

INTRODUCTION

Single-Incision Laparoscopic Cholecystectomy (SILC) has been widely adopted for benign gallbladder diseases due to its minimal invasiveness and favorable cosmetic outcomes. However, technical limitations such as instrument interference, limited operative field, and steep learning curve hinder its broader application. To address these limitations, robotic platforms have been introduced, offering superior visualization, enhanced precision, and improved ergonomics. Single-incision robotic cholecystectomy (SIRC) has gradually gained acceptance among surgeons and patients. The EDGE SP1000, a domestically developed single-port robotic system. This study aimed to evaluate the safety, feasibility, and perioperative outcomes of EDGE SP1000-assisted SIRC compared with conventional SILC.

METHODS

A retrospective analysis was conducted on 30 patients who underwent SIRC using the EDGE SP1000 system between January and May 2025. During the same period, another 30 patients who underwent SILC served as controls. Baseline characteristics of the two groups were comparable. Perioperative variables, postoperative pain scores, recovery outcomes, and surgeon-reported assessments were analyzed. Pain intensity was assessed at 6, 12, and 24 hours postoperatively using standardized scales. Recovery parameters included intraoperative blood loss and time to first flatus. Learning curves were evaluated using cumulative summation (CUSUM) analysis to determine the number of cases required to achieve procedural proficiency.

RESULTS

SIRC was successfully completed in 93.75% of the planned cases without conversion to open surgery. Compared with SILC, SIRC was associated with a significantly longer operative time (45.5 ± 10.8 vs. 32.8 ± 6.4 min, $P < 0.0001$). However, it demonstrated notable advantages in other perioperative outcomes, including reduced intraoperative blood loss (12.8 ± 3.7 vs. 24.5 ± 7.5 mL, $P < 0.0001$), shorter time to first flatus (13.0 ± 4.6 vs. 18.5 ± 6.5 h, $P = 0.0004$), and lower postoperative pain scores at 6, 12, and 24 hours ($P < 0.05$). Surgeon evaluations indicated high satisfaction with the system’s ergonomics and performance. The learning curve analysis revealed stable proficiency after approximately 8-10 cases.



Figure 2. Single-incision robotic cholecystectomy
A) Insertion of the single-port cannula; B) Surgeon operating from the console; C) Dissection of Calot's triangle; D) Ligation of the cystic duct.

Table 3. Comparison of surgical data between the SIRC and SILC groups				
	SIRC (n = 30)	SILC (n = 30)	χ^2 / T-test	P-value
Operative time (min, $\bar{x} \pm SD$)	45.5 ± 10.8	32.8 ± 6.4	T = 5.541	< 0.0001
Blood loss (mL, $\bar{x} \pm SD$)	12.8 ± 3.7	24.5 ± 7.5	T = 7.663	< 0.0001
Time to first flatus (h, $\bar{x} \pm SD$)	13.0 ± 4.6	18.5 ± 6.5	T = 3.783	0.0004
Abdominal pain ($\bar{x} \pm SD$)	6 h 3.4 ± 1.2	4.4 ± 1.6	T = 2.739	0.0082
	12 h 4.5 ± 0.6	4.9 ± 0.8	T = 2.191	0.0325
	24 h 4.0 ± 0.8	4.7 ± 1.7	T = 2.041	0.0459
Satisfaction with the procedure ($\bar{x} \pm SD$)	9.1 ± 1.6	9.3 ± 0.5	T = 0.6535	0.516
Satisfaction with the surgical incision ($\bar{x} \pm SD$)	9.4 ± 0.4	9.5 ± 0.4	T = 0.9682	0.3369
Hospital stay ($\bar{x} \pm SD$)	3.3 ± 0.8	3.3 ± 1.1	T = 0	> 0.9999
Postoperative complications	surgical-site infection (n, %)	0 (0.00%) 1 (3.33%)	$\chi^2 = 1.017$	0.3132
	bile leakage (n, %)	0 (0.00%) 0 (0.00%)	/	/
	abdominal hemorrhage (n, %)	0 (0.00%) 0 (0.00%)	/	/
	biliary-tract injury (n, %)	0 (0.00%) 0 (0.00%)	/	/

SIRC, single-incision robotic cholecystectomy; SILC, single-incision laparoscopic cholecystectomy.

CONCLUSION

The findings of this study suggest that SIRC performed with the EDGE SP1000 is a safe and feasible alternative to SILC.EDGE SP1000-assisted SIRC provided significant benefits, including reduced blood loss, faster recovery, and lower postoperative pain. In addition, its ergonomic advantages and manageable learning curve make it an attractive option for surgical practice. These results highlight the potential of the EDGE SP1000 system to facilitate wider clinical adoption of single-incision robotic surgery and to improve perioperative outcomes for patients with benign gallbladder disease.

CONTACTS

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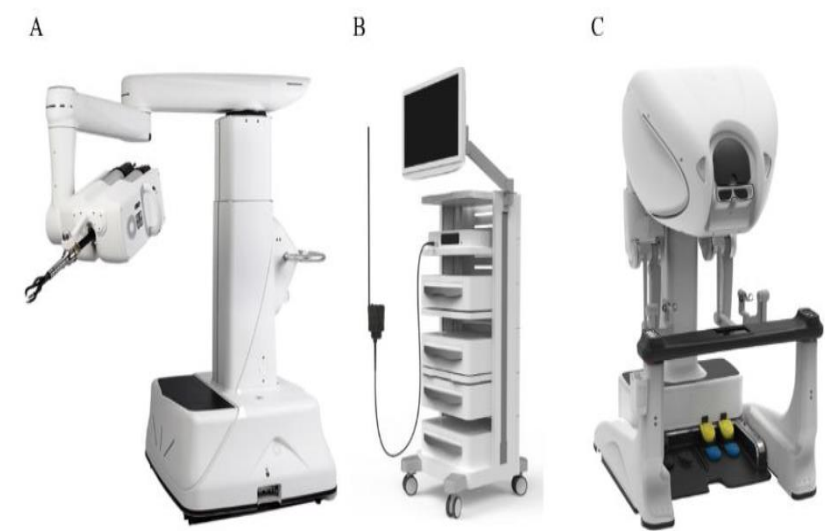


Figure 1. Components of the EDGE SP1000 laparoscopic surgical robot
A) The patient cart; B) The video cart; C) The doctor console.

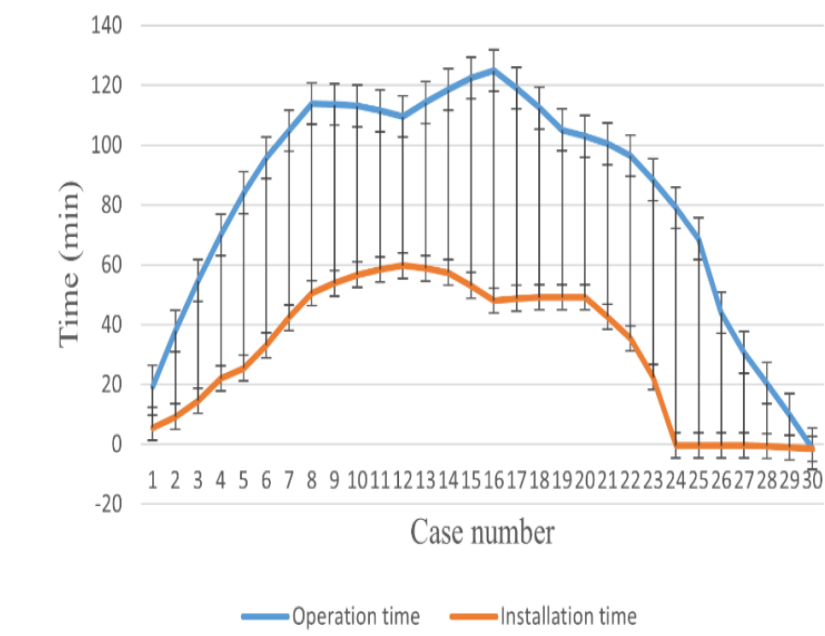


Figure 5. Cumulative summation analysis of the surgical learning curve