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# Efficacy of Single-incision Laparoscopic Appendectomy in Adults and Adolescents Using an Endoliner Stapler

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## Abstract

### **Background**

Some investigators recently introduced transumbilical single-incisional laparoscopic appendectomy (SILA), however, those SILA require expensive surgical instruments, or difficult technique. We uniquely propose performing SILA using with endoliner stapler, and compare the clinical results of the present SILA with those of conventional laparoscopic appendectomy.

### **Materials and Methods**

In brief, the skin of the umbilical hollow is cut, the anterior layer of the rectus sheath and subcutaneous fat is exfoliated widely, and the linea alba is opened. Two low-profile 5-mm-diameter trocars are stabbed through the right rectus sheath, and a 12-mm-diameter trocar is inserted from the opened linea alba. Using a 5-mm laparoscope, and endoliner stapler, the appendix is dissected. Some clinical and operative data of 16 cases treated the present SILA are compared with those of 35 cases treated conventional laparoscopic appendectomy.

### **Results**

We performed the present SILA for 16 patients consisted of young women mostly, compared with cases treated conventional laparoscopic appendectomy (mean, 26-year-old vs 51-year-old,  $p < 0.0001$ ). The results of the SILA we have proposed in adults and adolescents are good in terms of operation time (mean, 64 minutes vs 89.3 minutes,  $p = 0.049$ ), duration of hospitalization (mean, 4.2 days vs 8.1 days,  $p = 0.0038$ ), and low frequency of intra- and postoperative complications (one patient of postoperative umbilical granuloma).

### **Conclusions**

We assume that convenience of surgical procedure of the present SILA would affect the shortness of operation time, and that minimal invasive surgical stress of the present SILA would reduce perioperative stress of appendicitis, and ameliorate adolescents with appendicitis earlier. We believe that the SILA we have proposed offers advantages in diversion of conventional surgical instruments,

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similarity to conventional manipulation of laparoscopic forceps, usage of an endoscopic stapler able to cut cecum in cases of advanced appendicitis extending to the cecum, and obviation of extra-abdominal appendectomy demanding excessive traction of the appendix.

Key Words: Surgical stapler; Laparoscopic surgery; Appendectomy

## **Introduction**

The adaptation to transumbilical single-incisional laparoscopic surgery has enlarged because of cosmetic results and safety. Several surgeons have also proposed various methods of single-incisional laparoscopic appendectomy (SILA) since 1992<sup>1)</sup>. In our institute we have performed SILA as proposed by several surgeons, but the methods proposed proved difficult. Considering that the most important points would be the sutures for the orifice of the appendix and the cosmetic results, we attempted to improve SILA using an endoliner stapler after attempting to perform SILA as proposed by others.

## **Materials and Methods**

### ***Selection of patients***

We selected patients with acute appendicitis who maintained a fair condition under systemic anesthesia, limited to cases of appendicitis demonstrating no perforation or abscess formation on preoperative imaging during 2011 to 2012.

After obtaining informed consent to perform SILA, the patients and their families chose between SILA and conventional laparoscopic appendectomy. We obtained 16 patients who assented to the consent, and performed the present SILA for 16 patients with acute appendicitis. These 16 patients comprised 2 men and 14 women (mean age, 26 years; range, 12-42 years). The 16 cases of appendicitis consisted of 12 catarrhal and 4 phlegmonous cases.

The patients who chose conventional laparoscopic appendectomy were 42 cases. Of the 42 patients, we selected 35 patients who had no intraabdominal abscess or indwelling drain intraoperatively, as a control group. The 35 patients comprised 20 men and 15 women (mean age, 51 years; range, 17-94 years). The 35 cases of appendicitis consisted of 13 catarrhal 18 phlegmonous, and 4 gangrenous cases. We also obtained informed consent to analyze the clinical data from the 16 and 35 patient, and examined height, weight, body mass index, type of appendicitis, preoperative white blood cell test, serum C-reactive protein, operation time, intraoperative blood loss, days of hospitalization, and days spent in hospital after surgery. We performed the conventional laparoscopic appendectomy using 3 trocars (two 5 mm ports, and one 12 mm ports at umbilical, suprapubic, and left lower abdominal region), and linear stapler under continuous CO<sub>2</sub> pneumoperitoneum at a pressure ranging between 10-13 mm Hg. The procedure of SILA was described the followings.

The research project has been approved by a suitably constituted Ethics Committee of Ishikiri Seiki Hospital within which the work was undertaken and that it conforms to the provisions of the Declaration of Helsinki.

### ***Instruments of SILA***

The following surgical instruments for SILA were prepared. The instruments were almost the same as those for conventional laparoscopic appendectomy:

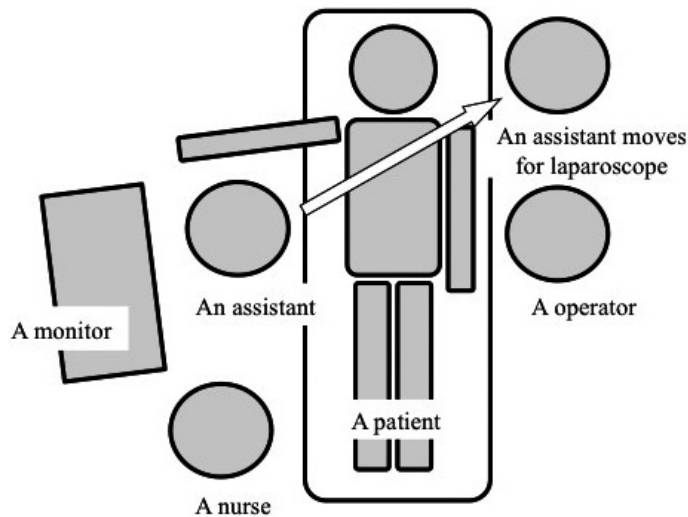
- 1) Laparoscope, 5 mm in diameter with a 30° angle.
- 2) Laparoscopic intestinal forceps.
- 3) One 12-mm-diameter trocar, and two 5-mm-diameter trocars with a low-profile small head housing.

- 4) Ultrasonic dissection
- 5) Endolinear stapler
- 6) 1-0 silk thread, and 2-0 and 4-0 absorbable surgical sutures
- 7) Saline irrigator for endoscopic surgery (in case of appendicitis with severe abscess)

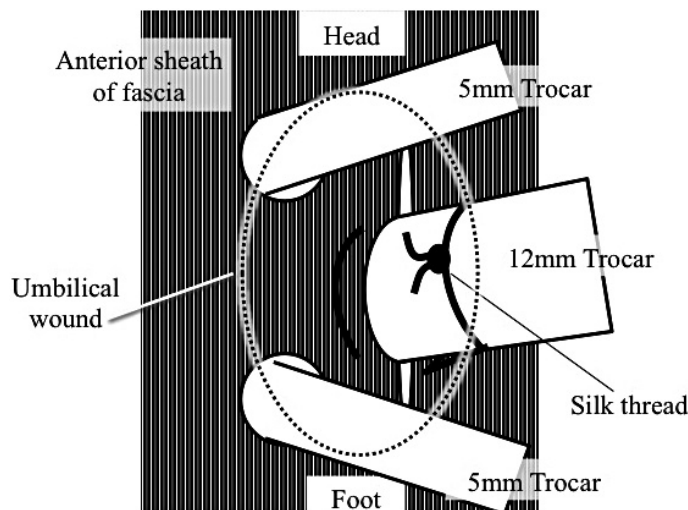
**Procedure**

The position of the patient is supine with the left upper limb next to the trunk. After setting trocar ports, the patient is placed in the Trendelenburg position, with the left side down (Fig. 1).

The skin was cut lengthways with 2-3 cm along the umbilical hollow. Ligaments between the umbilical skin and linea alba were also cut. Under the skin incision, the anterior layer of the rectus sheath and subcutaneous fat is exfoliated within a radius of 4-5 cm, and the linea alba is opened to a width of 2 cm. Two low-profile small head housing trocars, 5 mm in diameter, are stabbed through the anterior layer of the right rectus sheath (Fig. 2). A surgeon monitors direct puncture of the trocars from the visceral side through the opened linea alba, avoiding bleeding and intestinal injury (Fig. 3A). The operator inserts a 12-mm trocar into the space of the linea alba cut, places a 1-0 silk mattress suture, and ties the thread with the trocar to prevent gas leakage (Figs. 2 and 3B).



**Figure 1.** Schema for standing positions in our single-incision laparoscopic appendectomy.



**Figure 2.** Schema for instrument dispositions in the umbilical region. The exfoliative area under the skin is wider than the skin incision.

Patients were operated on under continuous CO<sub>2</sub> pneumoperitoneum at a pressure ranging between 10-13 mm Hg. The endoscope was inserted from a 12-mm port, and endoscopic forceps or ultrasonic dissection were inserted through 5-mm ports.

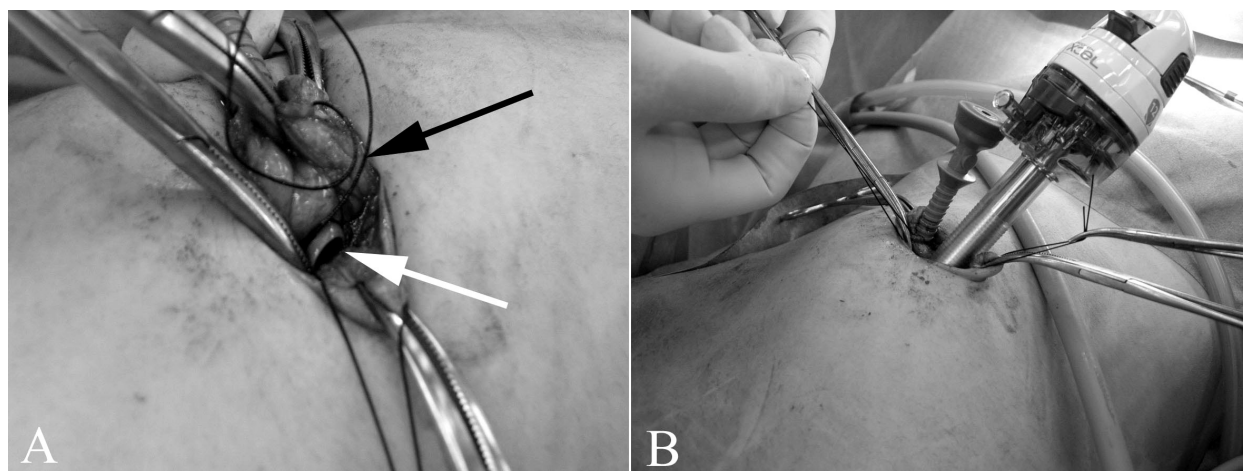
Through the 5-mm trocars, the operator inserts the laparoscopic forceps and ultrasonic dissector, and exfoliates the appendix. The surgeon dissects the mesoappendix using ultrasonic dissectors (Fig. 4A). The assistant surgeon changes equipment, inserting the scope through the 5-mm trocar. The surgeon uses the 5- and 12-mm trocars, inserting the endoliner stapler through the 12-mm trocar, and amputates the appendix entirely intracorporeally at the orifice of the appendix (Fig. 4B).

In cases showing severe abscess formation, a drain is inserted from the suprapubic area to Douglas' pouch after saline irrigation. In cases with no or only mild abscess formation, the fascia and skin incision are closed directly using absorbable surgical sutures after saline irrigation.

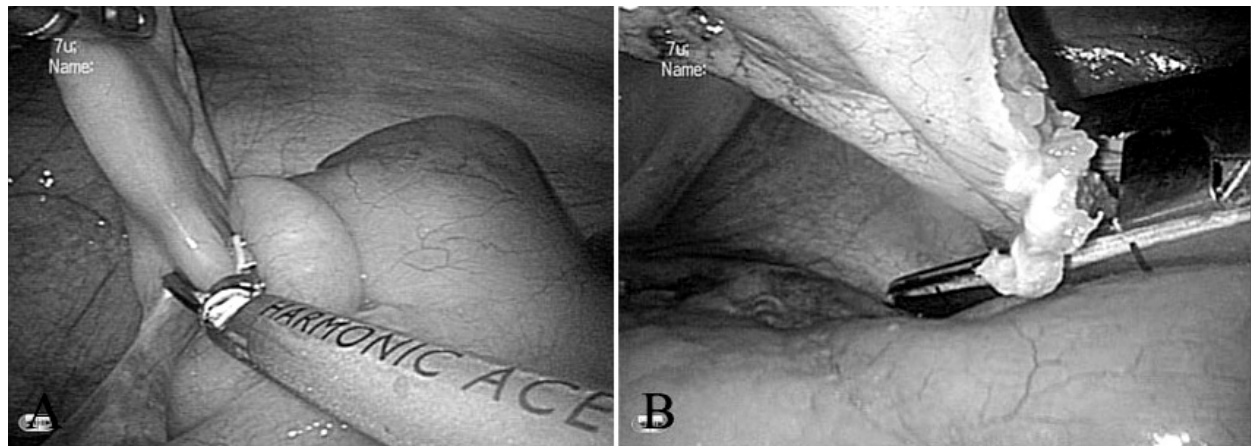
### Results

The clinical data of the 12 cases performed the present SILA, and 35 cases performed conventional laparoscopic appendectomy using with linear stapler was summarized in table 1. Preoperative complications were detected in 4 patients (aortic regurgitation, rheumatoid arthritis, gallstone in conventional laparoscopic appendectomy, and fatty liver in the present SILA), and postoperative complications were only detected in one patient (granuloma of the operative umbilical scar in the present SILA). No significant difference of measurable intraoperative blood loss, or frequency of pre-/post-operative complication between the two groups was seen.

Mean operation time of the present SILA was 64 minutes (range, 44-187 minutes), mean duration of hospitalization was 4.2 days (range, 3-9 days), and the mean days spent in hospital after surgery was 4.1 days (range, 2-9 days). Compared with the conventional laparoscopic group, no significant differences in height, weight, body mass index, white blood cell, C-reactive protein, type of appendicitis were seen. Meanwhile, significant differences in frequency of sex, age, operation time, days of hospitalization, and days spent in hospital after surgery were seen (Table 1).



**Figure 3.** A, The operator turns the right rectus sheath (black arrow), stabs 5-mm trocar directly, and monitors the direct puncture of the trocars (white arrow) from the visceral side through the opening in the linea alba. B, Because the 5-mm trocar is low-profile with a small head housing, the three trocars do not obstruct each other. This image shows only two ports; after checking to ensure that no conflicts are present, the remaining 5-mm trocar is inserted.



**Figure 4.** A, Using an ultrasonic instrument, the mesoappendix is resected. B, Using the endoliner stapler through the 12-mm trocar, the appendix is resected at the point of the orifice.

**Table 1. Summary of results and background of the cases performed laparoscopic appendectomy**

	Single-incision laparoscopic appendectomy (n=16)	Conventional laparoscopic appendectomy (n=35)	p value
Sex, n (male: female)	2: 14	20: 15	p=0.0052
Pre-/post-operative complication (n)	2	3	n.s.
The mean age (years old)	26 (range, 12-42)	51 (range, 17-94)	p<0.0001
The mean height (cm)	157.6 (range, 144-171)	161.6 (range, 140-180)	n.s.
The mean weight (kg)	52.3 (32-76)	59.8 (37-97)	n.s.
The mean body mass index	20.9 (range, 15.4-28)	22.9 (range, 16.7-32.8)	n.s.
The mean white blood cell ( $\mu\text{L}$ )	12126 (range, 8810-16600)	13008 (range, 8440-20380)	n.s.
The mean C-reactive protein (mg/dL)	2.7 (range, 0.04-8.81)	6.2 (range, 0.07-29.18)	n.s.
Type of appendicitis (catarrhal: phlegmonous: gangrenous)	12: 4: 0	13: 18: 4	n.s.
The mean operation time (minute)	64 (range, 44-187)	89.3 (range, 45-220)	p=0.049
The mean blood loss (cc)	0	0	n.s.
The mean days in hospitalization (days)	4.2 (range, 3-9)	8.1 (range, 4-29)	p=0.0038
The mean days spent in hospital after surgery (days)	4.1 (range, 2-9)	7 (range, 3-27)	p=0.0092

n, number indicating case; and n.s, no significant difference.

## Discussion

Laparoscopic appendectomy via 3 ports offers patients treated advantages over laparotomic appendectomy on the viewpoints of healing and rehabilitation in society<sup>9</sup>. Recently, some investigators introduce single-incision laparoscopic appendectomy (SILA), report that SILA offers cosmetic advantage over conventional laparoscopic appendectomy. Pelosi et al first introduced SILA in 1992<sup>1</sup>, and various methods of SILA have since been reported<sup>3-7</sup>. For example, extra-abdominal appendectomy pulled out through a single skin incision<sup>1,8-11</sup>, use of a wound retractor covered with a surgical glove<sup>12-14</sup>, and special surgical instruments attached to single-incision<sup>15,16</sup> have been proposed. We have performed conventional laparoscopic appendectomies and single-incision laparoscopic cholecystectomies in our institute, and attempted to perform SILA as described by several researchers. These methods, however, proved difficult. We believe that each method shows particular problems, such as: associations with



excessive traction of the appendix in methods requiring extra-abdominal appendectomy; the need for special expensive surgical instruments for SILA; difficulty with intra-abdominal suture of the stump of the appendix; and freehand manipulation of laparoscopic forceps without trocar fixation on the abdominal wall. To address these difficulties, we devised the present surgical method by trial-and-error using 5- and 12-mm trocars<sup>17-20</sup>.

The present method seems to offer the following advantages: use of basically the same surgical instruments applied in conventional laparoscopic appendectomy; no extra-abdominal operation with excessive traction on the appendix; easy amputation of the appendix using an endolinear stapler through the 12-mm trocar; and easy use of laparoscopic forceps with leverage technique. These techniques are well adapted to application through multiple ports in conventional laparoscopic surgery, and use of the endolinear stapler offers the advantage of allowing stump suture if inflammation extends to the cecum and the cecum must be resected.

In the present retrospective study, the present SILA with an endolinear stapler could not be compared with the conventional SILA without an endolinear stapler because of no case treated by the conventional SILA without an endolinear stapler. Comparing with the conventional laparoscopic appendectomy with an endolinear stapler, the present operation, however, exhibited good results in both adults and adolescents, as mentioned above. Unexpectedly on the other viewpoints except cosmetics, SILA demonstrated some advantages, namely, days in hospitalization, days spent in hospital after surgery, and operation time. Although we can't explain well the reason why the shortness of mean operation time, we assume that convenience of surgical procedure would affect the shorter operation time of the present SILA. The minimal surgical stress of the present SILA, then, would reduce perioperative stress of appendicitis, and contribute the shortness of hospitalization. On the other hand, we assume that high occupancy of young women in the group of SILA, who generally have better homeostasis than elder adults, might contribute to the shortness of hospitalization.

The present results, at least, revealed advantages of the present SILA as well as the conventional laparoscopic appendectomy using with endolinear stapler, then no significant difference was seen between our results and the results reported by other investigators<sup>3-7</sup>.

Although Japanese medical social/ national health insurance does not guarantee the cost of linear stapler in the present surgical procedure, the other surgical instruments above mentioned which are low-price, totally keep the expenses low. Until the new development of useful, safe surgical instruments at low prices, we recommend the present method for beginner learning SILA.

The method of SILA we propose allows easy, safe SILA without the need for special surgical instruments. We believe that the present surgical method will help beginners in SILA to convert from conventional laparoscopic appendectomy in adult and adolescents.

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