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## Single-Incision Laparoscopic Appendectomy

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### Abstract

**Introduction:** Single-incision laparoscopic surgery (SILS) may represent an improvement over conventional laparoscopic surgery (CLS). Recently, general interest has been focused on a single-incision approach for laparoscopic appendectomy. On the other hand, surgeons must be aware of the cost of laparoscopic surgery using the specialized instruments for single-incision procedures. In the present study, single-incision laparoscopic appendectomy (SILA) using a handmade glove port and conventional laparoscopic instruments.

**Patients and Surgical technique:** From December 2012 to January 2014, SILA was performed in 28 patients (12 males, 16 females). The median age was 31 years (range, 11-68 years), and their mean BMI was 22.8 (range, 16.0 to 34.5) kg/m<sup>2</sup>. The indication for surgery was acute appendicitis in all cases. Under general anesthesia, we made a 1.5-cm longitudinal skin incision was made at the umbilicus. To produce, pneumoperitoneum method, a wound retractor and a surgical glove were applied at the incision. Three ports (three 5-mm ports or two 5-mm ports and one 10-mm port) technique was used. The entire peritoneal cavity was visualized to confirm the diagnosis and observed the position of appendix. A 5-mm LigaSure<sup>TM</sup> was used to dissect a mesoappendix as well as periappendiceal tissues. After double ligations of the root of appendix by an ENDOLOOP<sup>TM</sup>, the appendix was divided with the LigaSure<sup>TM</sup>. The resected appendix was retrieved from the umbilical wound.

**Results:** All procedures were completed without a conversion to open laparotomy. There were no intraoperative complications. The additional ports were required in 5 (17.8%) cases. Although the mean operative time was 81 min (range, 32-193 min) in all

cases, it was 67 min (range, 47-120 min) in the last 8 cases. The median postoperative hospital stay ranged from 3 to 25 days (median: 7 days).

Conclusion: SILA requires no novel instruments other than ordinary laparoscopic instruments. SILA under pneumoperitoneum by experienced surgeons is a feasible and safe procedure.

## Introduction

Laparoscopic surgery is now replacing laparotomy for treating various types of gastrointestinal disorders and has been proven as a safe procedure with several advantages including less scarring, shorter hospital stay, less postoperative pain and earlier recovery. These potential benefits coupled with superior outcomes have facilitated the adoption of the laparoscopic approach as the gold standard for surgical procedures such as cholecystectomy [1, 2]. Recently, the European Association for Endoscopic Surgery and the Society of American Gastrointestinal and Endoscopic Surgeons recommends laparoscopic appendectomy (LA) in their evidence-based guidelines due to a significantly lower rate of wound infections and earlier postoperative recovery [3, 4].

During the past two decades, technology and operative techniques have allowed for surgical procedures such as natural-orifice transluminal endoscopic surgery (NOTES) or single-incision laparoscopic surgery (SILS), to be performed with fewer incisions [5-7]. However, NOTES needs special surgical instruments and complicated techniques. In comparison with NOTES, SILA can be performed using ordinary laparoscopic instruments and simple techniques.

The number of laparoscopic single-site procedures based on a single incision has increased in recent years. The application of SILS for appendectomy may represent an improvement over conventional laparoscopic surgery (CLS). We introduced laparoscopic surgery for acute and chronic appendicitis since December 2012, and have performed SILS for all patients with the diagnosis of appendicitis since then. The aim of this study is to introduce our techniques of SILA and to compare our results with those of the previous reports.

## Patients and Methods

### Patients and Indications

From December 2012 to January 2014, SILA was performed in 28 patients with the diagnosis of acute appendicitis in the Isesaki Sawa Medical Hospital. The diagnosis of appendicitis was based on the following criteria, as proposed by Katkhouda et al., [8]: a history of right lower quadrant pain or periumbilical pain migrating to the right lower quadrant with nausea and/or vomiting, a fever of more than 38°C and/or leukocytosis of more than 10,000 cells per mL, right lower quadrant guarding, and tenderness on physical examination. In addition, abdominal ultrasonography or computed tomography scan was performed to confirm the diagnoses [8]. Initially, the exclusion criteria for SILA in our institution consisted of suppurative appendicitis, previous abdominal surgery, and body mass

index (BMI) greater than 35 kg/m<sup>2</sup>. However, after several cases and improvement of our surgical skills, there were no exclusion criteria for SILA. All procedures were strictly based on the patient's decision after obtaining informed consent concerning the surgical risk. A detailed information about the operative strategy of receiving a single incision in the abdomen with the possibility of additional incisions or conversion to an open procedure, and the difference in cost between SILA and conventional LA (CLA) was provided. No patients declined SILA.

## Surgical Techniques

Following routine preoperative care and induction of general anesthesia, patients were placed in the supine position with both upper extremities abducted. The surgeon and the assistant stood on the patient's left and right sides, respectively. A handmade glove port was prepared before the initial skin incision. Three fingers of the powder-free surgical glove were cutoff, and three 5-mm trocars were inserted and fixed with 1-0 silk suture (Figure 1). A 1.5-cm, transumbilical, longitudinal skin incision was made to enter the peritoneal cavity. An Alexis Wound Retractor™ (Applied Medical Resources Co., Rancho Santa Margarita, CA) and the surgical glove were used for the single channel (Figure 2).

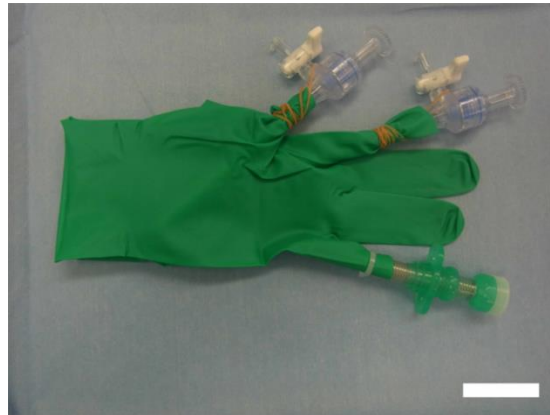


Figure 1. Hand-made single glove-port system.

The monitor was placed on the patients' right side at the level of their waist level. After establishing a pneumoperitoneum, the assistant moved to the left side of the patient. The operating table was tilted to the Trendelenburg position with its left side down. A 0-degree 5-mm rigid type laparoscope of standard length was placed through the central trocar. Other trocars were used for 5-mm laparoscopic instruments and the vessel sealing system (LigaSure™; Covidien, Mansfield, MA). After the location of the appendix was confirmed, the mesoappendix was divided using LigaSure™. Then, the root of the appendix was treated with one or two ligations (ENDOLOOP™; Ethicon, Cincinnati, OH) and resected with a 5-mm LigaSure™. The resected specimen was retrieved from the umbilical incision without a disposable plastic bag. After ensuring satisfactory hemostasis and evacuation of the pneumoperitoneum, the surgical glove port and wound retractor were withdrawn, and the surgical wound was closed with two layers using absorbable sutures.

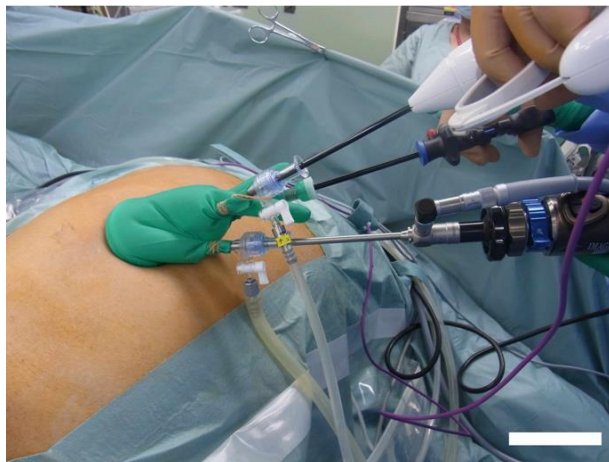


Figure 2. The external setup.

## Clinical Outcomes

### Demographic Data

SILA was performed in 28 patients (12 males and 16 females), with a median age of 31 (range, 11-64) years. The indication for SILA was acute appendicitis in all patients. The mean operation time was 81 min (range, 32-193) in all cases. The operation time in the first period (10 patients) and the second period (10 patients) ranged from 47 to 193 min (median: 96 min) and from 32 to 122 min (median: 77 min), respectively. Furthermore, the mean operative time was 67 min (range, 47-120 min) in the last 8 cases. The patients' BMI ranged from 16 to 34.5 kg/m<sup>2</sup>, with a median of 22.8 kg/m<sup>2</sup>. The postoperative hospital stay ranged from 3 to 25 days (median: 7 days).

### Outcomes and Postoperative Complications

All procedures were performed without conversion to the open approach. There were no major perioperative complications related to the SILA procedure. Five patients (17.8%) required one or two additional ports to complete the appendectomy. The main reason for conversion to multi-port surgery was the difficulty obtaining local triangulation due to a poor experience in the early stage of our procedure. As postoperative complications, there were 2 cases (7.1%) of wound infection and one case (3.6%) received a percutaneous drainage after the appendectomy due to an intra-abdominal abscess, but there were no cases of incisional hernia at the umbilicus or intestinal obstruction.

## Discussion

Appendectomy for acute appendicitis is one of the most commonly performed surgical procedures, and SILA has thus become the subject of more recent investigation. Therefore, many studies have been performed to evaluate the differences between SILA and CLA. More recently, a meta-analysis of randomized controlled trials (RCT) concluded that although SILA had revealed a long operation time, postoperative complications, length of hospital stay, postoperative pain score and open conversion rate were similar compared with CLA [9]. A drawback of SILA technique is the increase in technical difficulty because all surgical procedures have to be performed through one incision. The open conversion rate for laparoscopic appendectomy was reported to be about 4-30 % [10, 11]; however, no conversion to the open procedure was needed in the present series. The difficulty of achieving triangulation during the surgical procedure, especially in the setting of SILA may cause to the limitation of the manipulation of the instruments with the presence of retrocecal localization or perforation of appendix. Although there were five complicated cases and one perforated case in our series, all of these cases only added one- or two-port to complete appendectomy.

Although SILA was initially performed using the EZ access-port™ (Hakko; Nagano, Japan) in some cases, we currently prefer to use the hand-made glove port consisting of a surgical glove and a wound retractor. This port is not only easy to set-up and less expensive, but it also provides a similar manipulation of the instruments compared with other designed ports. Additionally, the use of a wound retractor may avoid infection of the surgical site despite of the extraction of the appendix even without a disposable plastic bag. With the glove port, gas leakage at the pipes and cluttering of the instruments were reported [12]. However, the ports were placed through the fingers of the glove and fixed with ties, and air leakage was also avoided. Since the external area within which the surgeon's hands are located is much smaller than in CLS, movement of the instruments often results in inadvertent movement of an adjacent instrument, which can make even simple task very difficult [13]. This problem will eventually be reduced in time with increasing operator experience, with increased familiarity with reverse handling of the dissector, and the introduction of new special equipment including multi-lumen ports or trocar with a low profile.

Several studies reported SILS using specifically designed trocar or instruments, which significantly increased the costs of the surgical procedure significantly [14, 15]. The cost relating to the surgical procedure itself depends greatly on the surgeon's choice for the type of trocar and on the treatment of the mesoappendix and the appendix stump. Chu et al. [16] reported that these three factors alone cause costs to vary between \$81 and \$873. The use of a surgical glove as a pathway into the abdominal cavity is very inexpensive and readily available in any hospital. We prefer to use it for single-incision laparoscopic cholecystectomy (SILC) [17]. It appeared to us that SILA using a glove port with a small wound retractor did not increase the operation time and the complication rate. Lee et al. [18] also reported that the mean operative time tended to be shorter in patients who underwent a SILA using a glove port with a wound retractor than in the commercial port patients. SILA using a small retractor can reduce not only the length of the umbilical fascia incision but also postoperative pain, which is closely related to the length of the fascia incision [19]. On the other hand, endostaplers are easy and quick to use, and they provide secure closure of the stump of the appendix, alternative options that are equally safe and much less expensive have been

described and used to secure the stump. Among the alternative options, we prefer to use the ENDOLOOP™ which is easy to use and relatively inexpensive. However, the use of ENDOLOOP™ is usually not recommended by several authors in case of a perforated appendicitis or inflammation occurring on the cecum wall [20]. Therefore, we opted for limited use of staplers in case of those conditions.

Regarding the operation time, the median was 67 min in the last 8 cases. This is similar to that of other recent reports [21-23], and the present outcome is also acceptable compared with CLA. More recently, a meta-analysis of non-RCT concluded that there was a small difference in operation time of just 5 min between SILA and CLA in operation time [8]. Since 30% of all appendicitis cases was complicated, SILA, which is technically difficult, necessarily has a longer operation time than CLA [24]. While the operation time has been improved with greater experience, the expansion of indications often increases the time loads. Indeed, the mean operation time shortened from 96 to 67 min comparing with the first 10 patients and the last 8 patients in the present series. This suggests that this procedure has a very short learning curve for the experienced laparoscopic surgeon. In the present series, if the surgeon has expertise with CLA or other advanced laparoscopic surgery such as colorectal or gastric cancer, it is not difficult to perform SILA without increasing the operation time. However, we should not evaluate the success of SILA by the absolute time for performing the procedure, and it is important to maintain a safe and steady procedure at all times. Several postoperative complications occurred. Wound infection (2 cases; 7.1%) was the most common complication, but all were treated conservatively. To date, although our follow-up time is still short, we have never seen an incisional hernia or intestinal obstruction. One patient required a percutaneous drainage due to an intra-abdominal abscess. There were no reoperations related to SILA. In present study, the cosmetic benefit, which has been one of the advantages of SILA compared with CLA, was not evaluated because wound healing might be a long-term process, and it is necessary to assess on the aspects it on the basis of short- and long-term follow-up examinations.

## Conclusion

Even though, there are several limitations to SILS in contrast to multiple port surgery, such as the clashing of instruments or the difficulty of achieving triangulation, SILA was performed successfully using a glove port and conventional instruments. The costs of the surgical procedure are certainly reduced using the glove port, conventional instruments, and ENDOLOOP™ in SILA except in case of perforated or severe complicated appendicitis. Although there are many reports described the safety and positive outcome of SILA, surgeons should tend to a careful selection of low-risk or healthier patients requiring appendectomy for SILA, in particular when a new technique is performed. Based on our experience, the glove port, ENDOLOOP™, and use of conventional instruments transform SILA, making it safer and more feasible, and a surgeon experienced in CLA can perform SILA for surgeon without delay.

The authors declare no conflicts of interest.

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