Single Incision Laparoscopic Appendectomy for Management of Complicated Appendicitis: Comparison between Single-Incision and Conventional

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Purpose: Single incision laparoscopic appendectomy (SILA) is a widely used surgical procedure for treatment of appendicitis with better cosmesis. However, many surgeons generally tend to choose conventional multiport laparoscopic appendectomy regarding with complicated appendicitis. The aim of this study is to demonstrate the safety and feasibility of SILA for treatment of complicated appendicitis by comparison with 3-ports conventional laparoscopic appendectomy (CLA).

Methods: Retrospective chart review of patients diagnosed appendicitis at single hospital during January 2015 to May 2017 collected 500 patients. Among 134 patients with complicated appendicitis, we compared outcomes for 29 patients who got SILA and 105 patients who got CLA.

Results: 179 and 321 patients were treated by SILA and CLA, respectively. 134 (26.8%) patients were treated for complicated appendicitis, 29 patients by SILA and 105 patients by CLA, respectively. There was no case converted to open or added additional trocar in both groups. There were no differences in demographics with regard to age, sex, body mass index (BMI), and American society of anesthesiologists (ASA) scores. There was no difference in mean operating time (58.97±18.53 (SILA) vs. 57.57±21.48 (CLA), p=0.751). The drain insertion rate (6.9% vs 37.1%, p=0.001) and the length of hospital stay (2.76±1.41 vs. 3.97±2.97, p=0.035) were lower in SILA group with significance. There was no significant difference in the rate of surgical site infection (6.9% vs. 6.7%, p=1.000).

Conclusion: This study demonstrates that SILA is a feasible and safe procedure for treatment of complicated appendicitis.

Keywords: Single-incision Laparoscopic Appendectomy (SILA), Conventional laparoscopic appendectomy (CLA), OA (Open appendectomy)

INTRODUCTION

Acute appendicitis is one of the most common disease known incidence of 10 per 10,000 person requiring emergent abdominal surgery. Claudius Amyand firstly performed open appendectomy successfully in 1735. The first laparoscopic appendectomy was performed by Kurt Semm in 1981.
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also applied for treatment of complicated appendicitis such as gangrenous, perforated appendicitis, or periappendiceal abscess.3

Minimally invasive appendectomy techniques thereafter have been developed, and Single Incision Laparoscopic Appendectomy (SILA) was introduced in 2003. Despite of technical and ergonomic difficulty, SILA has become one of the most popular procedure among the single incision laparoscopic surgery with safety and feasibility in terms of complications, post-operative pain and recovery and better cosmetic results.4,5 However, there is no sufficient evidence for treatment of complicated appendicitis by SILA, and so we conducted this study to demonstrate the safety and feasibility of SILA for treatment of complicated appendicitis by comparison with 3-ports CLA.

MATERIALS AND METHODS

We retrospectively reviewed medical records of total 500 patients who diagnosed acute appendicitis and underwent laparoscopic appendectomy at Konyang University Hospital, Daejeon, Republic of Korea from January 2015 to May 2017 (IRB number is 2018-04-035). The type of surgical technique between CLA and SILA was determined not according to the severity of inflammation estimated by preoperative abdominal CT or ultrasound examination but according to the preference of surgeon, and one surgeon mostly performed SILA cases. The number of surgeon who participated in laparoscopic appendectomy was six. Six surgeons are proficient and well-experienced physicians of laparoscopic appendectomy. In this study, acute appendicitis with gangrenous change, perforation, or abscess formation confirmed by surgical or histological findings was defined as a complicated appendicitis. Patients’ demographics, perioperative outcomes, and postoperative complications within 30 days were analyzed. Firstly, we compared SILA with CLA in all patients diagnosed appendicitis. Secondly we compared SILA with CLA in patients whose final pathology of appendicitis was complicated appendicitis. We excluded cases of open conversion and additional insertion of trocars.

Surgical technique

Ports placements

CLA was performed using three trocars including a 10 mm trocar inserted through the umbilicus for a 10 mm rigid 30° telescope and two additional 5 mm acting trocars inserted at the suprapubic area and left lower abdominal area. But SILA was performed using a commercial single glove port with multi-channel (Nelis, Republic of Korea) inserted through the 1.5 to 2 cm sized trans-umbilical incision (Fig. 1). In SILA, we always keep the camera in the middle of the port and insert the instruments crossing the camera to minimize the effect of chopsticks while maximizing the effect of reverse-triangulation (Fig. 2A, B).
Steps of laparoscopic appendectomy

The each step and laparoscopic instruments used in CLA and SILA were exactly same. First, the appendiceal artery was dissected and ligated with 5 mm laparoscopic surgical clips, then the base of appendix was ligated with an endoloop and resected. The appendix was wrapped out in a plastic bag to avoid contamination in CLA cases, whereas removed throughout the umbilicus protected by the glove port in SILA. If drainage was required, the closed suction drain was inserted using a trocar at suprapubic area in CLA but inserted through an incision made additionally at right lower abdominal area in SILA.

Statistical analyses

Qualitative variables (Age, BMI, Severity of inflammation, Mean operating time, Length of hospital stay) are all expressed as numbers (%), and they were compared by Chi-square test or the Fisher’s exact test. Quantitative variables (Sex, Smoking, ASA score, Drain insertion, Each postoperative complication) are expressed by a mean (range), and they were analyzed using an independent Student t-test. The level of statistical significance was set at p<0.05. SPSS 18.0 (SPSS, Inc., Chicago, IL) was used for statistical analyses.

RESULTS

The number of patients who got SILA or CLA is totally 500. We investigated for demographic outcomes (Age, Sex, Operation History, BMI, Smoking and ASA score) about all patients. Then we also investigated for perioperative outcomes (Mean operating time, Length of hospital stay, Severity of inflammation, Drain insertion, Postoperative complication). The postoperative complication was observed in 46 (9.2%) patients with 39 (7.8%) superficial surgical site infection (SSI), 2 (0.2%) deep SSI, 3 (0.6%) post-operative intra-abdominal abscess, 2 (0.4%) urinary retention and 1 (0.2%) postoperative ileus.

Compared with SILA group (n=179) and CLA group (n=321), mean age is much higher in CLA group (43.51±20.58) than SILA group (31.34±18.84). Severity of inflammation is also higher in CLA group than SILA group (p<0.001) (Table 1). For correction of the selective bias, we compared two groups (SILA vs. CLA) after 1:1 matching by Propensity-matched score.

Comparisons between SILA and CLA in all appendicitis after 1:1 matching by Propensity-matched score (Table 2)

There were no significant differences in patient’s demographics including sexual distribution, smoking history, BMI, the ASA score, mean age and severity of appendiceal inflammation after 1:1 matching by Propensity matched score. In terms of perioperative outcomes, the closed suction drainage was inserted more frequently in CLA with statistical significance (1.7% vs. 8.4%, p<0.004). The mean operating time and the length of hospital stay were similar between two groups (46.84±15.61 vs. 49.03±18.89 minutes, p=0.187) (2.30±0.99 vs. 2.80±1.95 days, p=0.072).

Comparisons between SILA and CLA in complicated appendicitis (Table 3)

There was no significant difference in patients’ demographics including mean age, sexual distribution, BMI, and the ASA score. In terms of perioperative outcomes, the drain insertion

| Table 1. Comparisons between SILA and CLA in all appendicitis |
|-----------------|-----------------|-----------------|-----------------|
|                 | SILA (n=179)    | Conventional (n=321) | p value |
| Age             | 31.34±18.84     | 43.51±20.58      | 0.000  |
| Sex             |                 |                 | 0.258  |
| Male            | 82 (45.8)       | 164 (51.1)       |        |
| Female          | 97 (54.2)       | 157 (48.9)       |        |
| Smoking         |                 |                 | 0.288  |
| Male            | 35 (19.6)       | 76 (23.7)        |        |
| Female          |                 |                 |        |
| BMI (kg/m²)     | 22.82±2.78      | 23.34±3.25       | 0.071  |
| ASA score       | 0.102           |                 |        |
| 1~2             | 176 (98.3)      | 298 (92.9)       |        |
| 3~4             | 3 (1.7)         | 23 (7.1)         |        |
| Severity of inflammation |       |                 | <0.001 |
| Edematous       | 41 (22.9)       | 29 (9.0)         |        |
| Suppurative     | 109 (60.9)      | 187 (58.3)       |        |
| Gangrenous      | 13 (7.3)        | 40 (12.5)        |        |
| Perforated      | 13 (7.3)        | 61 (19.0)        |        |
| Abscess         | 3 (1.7)         | 4 (1.2)          |        |
| Drain insertion | 3 (1.7)         | 45 (14)          | <0.001 |
| Mean operating time | 46.84±15.61    | 49.03±18.89      | 0.187  |
| The length of hospital stay | 2.30±0.99      | 2.80±1.95        | <0.001 |
| Surgical site infection | 17 (9.5) | 23 (7.2) | 0.357  |

Values are presented as mean±standard deviation (range), or number (%). CLA = conventional laparoscopic appendectomy; SILA = single port laparoscopic appendectomy; BMI = body mass index; ASA = American Society of Anesthesiologists.
rate was significantly lower in SILA (6.9% vs. 37.1%, p=0.001). The mean operating time was similar between two groups (58.97 ±18.53 vs. 57.57±21.48 minutes, p=0.751). The length of hospital stay was significantly shorter in SILA (2.76±1.41 vs. 3.97 ±2.97 days, p=0.035), but there was no significant difference in rate of surgical site infection (6.9% vs. 6.7%, p=1.000).

Table 2. Comparisons between SILA and CLA in all appendicitis after 1:1 matching by Propensity-matched score

|                | SILA (n=179) | Conventional (n=179) | p value |
|----------------|--------------|----------------------|---------|
| Age            | 31.34±18.84  | 33.98±17.13          | 0.166   |
| Sex            | 0.832        |                      |         |
| Male           | 82 (45.8)    | 84 (46.9)            |         |
| Female         | 97 (54.2)    | 96 (53.1)            |         |
| Smoking        | 35 (19.6)    | 41 (22.9)            | 0.288   |
| BMI (kg/m²)    | 22.82±2.78   | 22.93±3.27           | 0.728   |
| ASA score      | 0.308        |                      |         |
| 1 ~ 2          | 176 (98.3)   | 171 (96.0)           |         |
| 3 ~ 4          | 3 (1.7)      | 8 (4.5)              |         |
| Severity of inflammation | 0.202 |                      |         |
| Edematous      | 41 (22.9)    | 26 (14.5)            |         |
| Suppurative    | 109 (60.9)   | 119 (66.5)           |         |
| Gangrenous     | 13 (7.3)     | 14 (7.8)             |         |
| Perforated     | 13 (7.3)     | 19 (10.6)            |         |
| Abscess        | 3 (1.7)      | 1 (0.6)              |         |
| Drain insertion| 3 (1.7)      | 15 (8.4)             | 0.004   |
| Mean operating time | 46.84±15.61 | 45.98±16.77          | 0.613   |
| The length of hospital stay | 2.30±0.99  | 2.50±1.25            | 0.101   |
| Surgical site infection | 17 (9.5)   | 9 (5.0)              | 0.072   |

Values are presented as mean±standard deviation (range), or number (%).
CLA = conventional laparoscopic appendectomy; SILA = single port laparoscopic appendectomy; BMI = body mass index; ASA = American Society of Anesthesiologists.

Table 3. Comparisons between SILA and CLA in complicated appendicitis

|                | SILA (n=29) | Conventional (n=105) | p value |
|----------------|------------|----------------------|---------|
| Age            | 38.28±19.55| 47.30±22.54          | 0.052   |
| Sex            | 0.737      |                      |         |
| Male           | 15 (51.7)  | 58 (55.2)            |         |
| Female         | 14 (48.3)  | 47 (44.8)            |         |
| BMI (kg/m²)    | 22.69±2.84 | 23.15±2.68           | 0.418   |
| ASA score      | 0.296      |                      |         |
| 1 ~ 2          | 27 (93.1)  | 94 (89.5)            |         |
| 3 ~ 4          | 2 (6.9)    | 11 (10.5)            |         |
| Drain insertion| 2 (6.9)    | 39 (37.1)            | 0.001   |
| Mean operating time | 58.97±18.53 | 57.57±21.48          | 0.751   |
| The length of hospital stay | 2.76±1.41  | 3.97±2.97            | 0.035   |
| Surgical site infection | 2 (6.9)   | 7 (6.7)              | 1.000   |

Values are presented as mean±standard deviation (range), or number (%).
CLA = conventional laparoscopic appendectomy; SILA = single port laparoscopic appendectomy; BMI = body mass index; ASA = American Society of Anesthesiologists.

DISCUSSION

Since the first laparoscopic appendectomy by Kurt Semm in 1981, laparoscopic appendectomy has become the gold standard procedure for acute appendicitis with the technological advances and improvements in surgical laparoscopic techniques. Numerous studies has already shown superiority of laparoscopic surgery than open surgery for treatment of acute appendicitis. Yu et al. showed laparoscopic appendectomy has more benefit of short length of hospital stays, faster recovery time for oral intake and lower rate of surgical site infection than open appendectomy. Wang et al. also presented laparoscopic technique is feasible, safe, and efficacious for children with complicated appendicitis. Yeh represented hospital mortality and readmission rates for postoperative complications did not differ between laparoscopic appendectomy and open appendectomy in case of patients with comorbidities, the elderly with complicated appendicitis. Moreover, patients older than 65 years, with comorbidities, and with complicated appendicitis had benefit for lower cost and shorter hospital length of stay in the laparoscopic approach.

Conventional laparoscopic appendectomy has become more common, and surgeons tried to use lesser the number of ports than three ports. Turgut Donmez introduced two-port laparoscopic appendectomy (TLA) assisted with needle grasper. It results that TLA using a needle grasper was associated with a significantly lower pain score 12 hours after surgery, better cosmetic results, and lower cost than CLA 3-port procedure.

Efforts to reduce scar and postoperative pain have continued and new technique such as Natural Orifice Transluminal Endoscopic Surgery (NOTES) and single port surgery has been applied to various field including appendectomy. In the early period, most studies of SILA had focused on appendectomy for children. Wiek reviewed charts of children under 17 years old who underwent appendectomy at a tertiary pediatric...
hospital from 2011 to 2014. It resulted that SILA is faster and cost effectiveness than CLA. Moreover, SILA did not increase postoperative surgical site infection.10 Litz CN et al. demonstrated that SILA is feasible and safe in obese children.11 However, Zhao et al. showed SILA has only one advantage of shorter length of hospital stay. SILA failed to show advantages over CLA in operative time and postoperative complications which were wound infection, intra-abdominal infection, ileus.12 Concha showed that there were no differences in morbidity rate, the length of hospital stay, and the mean operating time between SILA and CLA except open conversion rate.13 Although, SILA was associated with longer operating time and more rate of additional port insertion compared with CLA, Markar et al. showed SILA is a safe procedure for the treatment of acute appendicitis.14 In previous studies including those mentioned above, it has been proven that SILA is a safe and feasible procedure for treatment of acute appendicitis in terms of perioperative outcomes. However, many surgeons apply CLA rather than SILA for complicated appendicitis because of technical difficulties. So, we conducted this study to demonstrate the safety and feasibility of SILA for complicated appendicitis.

In this study, patients performed SILA for complicated appendicitis is much lower compared to patients performed CLA (29 vs. 105), because one surgeon has mostly performed SILA for treatment of acute appendicitis regardless of severity in our institute.

Although, the closed suction drain insertion rate was significant lower in SILA, it was inserted in only two patients performed SILA with periappendiceal abscess, but there was no difference in surgical site infection rate (6.9% vs. 6.7%, p=1.000). Broad antibiotics (2nd generation cephalosporin plus metronidazole) were given to all patients of complicated appendicitis, when they discharged. There was no other complications in SILA, but there were 1 urinary retention and 1 postoperative ileus in CLA for complicated appendicitis.

There are a few limitations in this study. One is the small sample size of complicated appendicitis with retrospective nature, and the most SILA were performed by a single surgeon. And we did not investigate the pain score which would be related to the length of hospital stay.

In conclusion, SILA is a feasible and safe procedure so that it can be applied not only for simple appendicitis but also for complicated appendicitis without increase of the mean operating time and postoperative complication rate.

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