

Single-Incision Laparoscopic Appendectomy by Surgical Trainees

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Background: Single-incision laparoscopic appendectomy (SILA) is one of the most commonly performed single port surgeries in the world. However, there are few publications documenting a young resident's experience. The purpose of this study is to investigate clinical outcomes of SILA performed by a surgical trainee and to evaluate its feasibility and safety compared with conventional three-port laparoscopic appendectomy (TPLA) when performed by a surgical trainee and SILA by surgical staff.

Methods: Between September 2014 and August 2015, clinical data were retrospectively collected for SILA and TPLA cases performed at Chung-Ang University Hospital. Three surgical residents who have assisted at least 50 cases of TPLA and 30 cases of SILA performed by gastrointestinal surgery specialists performed the surgeries. The indication of SILA by surgical trainees was non-complicated appendicitis with no comorbidity.

Results: In total, 47 patients underwent SILA by surgical residents, 98 patients underwent TPLA by surgical residents and 137 patients underwent SILA by surgical staff. In comparing SILA and TPLA performed by surgical residents, the mean age was younger (26 vs. 41 y, $P < 0.005$) in the SILA group, the operative time (47.2 vs. 61.5 min, $P < 0.010$) and hospital stay (2.3 vs. 2.7 d, $P = 0.003$) were shorter in SILA group. In the SILA group, 2 cases of postoperative fluid collection (5.7%) occurred, necessitating antibiotic treatment. In TPLA group, 1 postoperative abscess occurred, requiring drainage. When comparing SILA performed by surgical residents and SILA performed by surgical staff, there were no significant differences in operation time, and postoperative complications.

Conclusion: Surgical residents safely performed SILA with good postoperative outcomes after short learning curve.

Key Words: appendicitis, appendectomy, laparoscopy, single-incision

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Acute appendicitis is one of the most common emergency surgeries and currently laparoscopic appendectomy has become the treatment of choice.^{1,2} On the basis of the

improvement of laparoscopic techniques and instruments, single-incision laparoscopic surgery has been proposed.³ Presently, single-incision laparoscopic appendectomy (SILA) is one of the most commonly performed single-incision laparoscopic surgeries. Its wide acceptance in the surgical community raised the need of surgical training programs to incorporate safe teaching methods of this technique to enable the new generation of general surgeons to confidently perform the procedure. This study was conducted to evaluate our early experience of training residents in SILA and to investigate the surgical feasibility and safety of SILA and three-port laparoscopic appendectomy (TPLA) clinical outcomes during the learning period by comparing SILA performed by surgical residents and surgical staff.

METHODS

Between September 2014 and August 2015, total 282 consecutive patients underwent laparoscopic appendectomy in Chung-Ang University Hospital. Among them, 47 patients underwent SILA performed by surgical residents, 137 patients underwent SILA performed by gastrointestinal surgical staff. The other 98 patients underwent TPLA performed by surgical residents. Surgical residents were in their third-year residency. They were encouraged to practice basic laparoscopic skills on the laparoscopic trainer box during their clerkship and performed laparoscopic technique on a pig each year at the training center. The residents performed > 30 cases of TPLA by operator during second-year of residency and assisted with at least 30 cases of SILA performed by a gastrointestinal surgery specialist. Gastrointestinal surgical staff performed SILA for all patients who needed an appendectomy and surgical residents performed SILA for selected patients who were relatively healthy, young patients. Patient demographic data, operation time, length of postoperative hospital stay, and perioperative complications (if present) were collected prospectively. Data and outcomes were compared between patients who received SILA performed by surgical residents and TPLA performed by surgical residents. Data and outcomes were compared between patients who received SILA performed by surgical residents and SILA performed by surgical staff. This study was approved by the Institutional Review Board of the Chung-Ang University Hospital in South Korea.

Surgical Procedure

Surgical procedures of TPLA and SILA were performed as documented in our previous report.⁴ To briefly described the SILA procedure, using the open incision method, a 1.5 to 2-cm vertical skin incision was made through the center of umbilicus into the peritoneum. A

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glove port (Nelis, Bucheon, Korea) with 3-trocar channels was placed into the created incision. Standard 5-mm laparoscopic equipments, such as 30-degree angle laparoscope was used, as well as, straight rigid instruments identical to those used for conventional laparoscopy including Babcock clamp, grasper, scissors, and electrocautery. The appendiceal base was ligated with 2 applications of vicryl endo-loop (Sejong Medical, Paju, Korea). TPLA was performed using 3-trocar techniques with an 11-mm infraumbilical trocar placed by needle insufflations and 2 additional 5-mm trocars placed in the suprapubic area and left lower quadrant, respectively. The remaining details of the appendectomy procedure were the same as those for SILA.

Postoperative Care

A standard postoperative order set for appendicitis was used for all patients with a computerized intravenous patient-controlled analgesia system (Automed 3300; Ace-Medical Co., Seoul, Korea). The patient-controlled analgesia consisted of 15 µg/kg of fentanyl, with or without 1 mg/kg of ketorolac tromethamine, diluted in saline to a 100-mL volume. Each patient started drinking sips of water 6 hours after surgery advanced to soft blended diet, and to regular diet when tolerated. Patients were discharged when tolerating a regular diet without other problems. This usually occurred on the second postoperative day.

Statistical Analysis

Continuous variables were compared using Student *t* test and expressed as mean ± SD values. Categorical variables were analyzed with the χ^2 test. Significance was defined as a *P* < 0.05. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 18.0 for Windows (SPSS Inc., Chicago, IL).

RESULTS

Of 282 patients, 47 patients underwent SILA (group A) performed by surgical residents, 98 patients underwent TPLA performed by surgical residents (group B), and 137 patients underwent SILA performed by surgical staff (group C). There was no conversion to TPLA or open procedure from SILA. Surgical residents achieved a mean operating time of below 48 minutes after about 10 cases of SILA (Fig. 1).

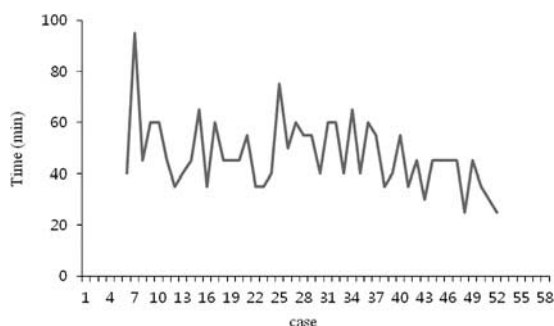


FIGURE 1. Surgical residents' operation time for SILAs over cases. This figure demonstrates the operation time of surgical residents decreased as their experience increased.

TABLE 1. Comparison of Clinical Outcomes of Single-Incision Laparoscopic Appendectomy (Group A) and Three-Port Laparoscopic Appendectomy (Group B) by Surgical Trainees

	Group A (n = 47)	Group B (n = 98)	<i>P</i>
Age (y)	25.9	40.5	< 0.001
Sex (M:F)	1:1.5	1:0.8	0.078
BMI (kg/m ²)	21.2	25.3	0.174
Pathology [n (%)]			0.121
Nonperforated	29 (57.4)	47 (48.0)	
Perforated	18 (42.6)	51 (52.0)	
Operation time (min)	47.2 ± 13.3	61.5 ± 24.6	< 0.001
Conversion to open	0	0	
Drain insertion [n (%)]	3 (6.3)	15 (15.3)	0.127
Hospital stay (d)	2.3 ± 0.6	2.7 ± 1.1	0.003
Complication [n (%)]	4 (8.5)	3 (3.1)	0.152
Wound problem	4 (8.5)	2 (2.1)	0.067
Abdominal abscess	2 (4.3)	1 (1.0)	0.200

BMI indicates body mass index; F, female; M, male.

Comparison of SILA (Group A) and TPLA (Group B) by Surgical Residents

When groups A and B were compared, the mean age was significantly younger (25.9 vs. 40.5 y, *P* < 0.001) in group A. Operation time (47.2 vs. 61.5 min, *P* < 0.010) and mean hospital stay (2.3 vs. 2.7 d, *P* = 0.003) was significantly shorter in group A (Table 1). No patient converted to TPLA from SILA in either group. In group A, 2 patients were readmitted due to postoperative intrabdominal fluid collection. Both were successfully treated by intravenous antibiotics and did not require drainage. In group B, 1 patient was readmitted due to postoperative intrabdominal abscess and underwent percutaneous drain insertion.

Comparison of SILA by Surgical Trainees (Group A) and SILA (Group C) by Staff

Mean age was significantly younger (25.9 vs. 31.0 y, *P* = 0.033) and mean hospital stay was significantly shorter (2.3 vs. 3.0 d, *P* = 0.003) in group A. There were

TABLE 2. Comparison of Clinical Outcomes of Single-Incision Laparoscopic Appendectomy by Surgical Trainees (Group A) and Single-Incision Laparoscopic Appendectomy by Staff (Group C)

	Group A (n = 47)	Group C (n = 137)	<i>P</i>
Age (y)	25.9	31.0	0.033
Sex (M:F)	1:1.5	1:1.1	0.312
BMI (kg/m ²)	21.2	24.8	0.208
Pathology [n (%)]			0.012
Nonperforated	29 (57.4)	60 (43.8)	
Perforated	18 (42.6)	77 (56.2)	
Operation time (min)	47.2 ± 13.3	47.3 ± 13.3	0.990
Conversion to open	0	0	
Drain insertion [n (%)]	3 (6.3)	13 (9.4)	0.481
Hospital stay (d)	2.3 ± 0.6	3.0 ± 1.3	< 0.001
Complication [n (%)]	4 (8.5)	10 (7.3)	0.756
Wound problem	4 (8.5)	10 (7.3)	0.756
Abdominal abscess	2 (4.3)	0	0.064

BMI indicates body mass index; F, female; M, male.

significantly more perforated appendicitis patients in group B. In group B, there were no readmitted patients (Table 2).

DISCUSSION

Acute appendicitis is one of the most common gastrointestinal surgical diseases and laparoscopic appendectomy has become gold standard procedure. Surgical techniques and instruments have improved and patients have demanded less postoperative pain intervention leading to better cosmetic outcomes. Single-incision laparoscopic surgery has been described as the next evolution of minimally invasive surgery. In this study, third-year residents proficient in conventional laparoscopic appendectomy performed a relatively simple procedure, appendectomy, using conventional laparoscopic instruments and technique through a single umbilical incision, showing comparable clinical outcomes to conventional TPLA. No cases had to be converted to an open procedure or conventional TPLA, although 3 cases necessitated additional trocar insertion to place an intra-abdominal drain. Operation time and hospital stay were significantly shorter for patients that underwent SILA performed by surgical residents compared with stays for patients who underwent TPLA by surgical residents. The limitation of this study is that relatively healthy and young patients were selected in SILA group performed by the residents (group A). However, there was no significant difference in postoperative pathology in the 2 groups. Therefore, positive results were not solely due to selection bias. In comparison with SILA by surgical staff, there was no significant difference in operation time and postoperative complication. Suggesting surgical residents perform SILA with satisfactory safety level. Notably, after about 10 cases of SILAs, the mean operation time was achieved and if residents have already performed TPLA, they quickly and easily overcame the SILA learning curve. Drain placement is a matter of consideration in SILA and we inserted additional 5-mm trocar around Mcburney's point to place a drain.

Some randomized controlled trials^{1,3,5} showed the mean SILA operative time was significantly longer than that of TPLA. However, in our study, operative time of SILA was significantly shorter than that of TPLA. This may be due to using the ready-made glove port in the SILA procedure. Therefore, less time was spent in trocar insertion and trocar removal. Further, we closed the fascia layer of umbilical incision in the same manner in both SILA and TPLA. Last, the subcutaneous layer of the umbilical incision in SILA was not sutured, but compressed by gauze.

Wound infection has been reported as the most common postoperative complication of SILA^{1,3,5,6} and our study demonstrated the same result. Although wound infection does not prolong hospital stay or require reoperation, thorough preoperative cleaning of the umbilicus and postoperative application of disinfectant decrease this phenomenon. A glove port, double-ringed wound retractor, was used in this study and further research is needed for the role of a wound retractor in wound protection. Some authors suggest umbilical hernia as a long-term complication of SILA. Among previously reported patients who underwent SILA at our institution,⁴ none developed incisional hernia during a 2-year follow-up period.

SILA is likely to become a standard operation for acute appendicitis in the near future and single-incision laparoscopic surgery for other organs will gradually become surgical option. Active training and involving of the residents in single-incision laparoscopic surgery should be included in the resident's education program hereafter.

In conclusion, SILA using conventional laparoscopic instruments by surgical residents is a technically feasible and safe procedure after a short learning curve. In the near future, SILA will become a surgical option alternative to TPLA. Now is the time to establish systematic training system for single-incision laparoscopic surgery.

REFERENCES

1. Gao J, Li P, Li Q, et al. Comparison between single-incision and conventional three-port laparoscopic appendectomy: a meta-analysis from eight RCTs. *Int J Colorectal Dis.* 2013;28:1319–1327.
2. Burjonrappa SC, Nerkar H. Teaching single-incision laparoscopic appendectomy in pediatric patients. *JSLs.* 2012;16:619–622.
3. Hua J, Gong J, Xu B, et al. Single-incision versus conventional laparoscopic appendectomy: a meta-analysis of randomized controlled trials. *J Gastrointest Surg.* 2014;18:426–436.
4. Lee SE, Choi YS, Kim BG, et al. Single port laparoscopic appendectomy in children using glove port and conventional rigid instruments. *Ann Surg Treat Res.* 2014;86:35–38.
5. St Peter SD, Adibe OO, Juang D, et al. Single incision versus standard 3-port laparoscopic appendectomy: a prospective randomized trial. *Ann Surg.* 2011;254:586–590.
6. Lee J, Baek J, Kim W. Laparoscopic transumbilical single-port appendectomy; initial experience and comparison with three-port appendectomy. *Surg Laparosc Endosc Percutan Tech.* 2010;20:100–103.