-Hwan Lee[4], Jun-Gi Kim[5]

[1]Department of Surgery, Keimyung University Dongsan Medical Center, Keimyung University School of Medicine, Daegu, Korea
[2]Department of Surgery, Ajou University Hospital, Ajou University School of Medicine, Suwon, Korea
[3]Division of Colorectal Surgery, Department of Surgery, College of Medicine, The Catholic University of Korea, Seoul, Korea
[4]Department of Surgery, Kyung Hee University Hospital at Gangdong, Kyung Hee University College of Medicine, Seoul, Korea
[5]Department of Surgery, Pyeongtaek St. Mary's Hospital, Pyeongtaek, Korea

Purpose: This study aimed to compare the wound cosmesis of a single-incision approach on scar assessment after laparoscopic surgery for colon cancer.

Methods: This study included 32 patients undergoing single-port laparoscopic surgery (SPLS) and 61 patients undergoing multiport laparoscopic surgery (MPLS) for colon cancer at 3 tertiary referral hospitals between September 2011 and December 2019. We modified and applied the Korean version of the Patient and Observer Scar Assessment Scale (POSAS) to assess cosmetic outcomes. To assess the interobserver reliability using intraclass correlation coefficient values for the Observer Scar Assessment Scale (OSAS), the surgeons evaluated 5 images of postoperative scars.

Results: No significant differences were observed in the time before the return of normal bowel function, time to sips of water and soft diet initiation, length of in-hospital stay, and postoperative complication rate. The SPLS group had a shorter total incision length than the MPLS group. The POSAS favored the SPLS approach, revealing significant differences in the Patient Scar Assessment Scale (PSAS), OSAS, and overall scores. The SPLS approach was an independent factor influencing the POSAS, PSAS, and OSAS scores. Eleven colorectal surgeons had a significantly substantial intraclass coefficient.

Conclusion: The cosmetic outcomes of SPLS as assessed by the patients and surgeons were superior to those of MPLS in colon cancer. Reducing the number of ports is an independent factor affecting scar assessment by patients and observers.

Keywords: Colonic neoplasms; Laparoscopy; Natural orifice endoscopic surgery; Wound healing; Treatment

INTRODUCTION

Laparoscopic surgery has replaced laparotomy for treating various types of abdominal surgery and has some advantages, including lower blood loss, fewer analgesic requirements, fewer complications, faster postoperative resumption, and shorter length of hospital stay, compared with open surgery. Since the introduction of laparoscopic colectomy by Jacobs et al. [1] in 1991, its application

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Correspondence to: Suk-Hwan Lee, MD
Department of Surgery, Kyung Hee University Hospital at Gangdong, Kyung Hee University College of Medicine, 8 892 Dongnam-ro, Gangdong-gu, Seoul 05278, Korea
Email: leeshdr@gmail.com

has expanded to include malignant diseases, and laparoscopic surgery has become an alternative standard procedure for colon cancer [2, 3].

With the rapid development of minimally invasive surgery in recent years, novel efforts have been made to minimize surgical trauma and improve cosmetic outcomes. These concepts have led to the development of single-port laparoscopic surgery (SPLS) for treating various diseases [4–10]. SPLS is rapidly gaining popularity in the field of colorectal surgery, and studies on SPLS have been published [7, 11]. However, body image and cosmetic outcomes have either been ignored or described from the point of view of the surgeon rather than the patient, and cosmetic outcome is often a secondary endpoint of studies comparing SPLS with conventional laparoscopy.

Until recently, survival rates were considered the most important endpoint in studies in patients with colorectal cancer. Quality of life, cosmesis, and functional outcomes are now considered important surgical outcome measures. Body image, a person's perception of, satisfaction with, and attitude towards his or her own body, has been broadly investigated in patients undergoing thyroidectomy, appendectomy, cholecystectomy, and bowel resection [12–16]. However, limited data are available regarding the cosmetic consequences of scarring in patients undergoing minimally invasive surgery with different access ports for colorectal cancer. This study aimed to investigate the effects of a single-incision approach on scar assessment by patients and surgeons after laparoscopic surgery for colon cancer.

METHODS

Ethics statement

The study protocol was approved by the Institutional Review Board of Keimyung Univertisty Hospital (No. DSMC 2023-07-021) and Kyung Hee University Hospital at Gangdong (No. KHNMC 2018-10-010), The Catholic University of Korea (No. OC20QCD10074). Data acquisition and analysis were performed with ethical considerations to ensure the patients' right to privacy. The requirement for informed consent was waived due to the retrospective nature of this study.

Patients

Between September 2011 and December 2019, a total of 2,083 patients underwent multiport laproscopic surgery (MPLS) and 179 patients underwent SPLS for colon cancer at Keimyung University Dongsan Medical Center, Kyung Hee University Hospital and The Catholic University of Korea in Korea. Among the 93 patients who completed Patient and Observer Scar Assessment Scale (POSAS) questionnaire, 32 patients underwent SPLS and 61 patients underwent MPLS. The exclusion criteria were open surgery, distant metastasis, synchronous or previous malignancies, perforation or obstruction, and combined resection of adjacent organs due to locally advanced lesions.

Evaluation parameters

Information on patient demographics, including age, sex, body mass index, tumor location, and preoperative carcinoembryonic antigen (CEA) levels, was obtained from a prospectively collected colorectal cancer database. The collected perioperative details included total operative time, total length of incision, time to sips of water and soft diet initiation, length of in-hospital stay, postoperative morbidity and mortality, and histopathological results. The strategy of adjuvant chemotherapy followed the National Comprehensive Cancer Network (NCCN) guidelines [17].

Surgical techniques

For SPLS, a single 25-mm vertical incision was made through the umbilicus for single-port placement. For MPLS, we used 4 to 5 ports: two 12-mm ports, one (at the umbilicus) for the camera and the other as a working port, and the two or three remaining 5-mm ports were placed in each remaining quadrant. The surgeons performed standard oncological operative procedures based on the tumor location. An extraction site was created by extending the umbilical incision for camera insertion.

Patient and observer scar assessment

The patients and surgeons completed the Patient and Observer Scar Assessment Scale (POSAS) questionnaire at the outpatient clinic during the follow-up period. Patient scar assessment was performed using questions regarding pain, itching sensation, color, stiffness, thickness, and surface area [18]. The observer scar assessment was further delineated into vascularity, pigmentation, thickness, relief, pliability, and surface area. Each subscale consists of items with 10-point categorical responses and scores ranging from 1 to 10 points (1 point is assigned to the most positive response and 10 points to the least favorable response). The interobserver reliability of the Observer Scar Assessment Scale (OSAS) was evaluated using intraclass correlation coefficient (ICC) values for the assessment of 5 postoperative scar images (Fig. 1).

Statistical analysis

Clinical characteristics and variables were compared between the SPLS and MPLS groups using the chi-square test for categorical data and the independent t-test for continuous data. P-values of <0.05 were considered statistically significant. To determine the

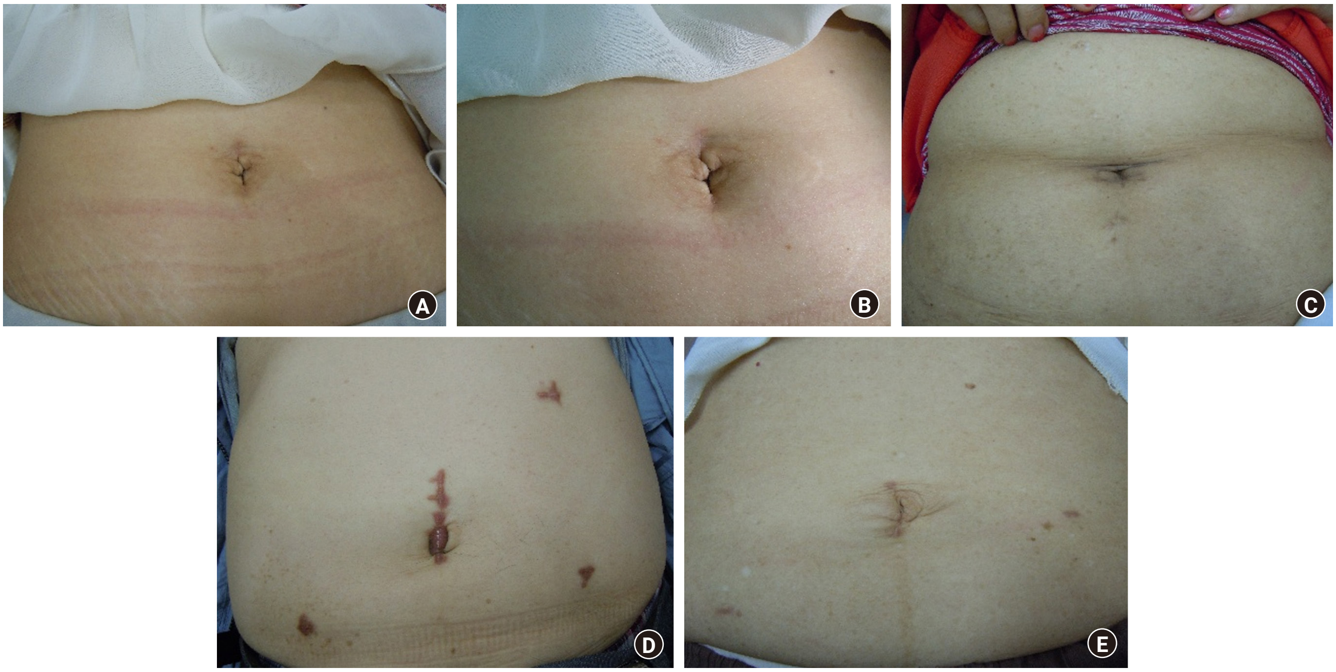

Fig. 1. The 5 representative postoperative images of single-port or multiport laparoscopic surgeries for interobserver reliability assessment. (A) Single-port surgery wound with wound extended above the umbilicus. (B) Single-port surgery wound extended upward and downward of the umbilicus. (C) Single-port surgery wound confined within the umbilicus. (D) Multiport surgery wound with keloid formation. (E) Reduced-port surgery wound with 1 additional port in the right lower quadrant.

significant factors of scar evaluation, univariate linear regression analysis was performed, and variables with $P < 0.1$ in the univariate analysis were subjected to multivariate regression analysis, with $P < 0.05$. Statistical analyses were performed using the IBM SPSS ver. 21.0 (IBM Corp), and data were expressed as medians with interquartile ranges.

RESULTS

Patient characteristics

Patients' demographic characteristics are summarized in Table 1. Demographic characteristics, including age, sex, body mass index, preoperative CEA level, and tumor location, did not differ significantly between the SPLS and MPLS groups.

Table 1. Patient characteristics (n = 93)

Characteristic	SPLS group (n = 32)	MPLS group (n = 61)	P-value
Age (yr)	61.8 ± 9.9	63.5 ± 12.3	0.516
Sex			0.062
Male	14 (43.8)	39 (63.9)	
Female	18 (56.3)	22 (36.1)	
Body mass index (kg/m^2)	24.2 ± 3.4	23.8 ± 3.3	0.562
Preoperative CEA level (ng/mL)	1.4 ± 1.0	17.1 ± 109.8	0.423
Tumor location			0.198
Cecum	2 (6.3)	1 (1.6)	
Ascending colon	6 (18.8)	17 (27.9)	
Transverse colon	7 (21.9)	5 (8.2)	
Descending colon	0 (0)	3 (4.9)	
Sigmoid colon	12 (37.5)	21 (34.4)	
Rectosigmoid colon	5 (15.6)	14 (23.0)	

Values are presented as mean ± standard deviation or number (%). Percentages may not total 100 due to rounding.
SPLS, single-port laparoscopic surgery; MPLS, multiport laparoscopic surgery; CEA, carcinoembryonic antigen.

Perioperative clinical outcomes

The perioperative clinical outcomes are summarized in Table 2. The operative time was significantly shorter in the SPLS group than in the MPLS group (140.4 minutes vs. 166.6 minutes, $P = 0.037$). The SPLS group had a shorter total incision length than the MPLS group (4.7 cm vs. 7.3 cm, $P < 0.001$). There were no significant differences in the time to gas out, time to sips of water and soft diet initiation, and length of in-hospital stay. Overall morbidity within 30 days after surgery was comparable between the 2 groups. Two patients (6.3%) in the SPLS group and 2 patients (3.3%) in the MPLS group developed superficial surgical site infection, without significant difference between the groups. In the MPLS group, 2 patients (3.3%) developed ileus, 2 (3.3%)

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Table 2. Perioperative and pathologic outcomes (n = 93)

Outcome	SPLS group (n = 32)	MPLS group (n = 61)	P-value
Total operative time (min)	140.4 ± 50.2	166.6 ± 59.4	0.037
Total length of incision (cm)	4.7 ± 2.6	7.3 ± 1.3	< 0.001
Conversion	1 (3.1)	0 (0)	0.425
Time to gas out (day)	3.0 ± 1.1	2.8 ± 1.2	0.342
Time to sips of water (day)	3.2 ± 1.2	3.2 ± 1.2	0.780
Time to soft diet initiation (day)	4.9 ± 1.1	5.9 ± 4.1	0.194
Hospital stay (day)	7.7 ± 3.0	8.9 ± 4.8	0.185
Morbidity within 30 days after surgery	2 (6.3)	7 (11.5)	0.418
Surgical site infection	2 (6.3)	2 (3.3)	
Ileus	0 (0)	2 (3.3)	
Pseudomembranous colitis	0 (0)	2 (3.3)	
Intra-abdominal abscess	0 (0)	1 (1.6)	
Mortality within 30 days after surgery	0 (0)	0 (0)	> 0.9999
T category			0.284
Tis–T2	8 (25.0)	25 (41.0)	
T3–T4	24 (75.0)	36 (59.0)	
N category			0.822
N0	20 (62.5)	42 (68.9)	
N1	8 (25.0)	13 (21.3)	
N2	4 (12.5)	6 (9.8)	
Histology			0.171
Well-differentiated	2 (6.3)	7 (11.5)	
Moderately differentiated	27 (84.4)	53 (86.9)	
Poorly differentiated	3 (9.4)	1 (1.6)	
Lymphovascular invasion	14 (43.8)	13 (21.3)	0.024
Perineural invasion	6 (18.8)	9 (14.8)	0.619
Tumor size (cm)	4.5 ± 2.1	4.1 ± 2.7	0.434
No. of retrieved LNs	29.6 ± 14.2	25.3 ± 11.0	0.115
Proximal resection margin (cm)	14.2 ± 9.4	17.1 ± 13.2	0.277
Distal resection margin (cm)	7.9 ± 4.0	11.4 ± 16.1	0.229
Adjuvant chemotherapy	18 (56.3)	26 (42.6)	0.211

Values are presented as mean ± standard deviation or number (%). Percentages may not total 100 due to rounding.
SPLS, single-port laparoscopic surgery; MPLS, multiport laparoscopic surgery; LN, lymph node.

had pseudomembranous colitis, and 1 (1.6%) had an intra-abdominal abscess. No reoperation or mortality occurred within 30 days of surgery.

Postoperative pathological outcomes

Table 2 summarizes the postoperative pathological outcomes. There were no significant differences in tumor and nodal stage distributions, histological differentiation, proportion of patients with perineural invasion, and tumor size between the 2 groups.

Table 3. Patient and observer scar assessment questionnaire scores (n = 93)

Questionnaire	Best possible score	SPLS group (n = 32)	MPLS group (n = 61)	P-value
PSAS	6	8.4 ± 4.7	13.8 ± 7.8	0.001
Pain	1	1.2 ± 0.6	1.7 ± 1.3	0.023
Itch	1	1.2 ± 0.7	1.7 ± 1.4	0.051
Color	1	1.8 ± 2.0	3.0 ± 2.3	0.009
Stiffness	1	1.6 ± 1.3	2.8 ± 2.1	0.006
Thickness	1	1.5 ± 1.2	2.7 ± 2.1	0.002
Surface area	1	1.3 ± 0.6	2.0 ± 1.6	0.013
OSAS	6	9.4 ± 7.3	14.9 ± 9.1	0.004
Vascularity	1	1.2 ± 0.6	2.0 ± 1.7	0.016
Pigmentation	1	1.5 ± 1.5	2.5 ± 2.1	0.031
Thickness	1	1.7 ± 1.5	2.5 ± 1.8	0.037
Relief	1	1.7 ± 1.4	2.6 ± 1.8	0.015
Pliability	1	1.7 ± 1.3	2.8 ± 1.7	0.003
Surface area	1	1.6 ± 1.3	2.6 ± 1.7	0.007
Total	12	17.8 ± 9.8	28.7 ± 13.3	< 0.001

Values are presented as mean ± standard deviation.
SPLS, single-port laparoscopic surgery; MPLS, multiport laparoscopic surgery; PSAS, Patient Scar Assessment Scale; OSAS, Observer Scar Assessment Scale.

However, there were more patients with lymphovascular invasion in the SPLS group than in the MPLS group. The mean numbers of harvested lymph nodes (29.6 vs. 25.3, P = 0.115) and resection margins were comparable between the 2 groups. The proportion of patients who received adjuvant chemotherapy was similar between the 2 groups (56.3% vs. 42.6%, P = 0.211).

Patient and observer scar assessment

Table 3 summarizes the postoperative assessment of scars using the POSAS. The mean time to survey after surgery were 46 and 26 months in the SPLS and MPLS groups, respectively (P < 0.001). For the Patient Scar Assessment Scale (PSAS), patients in the SPLS group provided better subscale ratings, including those for pain, color, stiffness, and surface area than the patients in the MPLS group (8.4 ± 4.7 vs. 13.8 ± 7.8, P = 0.001). For the OSAS, patients in the SPLS group also provided better subscale ratings, including those for vascularity, pigmentation, thickness, relief, pliability, and surface area than those in the MPLS group (9.4 ± 7.3 vs. 14.9 ± 9.1, P = 0.004). The overall POSAS score of the SPLS group was significantly lower than that of the MPLS group (17.8 ± 9.8 vs. 28.7 ± 13.3, P < 0.001).

Univariate and multivariate analyses of factors associated with scar assessment

Table 4 summarizes the results of the univariate analysis of factors

Table 4. Univariate analysis of factors associated with scar assessment

Factor	No. of patients	PSAS	P-value	OSAS	P-value	POSAS	P-value
Surgical approach			< 0.001		0.004		< 0.001
SPLS	32	8.4 ± 4.7		9.4 ± 7.3		17.8 ± 9.8	
MPLS	61	13.9 ± 7.8		14.9 ± 9.1		28.7 ± 13.3	
Sex			0.237		0.823		0.388
Male	53	11.2 ± 5.3		12.8 ± 7.6		24.0 ± 11.6	
Female	40	13.1 ± 9.3		13.3 ± 10.4		26.4 ± 15.3	
Age (yr)			0.406		0.233		0.715
> 65	42	11.3 ± 4.8		14.2 ± 8.9		25.6 ± 11.8	
≤ 65	51	12.6 ± 9.0		12.0 ± 8.8		24.6 ± 14.5	
Body mass index (kg/m^2)			0.759		0.769		0.987
< 18.5	3	15.0 ± 9.0		10.0 ± 3.5		25.0 ± 12.1	
≥ 18.5 and < 25	54	12.0 ± 7.8		12.8 ± 1.1		24.8 ± 12.9	
≥ 25	36	11.7 ± 6.7		13.6 ± 10.3		25.3 ± 14.2	
Sidedness			0.786		0.068		0.200
Right	38	11.7 ± 8.4		11.1 ± 6.4		22.9 ± 11.5	
Left	55	12.2 ± 6.6		14.3 ± 10.1		26.5 ± 14.3	
Total incision length (cm)			0.075		0.122		0.043
> 6.5	48	13.3 ± 5.7		14.4 ± 6.9		27.7 ± 10.4	
≤ 6.5	45	10.6 ± 8.6		11.5 ± 10.4		22.1 ± 15.4	
Tumor size (cm)			0.079		0.561		0.549
> 3.8	51	10.8 ± 5.2		13.5 ± 10.2		24.3 ± 14.1	
≤ 3.8	42	13.5 ± 9.2		12.4 ± 7.0		25.9 ± 12.4	
Surgical site infection			0.048		0.363		0.192
Yes	4	12.2 ± 7.5		13.2 ± 9.0		25.3 ± 13.4	
No	89	8.0 ± 2.8		9.8 ± 6.2		17.8 ± 9.0	

Values are presented as number only or mean ± standard deviation.
PSAS, Patient Scar Assessment Scale; OSAS, Observer Scar Assessment Scale; POSAS, Patient and Observer Scar Assessment Scale; SPLS, single-port laparoscopic surgery; MPLS, multiport laparoscopic surgery.

associated with the scar assessment using the PSAS, OSAS, and POSAS. For scar assessment using the PSAS, surgical approach related to the number of ports (P < 0.001) and surgical site infection (P = 0.048) emerged as significant factors. For scar assessment using the OSAS, surgical approach was a significant factor (P = 0.004). Surgical approach and total incision length were significant factors associated with scar assessment using the POSAS (P < 0.001 and P = 0.043, respectively). Table 5 displays the factors influencing scar assessment using the POSAS, as determined by multiple regression analysis. The surgical approach was found to be an independent factor influencing the POSAS (β = 12.35, P = 0.001), PSAS (β = 5.88, P = 0.005), and OSAS (β = 5.18, P = 0.006) scores.

Interobserver reliability using ICC values for the OSAS

ICC value was calculated to test the interobserver reliability of the OSAS score across 11 colorectal surgeons. The ICC was 0.721 (95% confidence interval [CI], 0.597–0.832; P < 0.001)] and the Cronbach α value was 0.976 for the 11 colorectal surgeons.

DISCUSSION

This study demonstrated that a single-incision approach positively affected scar evaluation through a questionnaire survey administered to patients and observers. In the multivariate analysis, a single-incision approach was an independent factor affecting scar assessment by both patients and observers. In the examination of the interobserver reliability of the OSAS, surgeons who participated in the survey exhibited a notably high ICC.

Several "scar scale" tools have been developed to convert subjective assessments of scars into stable, reproducible, measurable, and objective parameters. The Patient Scar Assessment Questionnaire was developed in Manchester and is based on the Scar Scale, adding a dimension to the effects of scarring on a patient's life and patient satisfaction [8, 19, 20]. Dunker et al. [12] developed a body image scale/questionnaire to assess patient-perceived cos-

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Table 5. Multivariate analysis of factors associated with scar assessment

Factor	Reference	β	SE	t	P-value
POSAS					
MPLS	SPLS	12.35	3.57	3.46	0.001
Wound > 6.5 cm	Wound ≤ 6.5 cm	−2.08	3.39	−0.61	0.542
PSAS					
MPLS	SPLS	5.88	2.02	2.91	0.005
Wound > 6.5 cm	Wound ≤ 6.5 cm	−1.04	1.90	−0.54	0.586
Mass size > 3.8 cm	Mass size ≤ 3.8 cm	−2.02	1.45	−1.40	0.167
Surgical site infection (yes)	Surgical site infection (no)	−2.81	3.56	−0.79	0.431
OSAS					
MPLS	SPLS	5.18	1.85	2.80	0.006
Right-sided tumor	Left-sided tumor	−2.72	1.79	−1.52	0.133

SE, standard error; POSAS, Patient and Observer Scar Assessment Scale; MPLS, multiport laparoscopic surgery; SPLS, single-port laparoscopic surgery; PSAS, Patient Scar Assessment Scale; OSAS, Observer Scar Assessment Scale.

mesis after surgery, and these scales have been used in several studies [21, 22]. Generally, questionnaires about cosmetic results are administered to patients who lack experience in scar assessment and cannot have different scars with 1 operation. However, surgeons can across cases of scars when using 2 different approaches. We believe that the POSAS, including evaluations by both patients and surgeons, can be used as a good evaluation tool. This study is the first to compare scar assessment in patients with colon cancer using both patient and surgeon scar assessments, with an interobserver reliability analysis.

Improvements in the early diagnosis of malignancies have resulted in longer survival rates in patients with cancer. However, postoperative patients with cancer have had to deal with the postoperative disabilities of both the disease and surgery, including intestinal function issues, postoperative scarring, and psychological distress [23, 24]. Minimally invasive surgery can provide societal needs with regard to the quality of life for cancer treatment, and cosmetic advantages can be expected to reduce the number of ports. Hamabe et al. [25] validated body image and photo series questionnaires after colorectal surgery and reported that a reduced-port laparoscopy group had significantly better cosmetic outcomes than a multiport group did. Bae et al. [20] reported that the Patient Scar Assessment Questionnaire favored the single plus 1-port robotic approach, revealing significant differences in appearance, consciousness, satisfaction with appearance, satisfaction with symptoms, and overall score. Our data reflect and support these findings and suggest that a reduced-port approach, such as SPLS, may offer advantages over the conventional multiport surgical approach in terms of improved cosmesis.

Several studies have shown the superiority of SPLS over MPLS in terms of cosmesis [8, 13, 26, 27]. Raakow et al. [26] reported that patients who underwent SPLS appendectomy had better short- and long-term cosmetic outcomes compared with those who underwent MPLS cholecystectomy or appendectomy. A randomized controlled trial conducted by Kudsi et al. [13] revealed that patient satisfaction with the surgical scar was significantly higher among female patients and those who underwent single-port laparoscopic cholecystectomy, with a significant improvement in cosmetic scores and a comparable quality of life, compared with those who underwent multiport laparoscopic cholecystectomy. However, Olweny et al. [28] reported that age was more strongly associated with cosmesis than the type of surgery in patients who underwent urological surgery. In this study, multivariate analysis revealed that the single-port approach was the only independent factor associated with a favorable scar assessment scale rating by patients and observers.

In this study, the interobserver variation in the OSAS score for postoperative scars was evaluated by calculating the ICC with a 95% CI. Cohen recommended that the κ result be interpreted as follows: 0 indicates no agreement, 0.01–0.20 indicates none to slight agreement, 0.21–0.40 indicates fair agreement, 0.41–0.60 indicates moderate agreement, 0.61–0.80 indicates substantial agreement, and 0.81–1.00 indicates nearly perfect agreement [29]. In our study, for 11 colorectal surgeons, the ICC for the OSAS was 0.721, indicating that this is a reliable tool for assessing postoperative scars and can be used with confidence in clinical practice. Moreover, Cronbach α typically yields a value between 0 and 1, with values above > 0.7 generally considered acceptable for reliability [30]. In our study, internal consistencies were estimated using Cronbach α > 0.9, which was considered adequate for all observers, SPLS surgeon observers, and MPLS surgeon observers.

The limitations of this study include its retrospective and nonrandomized nature, small sample size, and lack of data on quality of life. Scar assessment was determined by the patients' and surgeons' perceptions, which can be subjective rather than objective. We attempted to overcome these problems using POSAS. Moreover, the Korean version of the questionnaire has not yet been validated. Additionally, the time between surgery and scar evaluation was relatively different between the 2 groups (46 months for SPLS vs. 26 months for MPLS). More surgeons may need to participate in this study to confirm the reliability of the POSAS and interobserver variations.

In conclusion, the cosmetic outcomes of SPLS, as assessed by patients and surgeons, are superior to those of MPLS in colon cancer. Reducing the number of ports is an independent factor affecting scar assessment by both patients and surgeons.

ARTICLE INFORMATION

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Author contributions

Conceptualization: SUB, SHL; Data curation: CWK, JHK, WKJ, YSL, SKB, JGK; Formal analysis: SUB, KEK, SHL; Investigation: SUB, SHL; Methodology: CWK, JHK; Supervision: SHL, SKB, JGK; Validation: YSL, WKJ; Visualization: SUB; Writing–original draft: SUB, KEK; Writing–review & editing: all authors. All authors have read and approved the final manuscript.

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