Robotic surgery enables safe and comfortable single-incision cholecystectomy: A comparison of robotic and laparoscopic approaches for single-incision surgery

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Abstract

Background: Although single-incision robotic cholecystectomy (SIRC) overcomes various limitations of single-incision laparoscopic cholecystectomy (SILC), it is associated with high cost. In this study, we intended to investigate if SIRC is recommendable and advantageous to patients despite its high cost.

Materials and Methods: We prospectively collected and analysed data of patients who had undergone either SILC (n = 25) or SIRC (n = 50) for benign gallbladder diseases, with identical inclusion criteria, between November 2017 and February 2019.

Results: SILC and SIRC showed similar operative outcomes in terms of intra- and post-operative complications and verbal numerical rating scale (VNRS) for pain. However, the SIRC group exhibited significantly longer operation time than the SILC group (83.2 ± 32.6 vs. 66.4 ± 32.8, P = 0.002). The SIRC group also showed longer hospital stay (2.4 ± 0.7 vs. 2.2 ± 0.6, P = 0.053). Although the SILC and SIRC groups showed no significant difference in VNRS, the SIRC group required a higher amount (126.0 ± 88.8 mg vs. 87.5 ± 79.7 mg, P = 0.063) and frequency (3.0 ± 2.1 vs. 2.0 ± 1.8, P = 0.033) of intravenous opioid analgesic administration.

During surgery, the critical view of safety (CVS), the prerequisite for safe cholecystectomy, was identified in only 24% (n = 6) of patients undergoing SILC and in 100% (n = 50) of patients undergoing SIRC (P < 0.05).

Conclusion: We conclude that although SILC and SIRC have similar operative outcomes, SIRC is advantageous over SILC because of its potential to markedly enhance the safety of patients by proficiently acquiring CVS.

Keywords: Critical view of safety, operation time, pain score, single-incision laparoscopic cholecystectomy, single-incision robotic cholecystectomy

INTRODUCTION

Single-incision laparoscopic cholecystectomy (SILC) has drawn much attention and interest since its introduction. However, a recent meta-analysis of randomised controlled studies of SILC (5141 patients) concluded that although SILC offers a better cosmetic outcome and reduction of pain, it also leads to a high rate of adverse events, such

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as an incisional hernia.\cite{1} The authors recommended that the application of SILC should be reconsidered with the existing technology. In another meta-analysis of 2626 patients, the authors concluded that the rate of bile duct injury (BDI) was significantly higher in SILC than in multiport laparoscopic cholecystectomy (0.72% vs. 0.50%).\cite{2} It appears that SILC has unfavourable results, possibly because of difficulties in securing the “critical view of safety (CVS)” during cholecystectomy due to parallel instrument alignment and loss of triangular retraction.\cite{2,3}

Despite the lack of outstanding benefits of SILC, many patients, especially young women, still prefer to undergo the procedure, mostly due to improved cosmesis. In recent decades, the robotic surgical system, representatively the Da Vinci Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA), has been introduced to maximise the advantages of minimally invasive surgery.

Single-incision robotic cholecystectomy (SIRC) is more expensive than SILC, making SIRC less accessible than SILC. However, robotic surgery has several advantages over conventional laparoscopic surgery, especially when applied to single-incision surgery, in terms of facilitating optimised handling of instruments, providing widened and three-dimensional vision of the operative field, and operator-driven handling of the camera, enabling hand-eye coordination. In this study, we intended to investigate whether SIRC is recommendable and advantageous to patients in spite of its high cost. Our hypothesis for this study is that although SIRC offers similar operative and post-operative outcomes as SILC, SIRC would considerably lower the risk of possible complications by providing a safer and more comfortable environment for single-incision surgery.

MATERIALS AND METHODS

Study design and data collection

We utilised our prospectively collected electronic data of patients who underwent either SILC or SIRC in the Department of Surgery, Seoul St. Mary’s Hospital, the Catholic University of Korea, between November 2017 and February 2019. This study was approved by the Institutional Review Board at the hospital (IRB code: KC19RESI0285). During the study, a total of 75 single-incision cholecystectomies were performed either by laparoscopic ($n = 25$) or robotic ($n = 50$) approach. All the patients underwent pre-operative ultrasound or computed tomography scan. Our criteria included patients with benign gallbladder disease and without severe inflammatory signs, such as high fever (body temperature ≥38°C), leucocytosis (total leucocyte count ≥10,000/µl) or marked gallbladder wall thickening (radiologic gallbladder wall thickness ≥3 mm).

SIRC had identical inclusion criteria as SILC except for the additional requirement of the patient agreement for the high-cost surgery. Exclusion criteria were as follows: patients with severe cholecystitis, those who are suspicious for malignancy, those who are classified as the American Society of Anesthesiologists’ physical status Grade IV, or those who have the history of extensive upper abdominal surgery. Patients who had undergone additional surgical procedures simultaneously were also excluded from the study. In addition to the electronic medical records, we retrospectively reviewed the videos that had been recorded during surgery.

In this study, the presence of co-morbid disease means the presence of more than two additional medical conditions, such as insulin-dependent diabetes mellitus, hypertension requiring medications, cardiopulmonary disease and history of cerebrovascular diseases. The conversion was defined as the later addition of ports or an incision for open surgery to the initial operative procedure. Operation time refers to the time interval between the initial skin incision and completion of wound closure, as documented by the anaesthesiologist. In grading operation-related complications, we followed the commonly used grading systems of intra- and post-operative complications.\cite{4,5}

We defined minor bleeding as approximately greater than 100 ml of blood loss requiring intervention, such as electrocauterisation, clipping or compression.

Operative technique

Single-incision laparoscopic cholecystectomy

Patients were positioned on the operating table in a reverse Trendelenburg position with the right side up. The peritoneum was entered through a 1.5–2.0 cm vertical transumbilical incision. A Commercial Glove Port A (Meditech, Seoul, South Korea) was inserted through the peritoneal opening, and the abdominal cavity was insufflated with CO$_2$ up to an abdominal pressure of 12 mmHg. An assistant helped acquire operative vision by elevating the fundus of the gallbladder using a grasper. Subsequently, the primary surgeon dissected the Calot’s triangle to identify the cystic artery and duct, with one hand holding a grasper and the other, a monopolar hook or a harmonic scalpel (Ethicon, Cincinnati, Ohio). The clearly identified cystic artery and duct were then clipped with a 5-mm EndoClip (Covidien, North Haven, CT, USA) and then divided with endo-scissors. The gallbladder was completely detached from the gallbladder fossa with a hook electrocauterity device. After placing the detached
gallbladder into the retrieval bag, it was extracted from the abdomen through the umbilical port. The fascia and subcutaneous tissue at the umbilical trocar site were closed separately using 2-0 and 4-0 Vicryl sutures, respectively.

**Single-incision robotic cholecystectomy**

Similar to SILC, an identical single port (Commercial Glove Port A) was inserted through the transumbilical incision, and the abdominal cavity was insufflated up to 12 mmHg with CO$_2$. Through the single port, we inserted a 12-mm trocar for the camera and two 8-mm trocars for a Cadiere grasper and a monopolar hook. The Cadiere grasper and the monopolar hook were used in the 1st and 2nd arms of the robot as the surgeon’s right- and left-hand instruments. An assistant helped acquire operative vision by elevating the fundus of the gallbladder using an additional grasper entered through the single port. The operation begins with the acquisition of the CVS using the surgeon’s right- and left-hand instruments. The following procedure is almost similar to conventional cholecystectomy.

**Post-operative management**

Immediately after closing the fascial layer, the umbilical wound was infiltrated with 10 mg of 0.5% bupivacaine. A verbal numerical rating scale (VNRS) was utilized in measuring acute pain. Postoperatively, intravenous analgesics were only administered to patients who complained of severe pain. Non-opioid analgesics were first chosen, and opioid analgesics were given to patients who were unresponsive to non-opioid analgesics. Patients were given oral non-steroidal anti-inflammatory drugs (NSAIDs) from post-operative day (POD) 1 onwards. Patients were discharged on POD 3 when there was no request of reduction or prolongation of hospitalisation.

**Statistical analysis**

Data were described as means and standard deviations or as medians and ranges. Statistical analysis was performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was accepted for $P < 0.05$. Continuous variables of either normal distribution or non-normal distribution were compared using independent $t$-test or non-parametric test, respectively. Discrete variables were compared using the Chi-squared test.

**RESULTS**

**General characteristics of patients with single-incision laparoscopic cholecystectomy and single-incision robotic cholecystectomy**

The subject of this study included a total of 75 patients who received either SILC ($n = 25$) or SIRC ($n = 50$) during the study [Table 1]. The mean patient age was 51.0 ± 14.4 years (range, 25–88). Women comprised 60% ($n = 45$) of all patients. Mean body mass index (BMI) was 25.0 ± 4.2; the SIRC group exhibited significantly higher BMI than the SILC group (25.7 ± 4.5 vs. 23.4 ± 3.3, $P = 0.045$). Of all patients, four patients (5.3%) had a history of upper abdominal surgery, which showed no significant difference between the two groups. Indications for single-incision cholecystectomies included gallstone-related diseases (58.7%, $n = 44$), benign polypoid lesions and adenomyomatosis (25.3%, $n = 19$), combined

| Table 1: Comparison of demographic features between single-incision robotic cholecystectomy and single-incision laparoscopic cholecystectomy |
|---------------------------------|-----------------|-----------------|-----------------|
| **Total patients ($n=75$)**     | **SIRC ($n=50$)** | **SILC ($n=25$)** | **P** |
| **Age (years)**                  | 51.0±14.4       | 52±15.2         | 49.1±12.9       | 0.362 |
| **Median (range)**               | 50.0 (25-88)    | 52 (25-88)      | 47 (29-79)      |       |
| **Sex**                          |                 |                 |                 |       |
| **Men**                          | 30 (40.0)       | 22 (44.0)       | 8 (32.0)        | 0.324 |
| **Women**                        | 45 (60.0)       | 28 (56.0)       | 17 (68.0)       |       |
| **BMI**                          | 25.0±4.2        | 25.7±4.5        | 23.4±3.3        | 0.045 |
| **Median (range)**               | 24.2 (18.1-38.9)| 24.6 (18.1-38.9)| 22.5 (18.6-30.3)|       |
| **Presence of co-morbid disease**|                 |                 |                 |       |
| **No**                           | 74 (98.7)       | 50 (100)        | 24 (96.0)       | 0.159 |
| **Yes**                          | 1 (1.3)         | 0 (0)           | 1 (4.0)         |       |
| **Previous upper abdominal surgery**|               |                 |                 |       |
| **No**                           | 71 (94.7)       | 49 (98.0)       | 22 (88.0)       | 0.071 |
| **Yes**                          | 4 (5.3)         | 1 (2.0)         | 3 (12.0)        |       |
| **Indications, n (%)**           |                 |                 |                 |       |
| **Acalculous cholecystitis**     | 10 (13.3)       | 7 (14.0)        | 3 (12.0)        | 0.344 |
| **GB stone (s)**                 | 44 (58.7)       | 31 (62.0)       | 13 (52.0)       |       |
| **GB polyp (s) or adenomyomatosis**|        | 11 (22.0)       | 8 (32.0)        |       |
| **Combined stone (s) with polyp (s)**| 2 (2.7)   | 1 (2.0)         | 1 (4.0)         |       |

GB: Gallbladder; SILC: Single-Incision laparoscopic cholecystectomy, SIRC: Single-incision robotic cholecystectomy, BMI: Body mass index, SD: Standard deviation
gallstones with polyp(s) (2.7%, \(n = 2\)) and non-calculous inflammation of the gallbladder (13.3%, \(n = 10\)). There was no significant difference with regard to operative indications between the SILC and SIRC groups. There was also no difference in the incidences of co-morbid diseases between the two groups.

**Comparison of intra- and post-operative variables of patients with single-incision laparoscopic cholecystectomy and single-incision robotic cholecystectomy**

Next, we compared intraoperative findings between the two groups [Table 2]. The two groups showed no difference in the incidence of peritoneal adhesions, distension of the gallbladder and gallbladder wall thickness. Intraoperative complications included gallbladder perforation \( (n = 2) \) and minor bleeding \( (n = 2) \), both of which showed no difference between the two groups. During the operative procedure, whereas CVS was acquired in 24% \( (n = 6) \) of patients undergoing SILC, it was identified in 100% of patients \( (n = 50) \) undergoing SIRC \( (P < 0.01) \). The SIRC group exhibited significantly longer operation time than the SILC group \( (83.2 \pm 32.6 \text{ vs. } 66.4 \pm 32.8, P = 0.002) \). In addition, the SIRC group had longer post-operative hospital stay than the SILC group, although this was not statistically significant \( (2.4 \pm 0.7 \text{ vs. } 2.2 \pm 0.6, P = 0.053) \). There were two post-operative complications, wound seroma \( (n = 1) \) and umbilical hernia \( (n = 1) \), both of which developed following SILC.

A graph of operation times was plotted for each of the patients arranged in chronological order, which demonstrated decreasing operative times and variance with increasing experience [Figure 1a]. From the CUSUM plot demonstrating the learning curve, two distinct phases of the learning process were identified: the initial adapting phase \((1^{\text{st}}–18^{\text{th}} \text{ cases})\) and the subsequent maturation phase \((19^{\text{th}}–50^{\text{th}} \text{ cases})\) [Figure 1b]. The resulting CUSUM curve showed a fluctuating nature from the 1\textsuperscript{st} to 18\textsuperscript{th} cases. After that point, the curve flattened, which meant that an acceptable level of performance was achieved. Although the curve thereafter showed temporal elevation during the 36\textsuperscript{th} to 38\textsuperscript{th} cases, the flattened curve was consistently maintained.

**Comparison of post-operative pain**

The SILC and SIRC groups showed no significant difference in VNRS on the operative day, POD 1 and POD 2. Table 2: Comparison of intra- and post-operative outcomes between single-incision robotic cholecystectomy and single-incision laparoscopic cholecystectomy

| Total patients \((n=75)\) | SIRC \((n=50)\) | SILC \((n=25)\) | \(P\) |
|---------------------------|---------------|---------------|-----|
| **Adhesion**              |               |               |     |
| No                        | 57 (76.0)     | 37 (74.0)     | 20 (80.0) | 0.572 |
| Yes                       | 18 (24.0)     | 13 (26.0)     | 5 (20.0)  |       |
| **GB distension**         |               |               |     |
| No                        | 51 (68.0)     | 34 (68.0)     | 17 (68.0) | 0.499 |
| Yes                       | 24 (32.0)     | 16 (32.0)     | 8 (32.0)  |       |
| **GB wall thickness (mm)**|               |               |     |
| \( <2 \)                  | 49 (65.3)     | 34 (68.0)     | 15 (60.0) | 1.000 |
| \( \geq 2 \)              | 26 (34.7)     | 16 (32.0)     | 10 (40.0) |       |
| **Intraoperative complications** |           |               |     |
| Grade II                  |               |               |     |
| GB perforation            | 2 (2.7)       | 0 (0.0)       | 2 (8.0)  | 0.105 |
| Minor bleeding            | 2 (2.7)       | 1 (2.0)       | 1 (4.0)  |       |
| **Acquisition of CVA**    |               |               |     |
| No                        | 19 (25.3)     | 0 (0.0)       | 19 (76.0) | <0.01 |
| Yes                       | 56 (74.7)     | 50 (100.0)    | 6 (24.0)  |       |
| **Conversion**            |               |               |     |
| No                        | 75 (100.0)    | 25 (100.0)    | 50 (100.0) | NA   |
| Yes                       | 0 (0.0)       | 0 (0.0)       | 0 (0.0)  |       |
| **Operation time (min)**  |               |               |     |
| Mean\(\pm SD\)           | 76.4±33.3     | 83.2±32.6     | 66.4±32.8 | 0.002 |
| Median (range)            | 70 (30-200)   | 75 (41-200)   | 60 (30-190) | 0.053 |
| **Post-operative hospital stay (days)** | | | |
| Mean\(\pm SD\)           | 2.3±0.7       | 2.4±0.7       | 2.2±0.6  | 0.053 |
| Median (range)            | 2 (1-5)       | 2 (2-5)       | 2 (2-4)  |       |
| **Post-operative complications** |           |               |     |
| Grade II                  |               |               |     |
| Wound seroma              | 1 (1.3)       | 0 (0.0)       | 1 (4.0)  | 0.108 |
| Umbilical hernia          | 1 (1.3)       | 0 (0.0)       | 1 (4.0)  |       |

GB: Gallbladder; SILC: Single-incision laparoscopic cholecystectomy, SIRC: Single-incision robotic cholecystectomy, CVS: Critical view of safety, SD: Standard deviation, NA: Not available
POD 2 [Table 3]. Our protocol includes the initiation of oral NSAIDs from POD 1 onwards, and intravenous administration of analgesics was allowed, if needed, during any period. Non-opioid analgesics were first chosen, and opioid analgesics were given to patients who were unresponsive to non-opioid analgesics. There was no difference in the amount and frequency of total intravenous analgesics given between the two groups. However, although not significant, the SIRC group was given a higher amount of opioid analgesics than the SILC group (126.0 ± 88.8 mg vs. 87.5 ± 79.7 mg, P = 0.063) [Figure 2]. The SIRC group also had a significantly higher frequency of intravenous opioid analgesic administration (3.0 ± 2.1 vs. 2.0 ± 1.8, P = 0.033).

**DISCUSSION**

In this comparative study, SILC and SIRC showed similar operative outcomes in terms of intra- and post-operative complications and VNRS. However, the SIRC group exhibited significantly longer operation time than the SILC group. The SIRC group also had a longer hospital stay, albeit insignificant (P = 0.053). Although the SILC and SIRC groups showed no significant difference in VNRS, the SIRC group required a higher amount and frequency of intravenous opioid analgesic administration. During surgery, whereas the CVS, the prerequisite for safe cholecystectomy, was identified in only 24% (n = 6) of patients undergoing SILC, it was identified in 100% (n = 50) of patients undergoing SIRC. Taken altogether, we could conclude that although SILC and SIRC have similar operative outcomes, SIRC significantly enhanced the acquisition of CVS during surgery, which is potentially beneficial in reducing critical complications following cholecystectomy.

In our series, the SIRC group exhibited a longer operation time than the SILC group. We think it is because the SIRCs herein were our initial experience with robotic surgery. Compared to SILC, SIRC necessitates additional time for robotic docking, which can be performed feasibly and promptly over time. A meta-analysis, which incorporated six comparative studies of 663 patients, demonstrated that SIRC and SILC had equivalent outcomes for operation time.[6] According to the learning curve analysis of our initial 50 consecutive SIRCs, there were two different phases during the whole process. The first 18 cases could be characterised as an initial learning phase (phase 1). During this phase, the surgeon would have a certain experience of SIRC, being accustomed to a spatial perception that might

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Table 3: Comparison of post-operative pain-related factors between single-incision robotic cholecystectomy and single-incision laparoscopic cholecystectomy

|                        | Total patients (n=75) | SIRC (n=50) | SILC (n=25) | P       |
|------------------------|-----------------------|-------------|-------------|---------|
| **VNRE**               |                       |             |             |         |
| Post-operative day     | 4.7±1.7 5 (1-10)      | 4.7±1.9 5 (1-10) | 4.7±1.3 5 (2-8) | 0.585   |
| POD 1                  | 2.7±1.1 2 (1-7)       | 2.7±1.1 2 (2-7) | 2.7±0.9 3 (1-5) | 0.665   |
| POD 2                  | 2.4±0.7 3 (0-3)       | 2.4±0.7 2 (0-3) | 2.6±0.7 3 (1-3) | 0.281   |
| **Intravenous analgesics** |                     |             |             |         |
| Amount of non-opioid analgesics | 35.3±48.4 0 (0-230) | 30.2±47.3 0 (0-200) | 45.6±50.1 50 (0-230) | 0.074   |
| Amount of opioid analgesics  | 113.2±87.9 100 (0-350) | 126.0±88.8 100 (0-350) | 87.5±79.7 100 (0-350) | 0.063   |
| Total amount of analgesics | 148.5±99.0 144.1 (0-400) | 156.2±100.6 140 (0-400) | 133.1±95.8 125 (0-400) | 0.324   |
| Frequency of non-opioid analgesics | 0.8±1.1 0 (0-6) | 0.7±1.2 0 (0-6) | 1.0±1.1 1 (0-5) | 0.085   |
| Frequency of opioid analgesics  | 2.7±2.0 2 (0-10) | 3.0±2.1 2.5 (0-10) | 2.0±1.8 2 (0-8) | 0.033   |
| Total frequency of analgesics | 3.5±2.3 3 (0-12) | 3.7±2.4 3 (0-12) | 3.0±2.3 3 (0-9) | 0.170   |

*P < 0.05, SILC: Single-incision laparoscopic cholecystectomy, SIRC: Single-incision robotic cholecystectomy

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Figure 1: The analysis of operation time. (a) Changes of operation time by case number accumulation for SIRC. (b) Learning curve for SIRC. CUSUM chart for operation time was displayed for a series of 50 consecutive patients undergoing SIRC. SIRC: Single-incision robotic cholecystectomy

Figure 2: Comparison of intravenous administration of non-opioid and opioid analgesics to the patients undergoing SIRC and SILC. (a) Comparison of amount of intravenous non-opioid and opioid analgesics administrated to the patients undergoing SIRC and SILC. (b) Comparison of frequency of intravenous non-opioid and opioid analgesics administrated to the patients undergoing SIRC and SILC. *P < 0.05, SILC: Single-incision laparoscopic cholecysectomy, SIRC: Single-incision robotic cholecystectomy

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be considerably different from that gained with the routine laparoscopic experience. After phase 1, the curve flattened, which meant that an acceptable level of performance was achieved. The phase after the initial 18 cases (phase 2) likely represents the period of being familiar with the robotic technique.

Although the SILC and SIRC groups showed no significant difference in VNRS, the SIRC group required a higher amount \((P = 0.063)\) and frequency \((P = 0.033)\) of intravenous opioid analgesic administration. Several recent meta-analyses indicated that SILC significantly decreases post-operative pain compared with conventional multiport laparoscopic cholecystectomy.\[1,7,8\] However, there were little and inconsistent data comparing post-operative pain between SILC and SIRC. Su \textit{et al.}\[10\] reported that the SIRC group showed significantly lower VAS scores than the SILC group and Gustafson \textit{et al.}\[10\] reported that the SIRC group required a longer duration of narcotic usage. We think that post-operative pain following SIRC may be different due to the surgeon's experience, criteria of opioid administration and the type of transumbilical port. Chiu \textit{et al.}\[11\] reported reduced post-operative pain following robotic total hysterectomy, and attributed the possible mechanism to the reduced chance of using the abdominal wall for leverage because the robotic arms pivot at the port sites and rotate around a fixed remote centre-of-motion, thereby decreasing mechanical injury at the abdominal wall.

BDIs cause long-lasting morbidity and can occasionally be fatal. BDIs requiring reconstruction are estimated to be five times more frequent during laparoscopic procedures in comparison to open surgery.\[2\] Laparoscopic cholecystectomy has incidences of BDIs requiring reconstruction five times higher than open surgery.\[3\] CVS refers to a clear view of the cystic duct, common bile duct and liver during dissection.\[4\] Achievement of the CVS has been advocated for preventing BDIs during laparoscopic cholecystectomy.\[5\] Nijsen \textit{et al.}\[12\] analysed 1108 consecutive patients who had undergone a laparoscopic cholecystectomy and reported that although CVS was achieved in 72% of control patients, it was achieved in only 10.8% of complicated patients.

There are three prerequisites for achieving CVS. The first is the acquisition of a clear vision of Calot’s triangle, minimising surrounding fat or fibrous tissue, and a 360° view of the cystic duct, as well.\[13\] The second is the dissection of the lowest third of the gallbladder from the liver bed. The third is the identification of only two structures entering the gallbladder: the cystic duct and cystic artery.\[14,17\] However, SILC provides only restrictive resources for the acquisition of CVS, rendering the operative process very vulnerable to accidental biliary and vascular injuries due to uncommon variations of anatomy, bleeding and unclear anatomy. Specifically, during SILC, triangulation between the camera and the working ports is lost. It also leads to a parallel instrument alignment and thus, an “in-line” view of the field of dissection. Because of the closely placed parallel ports, “sword fighting” of instruments can restrict freedom of movement and viewing, as well as dissecting angles. Therefore, during SILC, surgeons experience difficulties in managing instruments, especially when crossing them, since left is right and vice versa, rendering acquisition of CVS more difficult.

SIRC has ergonomic superiority to SILC, in terms of improved three-dimensional optics, increased dexterity and operator-driven camera enabling hand-eye coordination.\[18\] We think that robotic surgery is particularly advantageous in acquiring CVS during single-incision cholecystectomies. First of all, with the surgeon sitting at an ergonomically designed workstation, robotic surgery eliminates the need to twist and turn in awkward positions to move the instruments, rendering the operation very comfortable and secure.\[19\] Next, robotic surgery provides a remarkably enhanced vision, such as a three-dimensional view with depth perception, which is highly advantageous in identifying and dissecting Calot’s triangle. During robotic surgery, surgeons can directly control a stable visual field with increased magnification and maneuverability. We think that these factors collectively could enhance the surgeon’s ability to identify and dissect Calot’s triangle precisely, resulting in SIRC to be more safe single-incision cholecystectomies than SILC.

**CONCLUSION**

SILC and SIRC showed similar operative outcomes in terms of intra- and post-operative complications and VNRS. Our early series of SIRC exhibited a significantly longer operation time than SILC, possibly due to additional docking time. The SIRC group required a higher amount and frequency of intravenous opioid analgesic administration, although these groups showed no significance in VNRS. Moreover, SIRC showed an outstanding superiority in acquiring CVS during surgery compared to SILC. Taken altogether, we conclude that although SILC and SIRC have similar operative outcomes so far, SIRC is advantageous over SILC because of the potential to markedly enhance the safety of patients by proficiently acquiring CVS.

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Conflicts of interest
There are no conflicts of interest.

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