Gloved Appendectomy Performed With a Gloved Single Incision Laparoscopic Surgery Technique Versus Conventional Multiport Laparoscopic Technique

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ABSTRACT

Introduction: Using a commercially available multichannel port for single incision laparoscopic surgery (SILS) can be cost prohibitive to the development of this novel surgical technique. The use of a glove and Alexis wound protector allows laparoscopic surgeons to perform glove single incision laparoscopic surgery (G-SILS) at lower cost.

Objectives: This study sought to evaluate the feasibility and safety of the G-SILS technique as an alternative surgical procedure for appendectomy and to present a comparison between G-SILS with conventional multiport laparoscopic (CML) technique in terms of operative outcomes.

Materials and Methods: This was a case-control study to compare G-SILS and CML techniques in appendectomy. This is a retrospective analysis of all appendectomies done using the G-SILS technique by single surgeon from January 1, 2011, to December 31, 2012. It was performed to evaluate an initial experience of this surgical approach. Parameters for analysis include duration of surgery, conversion rate, perioperative complications, postoperative length of stay, and 6-month follow-up outcome. The control group of patients were specifically matched with respect to patient's age and sex before analysis of surgical outcomes to serve as the best comparison cohort.

Results: G-SILS was successfully performed in 18 patients (7 female, 11 male) with acute appendicitis versus CML group with 18 patients (8 female, 10 male). The mean age of the G-SILS case study group was 35 ± 15.4 years, and for the CML control group, mean age was 35 ± 15.1 years. The mean operative time of the G-SILS technique is slightly longer than that of the CML technique (55 ± 14.1 minutes vs 45 ± 10.2 minutes, $P = .053$). The mean postoperative length of hospital stay is almost similar for both groups (1.3 ± 0.6 days vs 1.1 ± 0.3 days, $P = .104$). There were no conversion, perioperative, or 6-month postoperative complications observed in either group.

Conclusions: The use of glove and Alexis wound protector for G-SILS is relatively safe. It is a feasible alternative surgical approach for appendectomy.

Key Words: Conventional multiport laparoscopy, Glove technique single incision laparoscopic appendectomy.

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INTRODUCTION

Acute appendicitis is a common intra-abdominal inflammatory disease that requires emergency surgery as gold-standard treatment. The lifetime risk of appendicitis is 12% in men and 25% in women, making appendectomy the most commonly performed emergency operation in the world.[1] Since the introduction of the laparoscopic technique, it has gained popularity as an alternative to open appendectomy. The advantages of laparoscopic appendectomy include reduced postoperative wound complications, pain, and length of stay, as well as improved patient cosmesis and satisfaction.[2]

The field of minimal access surgery has evolved dramatically in recent decades as a result of surgeons' creativity

as well as advancement in surgical technological innovation. The evolution of surgery toward less-invasive approaches has stimulated more new techniques for entering the peritoneal cavity with the aim to reduce the number of incisions for ports and, even better, in some cases, eliminating skin incision through the use of natural orifices. Single incision laparoscopic surgery (SILS) is an example of such a technique, and this novel technique has become an area of interest among laparoscopic surgeons. SILS uses a single skin incision typically via umbilical through which multiple instruments can be inserted into the abdominal cavity for surgery. Theoretically, SILS is a less invasive approach than standard multiport laparoscopic surgery is. Hence, use of the SILS technique has been reported for appendectomy, cholecystectomy, colectomy, tubal ligation, sleeve gastrectomy, and nephrectomy.

In conventional multiport laparoscopic (CML) appendectomy, a minimum of 3 trocars are needed with varying site placement depending on surgeon preference. Hence, with the development of the SILS technique, there is an increasing trend of SILS appendectomies performed with superior cosmetic outcomes. There are many commercially available multichannel single port devices such as, for example, Covidien SILS port (Mansfield, MA), Applied Medical Gelport (Rancho Santa Margarita, CA), Olympus TriPort Access System (Center Valley, PA). However, all these devices are very costly and will definitely increase the burden of the public health care costs in Singapore. Hence, we have modified a cheap transumbilical port using a glove and an Alexis wound protector to perform SILS appendectomy as an alternative way to reduce the cost of surgery. Although glove single incision laparoscopic surgery (G-SILS) is theoretically less invasive than standard CML appendectomy is, it may not allow the same level of manual dexterity and technical performance. In certain aspects, G-SILS even violates the principal of laparoscopic surgery. Therefore, we have retrospectively analyzed all G-SILS and comparable CML appendectomies done in Tan Tock Seng Hospital, Singapore, with the intention of determining the feasibility and safety of this new technique.

METHODS

Data Collections and Analysis

All G-SILS performed in Tan Tock Seng Hospital, Singapore, were analyzed to evaluate the feasibility and safety of this new surgical approach. All cases were performed by a single experienced surgeon between January 1, 2011, and December 31, 2012, as emergency cases. Data collection was performed retrospectively by combination of searching through the operating theater database and case notes. Parameters collected for analysis include: patient demographics, operative findings, duration of surgery, conversion rate, perioperative complications (bleeding, iatrogenic intra-abdominal organ injury, and wound infection), postoperative length of stay (LOS), and 6-month follow-up outcome (port site hernia and intestinal obstruction). All continuous variables were reported as mean ± standard deviation. Any G-SILS done by trainees were excluded from the study. Another group of patients who had CML appendectomy were selected to serve as the control group for this study. The control patients were specifically matched with respect to age and sex before analysis of surgical outcomes to serve as the best comparison cohort. Groups were compared using statistical analysis, including descriptive statistics using χ^2 and Student 2-tailed paired *t*-tests. Statistical significance is defined as $P < .05$. All analyses were performed with IBM SPSS Statistics version 22.

Surgical Technique

All patients were placed in supine position, cleansed, and draped in the usual sterile fashion following standard general anesthesia. A 4-cm umbilical skin incision was made down the peritoneum under direct vision. One end of Alexis wound protector (intraperitoneal part) was then squeezed through the umbilical incision into abdominal cavity **(Figure 1).** Another end of the wound protector was then connected to a nonpowdered green glove and secured tightly by twisting them together. Careful twisting motion would reduce the width of the wound protector and create a sealed transumbilical glove port. To prevent ischemic complications, it is important to ensure the intraperitoneal part of the wound protector does not catch any portion of the bowels. Three of the glove fingers were truncated with scissors. Conventional trocars were fitted into them and secured with suture tie knots. Two 5-mm working ports and 1 10-mm camera port were inserted via the newly created transumbilical glove port. Pneumoperitoneum was created by carbon dioxide gas insufflations, and the appendectomy was performed using conventional laparoscopic instruments.[3] After the operation, the appendix specimen was extracted by placing the appendix into the palm of the glove and removing the glove from the Alexis wound protector. This use of a glove eliminated the need for an extraction bag when retrieving the appendix specimen. The fascia was closed with 1–0

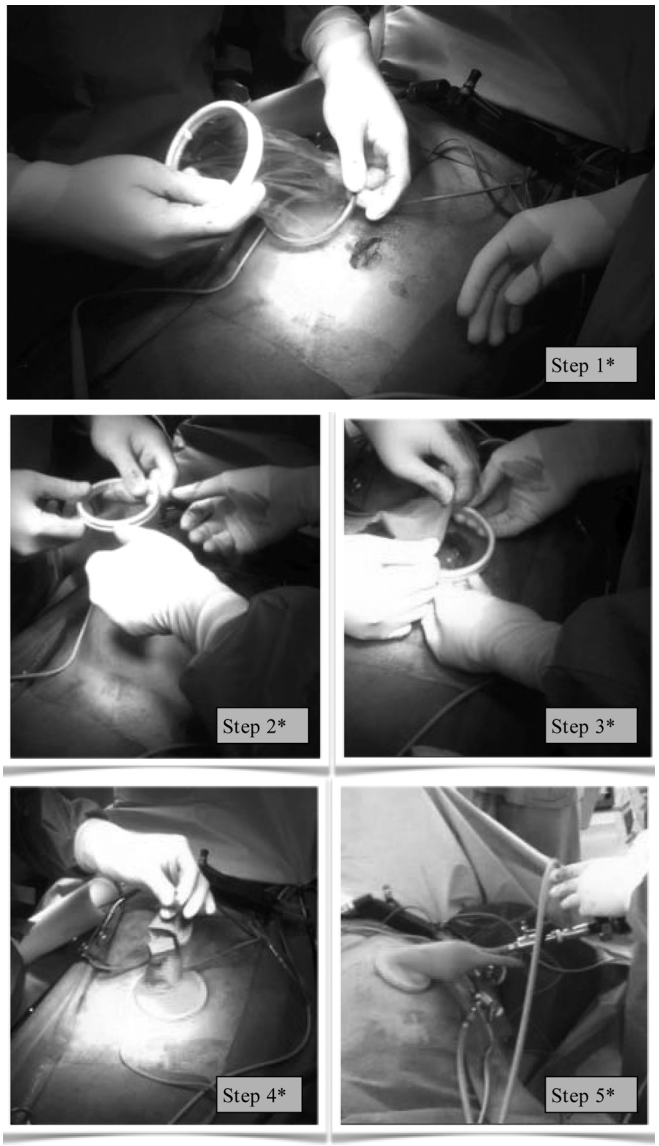

Figure 1. Steps showing technique in creating transumbilical port using a glove and an Alexis wound protector for SILS appendectomy (G-SILS).
Step 1: Preparing the Alexis wound protector for insertion through umbilical incision.
Step 2: Holding up the Alexis wound protector in preparation for nonpowdered green glove connection.
Step 3: Connecting nonpowdered green glove and continuously twisting movement toward umbilical incision.
Step 4: Forming a sealed transumbilical glove port.
Step 5: Truncating 3 of the glove fingers for insertion of standard laparoscopic instruments.

polydioxanone sutures at umbilicus, and the skin was approximated using 3–0 Vicryl rapid sutures.

RESULTS

Patients Demographic

A total of 18 patients underwent G-SILS by a single experienced surgeon consecutively in Tan Tock Seng Hospital between January 1, 2011, and December 31, 2012 (n = 18). In the G-SILS group there were 11 male and 7 female patients, whereas, in the matched control group, there were 10 male and 8 female patients who had had CML appendectomy. The mean age of the G-SILS case study group was (35 ± 15.4 years) as compared to CML control group with mean age 35 ± 15.1 years. Of the 36 patients, 25 patients had computed tomography scans of the abdomen and pelvis, with yielded 22 proven cases of appendicitis and 3 equivocal findings. Another 11 patients were diagnosed with acute appendicitis based on history and clinical examination findings. All patients were listed as priority 2 for emergency operation and the operations were performed within 6 hours from diagnosis of appendicitis. Intraoperative findings of appendix characteristics included 15 inflamed turgid (82%), 1 perforated (6%), 1 phlegmon (6%), and 1 normal (6%) in the G-SILS group **(Table 1).** There were 11 (61%) inflamed turgid, 5 (27%) perforated, 1 (6%) phlegmon, and 1 (6%) normal appendixes in CML group. The mean operative time of the G-SILS technique is slightly longer than that of the CML appendectomy technique (55 ± 14.1 minutes vs 45 ± 10.2 minutes, P = .053) **(Table 2).** The mean postoperative length of hospital stay (LOS) is similar for both groups (1.3 ± 0.6 days vs 1.1 ± 0.3 days, P = .104). Histology findings of appendix specimens in the G-SILS group showed 14 acute appendicitis, 2 acute suppurative appendicitis, 1 acute appendiceal diverticulitis, and 1 normal.

Cost Analysis on Instrument Usage

A basic cost analysis was performed based on instrument usage to compare G-SILS appendectomy with CML appendectomy. The cost of SILS laparoscopic appendectomy using a commercially available multichannel port was also included for comparison. As standard reusable laparoscopic equipment sets are used for all techniques, these costs were not included in our analysis. With the glove and Alexis wound protector, the cost of the G-SILS operation is S$100 ± 50 per operation, which is almost equivalent to CML appendectomy using a commercially avail-

Table 1.
Demographic and Clinical Characteristics of Study Patients

Demographic	G-SILS (Case)	CML (Control)
Patients, *n*	18	18
Mean age, y	35 ± 15.4	35 ± 15.1
Sex		
Male	11 (61)	10 (55)
Female	7 (39)	8 (45)
Intraoperative appendix characteristics		
Inflamed turgid	15 (82)	11 (61)
Perforated	1 (6)	5 (27)
Phlegmon	1 (6)	1 (6)
Normal	1 (6)	1 (6)
Appendix histology		
Acute appendicitis	14 (77)	11 (61)
Acute suppurative	2 (11)	6 (33)
Appendiceal diverticulitis	1 (6)	0 (0)
Normal	1 (6)	1 (6)

Abbreviations: CML, conventional multiport laparoscopy; G-SILS, glove single incision laparoscopic surgery.

Values are mean ± SD or *n* (%).

Table 2.
Surgical Outcomes

Outcome Measures	G-SILS (Case)	CML (Control)	*P* Value
Mean operative time, min	55 ± 14.1	45 ± 10.2	.053
Mean post-operative length of hospital stay, d	1.3 ± 0.6	1.1 ± 0.3	.104
Conversion rate, %	0	0	—
Perioperative complication rate, %	0	0	—
6-months post-operative complication rate, %	0	0	—

Abbreviations as in Table 1.

Values are mean ± SD.

able extraction bag (S$120 ± 50). However, G-SILS is cheaper when compared to commercially available multichannel port SILS in performing appendectomy (S$450 ± 50). Operation time and LOS costs were excluded from the cost analysis as both variables were influenced by surgeon, patient, and disease factors **(Table 3).**

Table 3.
Basic Cost Analysis of Appendectomy

Operation Technique	G-SILS without Extraction Bag	CML With Commercially Available Extraction Bag	SILS With Commercially Available Multichannel Port
Cost per operation[a]	S$100 ± 50	S$120 ± 50	S$450 ± 50

Abbreviations as in Table 1.

Values are mean ± SD.

[a]Excluding cost of standard laparoscopic sets, operation time, and length of hospital stay.

DISCUSSION

One of the undeniable benefits of SILS is better cosmesis outcome but the popularity of this operation is hindered by safety and feasibility issue of the new surgical technique. Higher cost of commercially available multichannel single port is also another resistant factor for development of the SILS operation.

To overcome the cost of SILS appendectomy, we have chosen to perform G-SILS using a glove and an Alexis wound protector to create transumbilical port. We have successfully performed 18 cases of G-SILS in our institution (n = 18). This technique is not only more cost effective than a commercially available single port would be, it also allowed a variety of conventional laparoscopic instruments (5-mm to 12-mm ports) to be used for the procedure with no gas leakage noted during surgery. In addition, it also eased the step of retrieving infected appendix specimens at the end of the operation without the need for specimen retrieval products such as Endo Catch or Endo bag. These make the cost of G-SILS almost equivalent to a standard CML appendectomy (S$100 ± 50 vs S$120 ± 50). The wound protector can also act as a barrier at umbilical incision site, which prevents port site contamination. Hence, in our series, there is no complication of wound infection postoperatively (0%) using the G-SILS technique.

In terms of feasibility and safety of G-SILS, we reported that all 18 cases were successfully performed by a single experienced surgeon with mean operative time of 55 ± 14.1 minutes. It is slightly longer than the CML technique (55 ± 14.1 minutes vs 45 ± 10.2 minutes, P = .053) because it requires challenging surgical skills as there is an absolute lack of triangulation within the limited surgical field in G-SILS. Because all G-SILS cases were performed by a single experienced surgeon, surgeon is eliminated as

a variable confounding factor. By plotting the operation time against sequential case number **(Figure 2),** our data showed that the operation time decreased dramatically after approximately 13 cases were performed. This finding is consistent with previous observations by Chow et al,[4] who found that a relatively gradual learning curve of 10 to 13 surgeries was needed for an experienced surgeons to perform SILS. However, it is difficult to determine the specific learning curve for G-SILS appendectomy as every surgeon has a different laparoscopic skills set to start with. The duration of the operation is affected by the severity of appendicitis where the longest duration was seen in 2 cases—the perforated appendicitis and phlegmon (as illustrated as the 13th and 17th cases in Figure 2). The higher severity of appendicitis is believed to be associated with longer duration of operation. The perforated appendix and phlegmon took 69 and 90 minutes each for G-SILS appendectomy, as both were associated with more challenging dissections. However, G-SILS can still be performed safely for all stages of appendicitis. None of the 18 cases in G-SILS were converted to open surgery, and no perioperative complications such as bleeding or iatrogenic intra-abdominal organ injury were reported in our G-SILS group. By eliminating additional incisions for insertion of trocars, surgeons could reduce the hazards of visceral perforation. Hence, the implications are that at present, severity of appendicitis should not be an absolute contraindication to the G-SILS technique. However, surgeons need to have low threshold for conversion to CML appendectomy should intraoperative difficulty be encountered. Our study results illustrated that G-SILS is comparable to CML appendectomy in short-term outcomes as both groups had zero conversion and perioperative complication rates.

The mean postoperative length of hospital stay (LOS) was similar in both groups of our study: for G-SILS, it is 1.3 ± 0.6 days as compared with 1.1 ± 0.3 days for the CML group (P = .104). However, our G-SILS LOS result is of shorter duration than the 3.4 days for conventional laparoscopic appendectomy reported by Cho et al.[5] The hastened recovery process can probably be attributed to the fact that reducing the number of incisions minimizes postoperative pain and results in fewer wound-related problems. We had 1 patient in the G-SILS group who stayed in the hospital for 3 days because a longer duration of intravenous antibiotic was needed. The patient was presented late to hospital and had appendiceal phlegmon with pus soilage intraoperatively. Hence, vigorous intraoperative irrigation was performed and a Redivac drain was inserted to minimize postoperative intra-abdominal abscess. Postoperative intra-abdominal abscess rates as high as 7% in patients with gangrenous appendix and 26% in those with perforated appendixes who underwent conventional laparoscopic appendectomy have been reported[6] Hence, laparoscopic surgeons should be more careful when performing the G-SILS appendectomy. There is no consensus at the moment whether gangrenous or perforated appendicitis should be performed by laparoscopic or open method. A group of surgeons is against laparoscopic appendectomy in perforated appendicitis,[7] but others believe laparoscopic appendectomy is safe in all forms of appendicitis.[8]

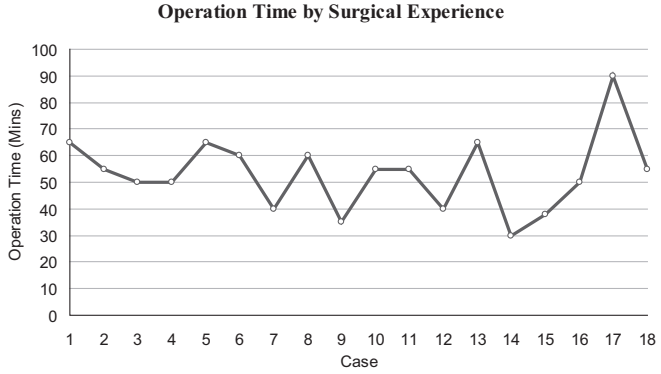

Figure 2. Operation time for G-SILS appendectomy (n = 18).

To date, our 6-month follow-up in both G-SILS and CML groups demonstrated no complication of port site hernia and intestinal obstruction after G-SILS appendectomy. It is relatively lower when compared with medical literature that reported overall incidence ranges from 0.65% to 2.8%, which typically occur in larger midline ports with the commonest site being the umbilicus (which is embryologically weak and often stretched during specimen retrieval).[9] However, in view of relatively short follow-up period and small number of cases in our study, a substantial comparison cannot be made. Furthermore, the retrospective nature of our case-control study means that late onset and asymptomatic hernias may remain undetected. Despite that, we believed that no port site hernia in our G-SILS case series could be due to surgical technique because all fasciae were closed meticulously under direct vision with 1–0 polydioxanone sutures.

There are several other limitations in our case-control study and these must be kept in mind while interpreting the results. First, the number of cases in our study is small, and the study is not powered to detect significant complications. The fact that all patients who underwent G-SILS were not randomized and were matched increases the risk of selective bias. Furthermore, all G-SILS demonstrated in

our study were done by single surgeon who is an experienced consultant, so the outcome may not be similar if the cases were performed by surgical trainees or residents. This is because the G-SILS operation technique had its own difficulty due to absolute lack of triangulation and "instrument crowding" effect. Instrument handle clashing, reduced operative workspace, inadequate retraction, and compromised view are other challenges for the surgeons performing the G-SILS technique.[10]

Despite the limitations, our case-control study does highlight the feasibility of G-SILS appendectomy as an alternative technique for laparoscopic appendectomy with lower cost and better cosmetic outcome. It is reassuring to see that at present G-SILS appendectomy is not associated with a higher morbidity rate. However, the safety issue of G-SILS appendectomy has yet to be proven by prospective randomized trials before its widespread practice.

CONCLUSIONS

The use of a glove and Alexis wound protector for SILS appendectomy is a feasible surgical approach and is cost-effective. It can be an alternative surgical approach and a relatively safe method to perform SILS appendectomy.

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