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WJGS mainly publishes articles reporting research results and findings obtained in the field of gastrointestinal surgery and covering a wide range of topics including biliary tract surgical procedures, biliopancreatic diversion, colectomy, esophagectomy, esophagostomy, pancreas transplantation, and pancreatectomy, *etc*.

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ORIGINAL ARTICLE

Retrospective Study

Comparative analysis of conventional laparoscopic surgery and single-incision laparoscopic surgery in gastric cancer treatment: Outcomes and prognosis

Ce Cao, Xue Tian, Xue-Zhao Wang, Qing Wang

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Abstract

BACKGROUND

Gastric cancer surgery has advanced with minimally invasive techniques. This study compares outcomes between single-incision laparoscopic surgery plus one port (SILS + 1) and conventional laparoscopic surgery (CLS) in treating gastric cancer.

AIM

To explore the curative effect of SILS + 1 and CLS on gastric cancer and their influences on prognosis.

METHODS

A total of 93 patients with gastric cancer undergoing radical gastrectomy in the hospital were retrospectively analyzed between September 2019 and September 2022. According to different surgical methods, they were divided into SILS + 1 group (n = 56) and CLS group (n = 37). The perioperative indexes, pain degree [visual analogue scale (VAS)] and stress response [C-reactive protein (CRP), white blood cell count (WBC)] in the two groups were compared. The postoperative complications, recurrence rate and mortality at 1 year after surgery were recorded.

RESULTS

Intraoperative blood loss was significantly lower in the SILS + 1 group (76.53 ± 8.12 mL) compared to the CLS group (108.67 ± 12.34 mL, $P < 0.001$), and the total incision length was also significantly shorter in the SILS + 1 group (5.29 ± 1.01 cm *vs* 9.45 ± 2.34 cm, $P < 0.001$). SILS + 1 patients experienced faster recovery, with shorter times to first flatus (1.94 ± 0.43 days *vs* 3.23 ± 0.88 days, $P < 0.001$) and ambulation (2.76 ± 0.58 days *vs* 4.10 ± 0.97 days, $P < 0.001$). Postoperative pain, as measured by VAS scores, was significantly lower in the SILS + 1 group on postoperative days 1, 2, and 3 ($P < 0.001$). Additionally, stress markers (CRP and WBC) were significantly lower in the SILS + 1 group on the first postoperative day (CRP: 6.41 ± 1.63 mg/L *vs* 7.82 ± 1.88 mg/L, $P < 0.001$; WBC: 6.34 ± 1.50 × 10^9/L *vs* 7.09 ± 1.61 × 10^9/L, $P = 0.024$). The complication rate in the SILS + 1 group was also significantly lower than in the CLS group (8.93% *vs* 27.03%, $P = 0.020$). However, there was no significant difference in recurrence rates between the two groups after one year (3.57% *vs* 8.11%, $P > 0.05$).

CONCLUSION

SILS + 1 and CLS have the comparable lymph node clearance effect in patients with gastric cancer. However, SILS + 1 is more beneficial to reduce intraoperative blood loss, relieve pain, alleviate stress response, reduce the incidence of complications and promote rapid postoperative recovery.

Key Words: Single-incision laparoscopic surgery + 1 port; Conventional laparoscopic surgery; Radical gastrectomy; Gastric cancer; Recurrence

Core Tip: This study compares the effects of single-incision laparoscopic surgery plus one port (SILS + 1) and conventional laparoscopic surgery (CLS) in treating gastric cancer. SILS + 1 was found to reduce intraoperative blood loss, relieve postoperative pain, and lower stress response, leading to quicker recovery and fewer complications. Both techniques showed comparable lymph node clearance and no difference in recurrence rate after one year. SILS + 1 offers a minimally invasive option with enhanced safety and recovery benefits, making it a promising alternative to CLS for gastric cancer patients.

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INTRODUCTION

Gastric cancer is a malignant tumor that occurs in gastric mucosal epithelial cells, and it is also one of the most common malignant tumors in the world, with high morbidity and mortality[1]. The lack of obvious early symptoms means that many patients are diagnosed in the advanced stages, when treatment becomes more challenging. Surgery remains the primary treatment option for gastric cancer, and laparoscopic radical gastrectomy has the advantages of less trauma, less bleeding contributing to improved postoperative quality of life and prolonged survival rates[2,3].

In recent years, as minimally invasive surgical techniques have advanced, conventional laparoscopic surgery (CLS) has evolved into single-incision laparoscopic surgery (SILS), which reduces the number of incisions needed for the procedure. SILS offers potential advantages such as reduced postoperative pain, better cosmetic outcomes, and a minimized impact on the abdominal wall. However, due to technical challenges, including limited tissue tension and instrument interference, the widespread clinical adoption of SILS has been restricted. To address these challenges, the SILS plus one port (SILS + 1) technique was developed, which adds an auxiliary operating port to reduce the difficulty of the procedure while maintaining the minimally invasive benefits of SILS. This modification is designed to achieve a balance between surgical safety and invasiveness, potentially making the procedure more widely applicable[4,5]. Despite the growing interest in SILS + 1, few studies have systematically compared its clinical efficacy with that of CLS, particularly in terms of perioperative outcomes, postoperative recovery, and long-term prognosis[6,7]. Previous research has suggested that SILS + 1 offers certain advantages, such as faster recovery and reduced postoperative pain, but its impact on the stress response, complication rates, and recurrence remains unclear. Understanding these differences is crucial for improving patient outcomes and guiding surgical decision-making in gastric cancer treatment[8,9]. This study aims to fill this gap by directly comparing SILS + 1 and CLS in patients undergoing radical gastrectomy for gastric cancer. By assessing perioperative outcomes, stress response, and long-term recurrence rates, this study seeks to determine whether SILS + 1 offers meaningful clinical benefits over CLS. The findings could provide valuable insights into the optimization of surgical approaches for gastric cancer, particularly in the context of minimally invasive surgery.

MATERIALS AND METHODS

Study design

A total of 93 patients with gastric cancer who underwent surgical treatment in our hospital from September 2019 and September 2022 were retrospectively analyzed. Inclusion criteria: In accordance with the guidelines for the diagnosis and treatment of gastric cancer[10], gastric cancer was diagnosed by gastroscopy and imaging examination, and the pathological stage was I-III. All patients underwent radical gastrectomy for gastric cancer. Body mass index (BMI) ≤ 25 kg/m^2; The American Society of Anesthesiologists (ASA) grade was I-II. Exclusion criteria: (1) Patients with a history of other malignant tumors; (2) Patients with incomplete clinical data; (3) People with mental illness; (4) Patients with abnormal liver and kidney function; (5) Patients with previous abdominal surgery or severe adhesion in the abdominal cavity; (6) Patients with lymph node and distant metastasis; and (7) Patients who received neoadjuvant chemotherapy before surgery.

The patients were divided into SILS + 1 group and CLS group according to the different surgical methods. SILS + 1 group (n = 56): Male/female = 37/19; The mean age was 54.12 ± 5.08 years (range: 42-67 years); The average BMI was 21.13 ± 1.57 kg/m^2; The mean tumor diameter was 3.61 ± 0.42 cm; Tumor location: 13 cases in gastric fundus and cardia, 16 cases in gastric body, 27 cases in gastric antrum; Tumor stage: Stage I/II/III = 21/18/17 cases. CLS group (n = 37): Male/female = 26/11; The mean age was 53.87 ± 5.12 years (range: 42-67 years); The average BMI was 21.02 ± 1.25 kg/m^2; The mean tumor diameter was 3.42 ± 0.59 cm; Tumor location: 11 cases in gastric fundus and cardia, 12 cases in gastric body and 14 cases in gastric antrum; Tumor stage: Stage I/II/III = 15/13/9 cases. There was no significant difference in baseline data between the two groups (P > 0.05).

Both groups underwent radical resection of gastric cancer, and the operation was performed by the same team. All patients were placed in supine position and received inhalation combined general anesthesia.

In SILS + 1 group, the surgeon stood on the left side of the patient, the mirror holder was between the legs of the patient, and the first assistant was on the right side of the patient. First, a 1.5 cm small incision was made at the natural fold around the umbilicus, and a 10 mm trocar was punctured for laparoscopic exploration. Then the periumbilical incision was extended to 3 cm-4 cm, a single-port instrument was inserted, pneumoperitoneum was established, and abdominal pressure was maintained at 13 mmHg. With the assistance of laparoscopy, a 1.5 cm incision was made 2 cm below the intersection of the left anterior axillary line and the costal margin, a 12 mm trocar was puncturing as the main operating hole, and an ultrasonic scalpel was inserted. All patients underwent D2 radical gastrectomy according to the standard[11,12]. A small hole was opened at the mesenteric edge of jejunum 30 cm away from Treitz ligament, and a 60 mm linear cutting stapler was inserted. The two ends were inserted into the residual stomach and the anal side, respectively, to complete the side to side anastomosis of the residual stomach and jejunum. The gastric specimens were removed through the umbilical foramen and anastomosed with Billroth I and II. The surgical field was rinsed, and no active bleeding points were checked. A drainage tube was placed through the main operation hole, pneumoperitoneum was closed, the distal gastric specimen was removed, and the abdomen was closed layer by layer.

In group CLS, a 4 cm curved incision was made under the umbilicus, a trocar puncture device was inserted to establish pneumoperitoneum, and then the laparoscope was inserted after the inner core of the trocar was removed. A 10 mm incision was made 2 cm below the left anterior axillary margin as the main operation hole. A 5 mm incision was made 2 cm above the left umbilical cord as an auxiliary operating hole. An incision of 5 mm and 12 mm was made at 2 cm below the costal margin of the right anterior axillary line and 2 cm above the right umbilical cord as the assistant operation hole, respectively. Instruments such as non-destructive grasping forceps and separating forceps were inserted, and the abdominal cavity and pelvic cavity were routinely explored. D2 radical gastrectomy was performed. After the end of the dissection, an auxiliary incision of about 6 cm was made under the xiphoid process and connected with the umbilicus. The gastric specimen was taken out and the digestive tract was reconstructed. The anastomosis was Billroth I and II. The surgical field was rinsed, and no active bleeding points were checked. A drainage tube was placed and fixed through the main operating hole, and the abdomen was closed layer by layer.

Both groups were routinely given anti-inflammatory, fluid infusion and parenteral nutrition support after operation. After anal exhaust, liquid food can be taken and gradually transitioned to a normal diet.

The operation time, intraoperative blood loss, incision length, number of lymph nodes removed, hospital stay, time to first flatus, time to first ambulation, and time to drainage tube removal were recorded. The degree of pain was evaluated by visual analogue scale (VAS)[13] on the 1st, 2nd and 3rd day after surgery. The scale ranges from 0 to 10, with higher scores indicating more severe pain. Before and 1 day after surgery, 3 mL of fasting venous blood was collected from the patients, and the upper serum was collected after centrifugation. Serum C-reactive protein (CRP) was detected by enzyme-linked assay (reagents and kits were obtained from Wuhan Fearn Biotechnology Co., Ltd.), and white blood cell (WBC) was detected by Myriad BC-760 CS automatic hematology analyzer. Postoperative anastomotic bleeding, intra-abdominal bleeding, pulmonary infection, anastomotic leakage and hypercapnia were recorded. The recurrence and survival of patients after 1 year were recorded. Recurrence[14]: Tumor lesions were found in the original resection site and within 1 cm of the surrounding area. This study was approved by the ethics committee. Signed written informed consents were obtained from the patients and/or guardians.

Statistical analysis

Data were analyzed using the statistical package for social science version 22.0 (International Business Machines Corporation, Armonk, NY, United States). For normally distributed continuous variables, data were presented as mean ± SD, and comparisons between groups were conducted using an independent samples t-test or repeated measures analysis of variance as appropriate. For categorical variables, frequencies were expressed as counts (n) and percentages (%), and

comparisons were performed using the χ^2 test or Fisher's exact test when necessary. A P value of less than 0.05 was considered statistically significant. To account for potential confounding factors, such as tumor stage, patient comorbidities, age, and gender, multivariate regression analysis was employed. Adjusted odds ratios with 95% confidence intervals were calculated to assess the association between surgical techniques and clinical outcomes. Additionally, stratified analyses were conducted based on tumor stage (Stage I, II, III) to determine the effect modification by tumor severity. A sensitivity analysis was also performed by excluding patients with significant comorbidities to verify the robustness of the findings.

RESULTS

Perioperative outcomes the SILS + 1 group demonstrated significantly less intraoperative blood loss (76.53 ± 8.12 mL *vs* 108.67 ± 12.34 mL; $P < 0.001$) and shorter total incision length (5.29 ± 1.01 cm *vs* 9.45 ± 2.34 cm; $P < 0.001$) compared to the CLS group (refer to Table 1). These findings suggest that the SILS + 1 technique is less invasive, potentially reducing surgical trauma and promoting quicker wound healing. Furthermore, the SILS + 1 group experienced a shorter hospital stay (7.88 ± 1.60 days *vs* 9.84 ± 1.73 days; $P < 0.001$), which can imply a faster recovery and reduced healthcare costs. No significant differences were observed between the groups regarding operation time and the number of lymph nodes removed ($P > 0.05$), indicating comparable effectiveness in achieving oncological clearance (refer to Table 1).

Postoperative recovery patients in the SILS + 1 group achieved first flatus and ambulation earlier than those in the CLS group (time to first flatus: 1.94 ± 0.43 days *vs* 3.23 ± 0.88 days; $P < 0.001$; time to first ambulation: 2.76 ± 0.58 days *vs* 4.10 ± 0.97 days; $P < 0.001$) (refer to Table 1). These results are clinically significant as they reflect enhanced postoperative gastrointestinal function and mobility, key indicators of patient recovery quality and reduced risk of complications such as deep vein thrombosis and pulmonary issues.

Pain and stress response postoperative pain scores (VAS) were significantly lower in the SILS + 1 group on days 1, 2, and 3 ($P < 0.001$) (refer to Table 2). Lower pain levels are crucial for improving patient comfort, reducing the need for analgesics, and potentially shortening hospital stays. Additionally, stress markers such as CRP and WBC counts were significantly lower in the SILS + 1 group on the first postoperative day (CRP: 6.41 ± 1.63 mg/L *vs* 7.82 ± 1.88 mg/L, $P < 0.001$; WBC: 6.34 ± 1.50 × 10^9/L *vs* 7.09 ± 1.61 × 10^9/L, $P = 0.024$) (refer to Table 3), suggesting a lower systemic inflammatory response, which is beneficial in reducing the risk of postoperative complications and enhancing recovery.

Complication rates and recurrence the complication rate in the SILS + 1 group was significantly lower (8.93% *vs* 27.03%; $P = 0.020$) (refer to Table 4). The reduced complication rate indicates that the SILS + 1 approach may be safer for patients by minimizing the risk of postoperative adverse events such as infections or anastomotic leaks. No significant difference in recurrence rates was observed between the two groups at the one-year follow-up (3.57% *vs* 8.11%; $P > 0.05$), confirming the oncological safety of the SILS + 1 procedure in the short term.

DISCUSSION

China is a high-incidence area of gastric cancer. The incidence of gastric cancer increases with age and tends to be younger. Studies have pointed out[15] that the long-term progress of gastric cancer will lead to the deterioration of gastrointestinal symptoms and increase the risk of death. Nowadays, laparoscopic radical gastrectomy is often used as the first choice for the treatment of gastric cancer. CLS has been widely carried out in clinical practice and has significant advantages over open surgery, but it still has shortcomings and deficiencies in terms of complications. With the development of laparoscopic technology, more minimally invasive surgical methods such as single-port have emerged, but they are difficult to operate and difficult to transection the bowel, which makes it difficult to be widely used in clinical practice. SILS + 1 laparoscopic surgery is to add an operation hole on the basis of single-port operation, and change the small triangle in single-port operation back to the large triangle, which improves the interference of instruments to a certain extent and greatly reduces the difficulty of operation[16,17]. Therefore, this study will further compare SILS + 1 and CLS laparoscopic surgery to explore its therapeutic effect, stress response and recurrence in patients with gastric cancer, in order to provide reference for the selection of the optimal surgical method.

In our study, the amount of intraoperative blood loss, the total length of incision, the length of hospital stay, the time to first flatus, the time to first ambulation, and the time to removal of drainage tube in the SILS + 1 group were shorter than those in the CLS group, which was similar to the study by Lu *et al*[18]. Compared with CLS, SILS + 1 has the advantages of less trauma, faster postoperative recovery and less impact on the intestinal tract. It is considered that SILS + 1 laparoscopic surgery has fewer surface operation holes, only one incision around the umbilicus and one drainage tube hole under the left costal margin, so the total length of incision is shorter, which is conducive to reducing abdominal trauma. The transhumbilical or peri-umbilical incision can not only maintain the integrity of abdominal wall, but also reduce the impact of pain on gastrointestinal tract, which is conducive to promoting the rapid recovery of gastrointestinal tract after surgery, thereby shortening the length of hospital stay. In addition, this procedure can not only deal with the anatomical level more accurately, but also reduce the risk of bleeding caused by the Trocar hole, thereby reducing the amount of intraoperative blood loss. In this study, there was no difference in the operation time and the number of lymph node dissection between the two groups, indicating that the effect of lymph node dissection of this surgical method and CLS is equivalent, and it does not affect the operation time, which is inconsistent with the study of Yang *et al*[19], which may be related to the small sample size included in this study and the lack of experience of the operators.

Table 1 Comparison of perioperative indicators between the two groups, mean ± SD

Index	SILS + 1 group (*n* = 56)	CLS group (*n* = 37)	*t* value	*P* value
Time of operation (minute)	205.18 ± 19.35	203.59 ± 19.20	0.389	0.698
Peroperative bleeding (mL)	76.53 ± 8.12	108.67 ± 12.34	15.164	< 0.001
Total length of incision (cm)	5.29 ± 1.01	9.45 ± 2.34	11.771	< 0.001
Number of lymph nodes removed (*n*)	25.31 ± 3.75	26.08 ± 3.51	0.994	0.323
Hospital stays (day)	7.88 ± 1.60	9.84 ± 1.73	5.598	< 0.001
The first postoperative exhaust time (day)	1.94 ± 0.43	3.23 ± 0.88	9.417	< 0.001
The time of first ambulation (day)	2.76 ± 0.58	4.10 ± 0.97	8.337	< 0.001
Drainage tube removal time (day)	5.69 ± 1.27	7.12 ± 1.56	4.849	< 0.001

SILS + 1: Single-incision laparoscopic surgery plus one port; CLS: Conventional laparoscopic surgery.

Table 2 Comparison of pain degree between the two groups, mean ± SD

Group	First day after surgery	Second days after surgery	Third days after surgery
SILS + 1 group (*n* = 56)	2.61 ± 0.55	1.79± 0.48	1.03 ± 0.22
CLS group (*n* = 37)	3.42 ± 0.98	2.31 ± 0.56	1.97 ± 0.43
F_{time}/P	153.003/< 0.001		
$F_{comparison\ among\ groups}/P$	112.865/< 0.001		
$F_{interaction}/P$	5.368/0.024		

SILS + 1: Single-incision laparoscopic surgery plus one port; CLS: Conventional laparoscopic surgery.

Table 3 Comparison of stress responses between the two groups, mean ± SD

Group	CRP (mg/L)		WBC (× 10^9/L)	
	Preoperative	Postoperative day 1	Preoperative	Postoperative day 1
SILS + 1 group (*n* = 56)	4.52 ± 1.23	6.41 ± 1.63[a]	5.16 ± 1.29	6.34 ± 1.50[a]
CLS group (*n* = 37)	4.69 ± 1.30	7.82 ± 1.88[a]	5.24 ± 1.37	7.09 ± 1.61[a]
t value	0.638	3.917	0.286	2.292
P value	0.525	<0.001	0.776	0.024

[a]$P < 0.05$.

CRP: C-reactive protein; WBC: White blood cell; SILS + 1: Single-incision laparoscopic surgery plus one port; CLS: Conventional laparoscopic surgery.

According to the study, VAS scores in the SILS + 1 group were lower than those in the CLS group at 1, 2, and 3 days after surgery, indicating that laparoscopic surgery with SILS + 1 was less painful. SILS + 1 laparoscopic surgery may reduce the number of severed muscles and incisions, resulting in less pain. Du *et al*[20] also pointed out that VAS score after SILS + 1 laparoscopic surgery was lower, and this study was basically similar to it, which again confirmed that SILS + 1 laparoscopic surgery was conducive to reducing the postoperative pain of patients with gastric cancer and was more in line with the concept of minimally invasive surgery. Although SILS + 1 laparoscopic surgery has better minimally invasive effect, as a surgical operation, it will still trigger a strong stress response, which has adverse effects on the stability of the body's various organ functions, resulting in an increase in the incidence of complications and affecting the postoperative recovery process of patients[21]. CRP and WBC are serological indicators of stress and infection, and when their levels are too high, they can easily lead to a stress reaction in the body, resulting in an increase in the release of inflammatory mediators and extensive damage to the body's tissues and cells, thus exacerbating the patient's pain and affecting his or her postoperative recovery. In this study, the levels of CRP, WBC in the two groups were increased at 1 day after operation, but those in the SILS + 1 group were lower than those in the CLS group, suggesting that SILS + 1 laparoscopic surgery in the treatment of gastric cancer causes less damage to patients and is conducive to reducing the stress response. The reasons are as follows: SILS + 1 has less incision than CLS, and the reduction of incision represents

Table 4 Comparison of complications between the two groups, *n* (%)

Group	Anastomotic bleeding	Intraperitoneal hemorrhage	Pulmonary infection	Stomal leak	Hypercapnia	Total complication rate
SILS + 1 group (n = 56)	1 (1.79)	0 (0)	1 (1.79)	3 (5.36)	0 (0)	5 (8.93)
CLS group (n = 37)	1 (2.70)	2 (5.41)	1 (2.70)	5 (13.51)	1 (2.70)	10 (27.03)
χ^2 value						5.395
P value						0.020

SILS + 1: Single-incision laparoscopic surgery plus one port; CLS: Conventional laparoscopic surgery.

less trauma, which is conducive to reducing the influence of cytokines produced by the abdominal wall injury site on the body, so as to alleviate the stress response of the body. In addition, this surgical approach has less intraoperative blood loss and shorter surgical incision. It also has less interference to the immune function of the body, inhibits the release of inflammatory factors, controls the occurrence and development of inflammatory response, and ultimately reduces the stress response.

In this study, the incidence of complications in the SILS + 1 group was lower than that in the CLS group, indicating that laparoscopic surgery with SILS + 1 can reduce the incidence of complications in patients with gastric cancer. This may be related to less trauma and less stress response of SILS + 1. At the same time, the drainage tube can be placed through the auxiliary main operation hole, and the complications such as abdominal hemorrhage and anastomotic leakage can be found early by observing the drainage situation while ensuring the drainage. This study also showed that there was no death at 1 year after operation and there was no difference in recurrence rate between the two groups, which further confirmed the long-term efficacy of SILS + 1 laparoscopic surgery in the treatment of gastric cancer.

In conclusion, this study demonstrates that SILS + 1 laparoscopic surgery offers significant clinical advantages over CLS for gastric cancer, including reduced intraoperative blood loss, lower pain scores, shorter hospital stays, and fewer postoperative complications. These findings suggest that SILS + 1 could be a preferable surgical option for suitable patients, potentially enhancing postoperative outcomes and overall patient quality of life. Given the promising results, future guidelines for gastric cancer surgery might consider incorporating SILS + 1 as a recommended approach, particularly for patients who meet specific criteria, such as lower BMI and lower ASA scores. However, to establish SILS + 1 as a standard practice, further research is needed. Future studies should focus on larger, multicenter, prospective randomized controlled trials to validate these findings across diverse populations and settings. Additionally, research should explore the long-term effects of SILS + 1 on overall survival, disease-free survival, and quality of life, as well as its cost-effectiveness compared to other surgical approaches. By addressing these areas, future research could provide the evidence needed to solidify the role of SILS + 1 in gastric cancer treatment, ultimately influencing clinical guidelines and surgical practices on a broader scale.

However, the study has several limitations that should be considered. Firstly, its retrospective design limits the ability to establish causal relationships between the surgical techniques and patient outcomes. Retrospective studies are prone to selection bias and cannot control for all potential confounding variables, such as differences in surgeon experience or variations in perioperative care. Additionally, the relatively small sample size (93 patients) may reduce the statistical power to detect differences in less common outcomes, such as long-term survival and recurrence rates. Furthermore, the study was conducted in a single institution, which may limit the generalizability of the results to other settings or populations with different surgical practices and patient characteristics. To validate these findings and provide stronger evidence of the benefits of SILS + 1 over CLS, future studies should consider a multicenter, prospective randomized controlled trial design. The generalizability of the results to other patient populations and surgical contexts remains uncertain. This study primarily included patients with a specific range of BMI (≤ 25 kg/m²) and relatively low ASA scores (I-II), which may limit the applicability of the findings to patients with higher BMI, more advanced disease stages, or greater comorbidities. Further research is needed to determine whether the benefits of SILS + 1 observed in this study extend to these broader patient groups. To enhance the understanding of the clinical value of SILS + 1, future research should focus on investigating its long-term outcomes, such as overall survival, disease-free survival, and quality of life measures. Moreover, studies should explore the cost-effectiveness of SILS + 1 compared to CLS, considering not only the direct costs of surgery but also the potential savings from reduced hospital stays and complication rates. Comparative studies that include other minimally invasive techniques, such as robotic-assisted surgery, would also be valuable in identifying the most effective and efficient surgical approaches for gastric cancer treatment.

CONCLUSION

This study demonstrates that SILS + 1 offers significant clinical advantages over CLS in the treatment of gastric cancer. SILS + 1 resulted in reduced intraoperative blood loss, lower postoperative pain, quicker recovery, and fewer complications, while maintaining comparable lymph node clearance and recurrence rates. These findings suggest that SILS + 1 could be a preferable surgical option for selected patients, particularly those who benefit from a minimally invasive

approach. However, larger studies and long-term follow-ups are needed to confirm its effectiveness and establish it as a standard practice in gastric cancer surgery.

FOOTNOTES

Author contributions: Cao C and Wang Q designed the study, performed the experiments and prepared the manuscript; Tian X collected the data; Wang XZ analyzed the data; All authors read and approved the final manuscript.

Institutional review board statement: This study was approved by the ethics committee of Zibo Central Hospital.

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