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Impact of experience on quality outcomes in single-incision laparoscopy for simple and complex appendicitis in children

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ABSTRACT

Background: Single-incision laparoscopic appendectomy (SILA) is an effective treatment for appendicitis in children. We report our experience with SILA, focusing on how surgeon experience may impact quality outcomes.
Methods: A retrospective review of patients who underwent SILA from August 2009 to November 2013 was performed. Patients were grouped by early experience, late experience without surgical trainees, and late experience with trainees and further stratified into simple and complex appendicitis.
Results: SILA was performed on 703 patients with a mean age of 11.8 ± 3.9 years. Four hundred eleven (58.5%) patients were diagnosed with simple and 292 (41.5%) with complex appendicitis. There was a significant decrease in operative time between early and late groups for both simple and complex appendicitis. Following the introduction of surgical trainees, there was a significant increase in operative time compared to the late group for simple appendicitis. There were no significant differences in complication rates between any of the groups.
Conclusion: The adoption of SILA requires a significant learning curve even for the experienced laparoscopist with the potential for decreased operative times with experience. While there may be an increase in operative time with the introduction of trainees, this does not impact quality outcomes.

Laparoscopic surgery has been shown to have significant advantages to open surgery including decreased post-operative pain, faster recovery, and improved cosmesis [1,2]. The development of new technology continues to advance the potential of minimally invasive surgery. Single-incision laparoscopy (SIL) involves performing abdominal operations through a single umbilical incision. The technique and feasibility of this approach has been described for many procedures in children [3–6].

Appendectomy is the most common urgent pediatric surgical procedure with approximately 71,000 cases performed per year in children younger than 15 years [7]. Multiple studies comparing multiport laparoscopic appendectomy to single-incision laparoscopic appendectomy in children have shown comparable outcomes between the two techniques [8–11]. SILA has been rapidly adapted into practice and its application has been increasing worldwide. One report found that up to 71% of pediatric surgeons have performed SIL surgery, with appendectomy, cholecystectomy, pyloromyotomy, intestinal surgery, fundoplication, and gynecologic adnexal surgery being some of the most commonly performed procedures in this population [12].

Although prospective studies have found SILA to be safe and feasible in the pediatric population, factors that impact outcomes are not well understood. The purpose of this study was to report our experience with single-incision laparoscopic appendectomy focusing on the impact experience may play on quality outcomes.

1. Materials and methods

At the inception of the single-incision laparoscopy program at our tertiary care children's hospital, all patients were entered into a prospective database for quality monitoring. After institutional review board approval (IRB 13-0666), a retrospective review of 703 patients who underwent single-incision laparoscopic appendectomy from August 2009 to November 2013 was performed. The first consecutive 100 cases were grouped as "early experience", cases beyond the first 100 and up until October 2012 were grouped as "late experience" and cases beyond October 2012 were labeled as "late experience after introduction of surgical trainees." Each cohort was then further stratified into simple (acute) appendicitis and complex appendicitis. Interval appendectomies were included in the complex appendicitis group (n = 48). Data were obtained on age, weight, gender, and degree or type of appendicitis. Quality measures including operative time, conversions to multi-port laparoscopy or open procedure, and 30 day complications were analyzed. Descriptive data are reported as mean ± standard deviation and range. Statistical analysis was performed using Students t-test to compare mean values, and significance was set at $p < 0.05$.

A learning curve for SILA was determined by evaluating operative times from the inception of the SIL program. A decrease in variance in operative times was noted at approximately 100 cases (Fig. 1A and B). Given these findings, early experience with SIL was considered to be

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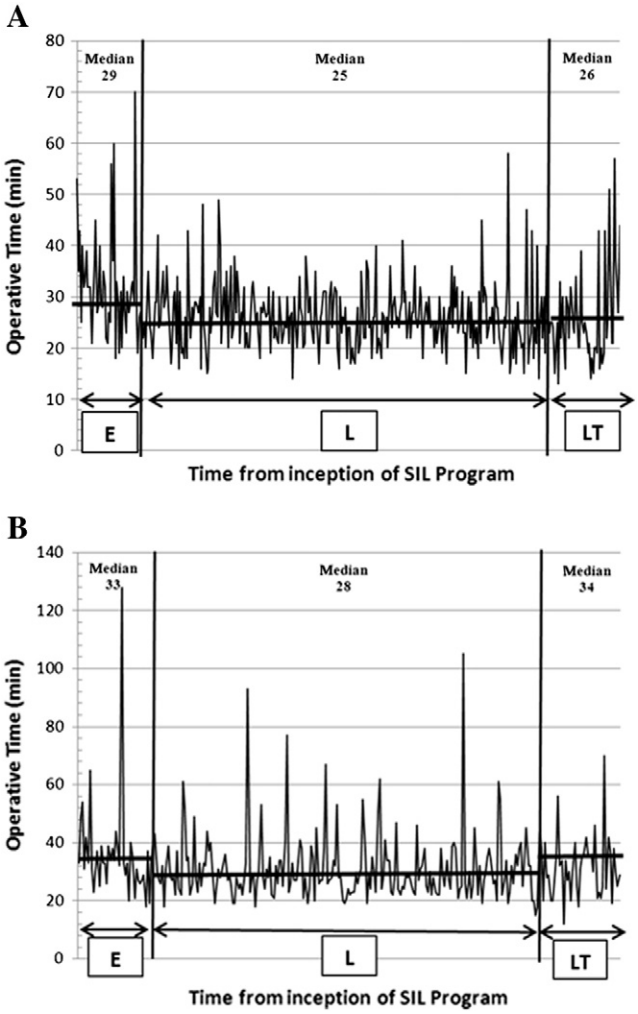

Fig. 1. A: Operative times from inception of SIL program for simple appendectomy. E: Early experience; L: late experience; LT: late cases with trainees. Horizontal bars represent median operative times. B: Operative times from inception of SIL program for complex appendectomy. E: Early experience; L: late experience; LT: late cases with trainees. Horizontal bars represent median operative times.

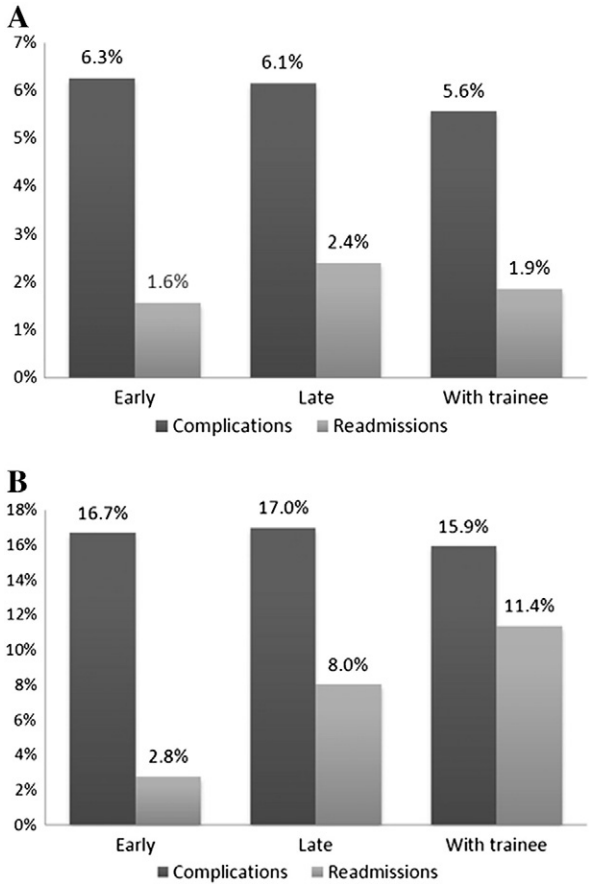

Fig. 2. A: 30 day complications and re-admissions following appendectomy for simple appendicitis. B: 30 day complications and re-admissions following appendectomy for complex appendicitis.

the first 100 consecutive cases performed. This corresponded with 64 simple appendectomy and 36 complex appendectomy cases. Simple appendicitis was defined as appendiceal hyperemia, dilation, or inflammation. Complex appendicitis included suppurative, gangrenous, perforated, or interval appendectomy. This included the presence of fibrinous exudate, turbid peritoneal fluid, gangrene, or gross evidence of perforation (See Fig. 2).

1.1. Operative technique

All single-incision laparoscopic appendectomies were performed on a rotating basis determined by call schedule by two attending surgeons. Appendectomies were performed with the assistance of a mid-level provider at the inception of the SIL program and with the aid of one of two pediatric surgery fellows at the start of our ACGME pediatric surgery fellowship training program in October 2012. Our group has previously described and published our operative approach for SILA [8]. The single-incision laparoscopic technique was performed through a single curvilinear or transumbilical incision made at the umbilicus. Early in the series (the first 9 patients), the SILS Port (Covidien, Norwalk, CT) was used. In subsequent procedures, the TriPort Access System (Advanced Surgical Concepts, Wicklow, Ireland) was used. Standard non-articulating 5 mm laparoscopic telescopes and instruments were used. After identification and isolation of the appendix and mesoappendix, a 12 mm stapling device (Ethicon Endo-Surgery, Cincinnati, OH) was used to divide the appendix at the base of the cecum. The appendix was removed either through the single incision port or using a specimen retrieval bag. The TriPort device has an innate wound protector as part of its design.

2. Results

Mean age for all patients was 11.8 ± 3.9 (1.2–21.5) years, and mean weight was 47.5 ± 20.5 (9.8–134) kilograms. The population consisted of 61% males. Four hundred eleven (58.5%) patients were diagnosed with simple appendicitis and 292 (41.5%) were diagnosed with complex appendicitis. Demographic data for each group are further described in Table 1. Demographics were similar between the simple appendicitis and complex appendicitis groups. However, patients presenting with complex appendicitis were noted to be significantly younger compared to those with simple appendicitis ($p < 0.05$).

Prior to the start of our training program, 357 patients underwent SILA for simple appendicitis while 248 underwent SILA for complex

Table 1
Patient demographics.

	Simple appendectomy	Complex appendectomy	*P*
No. of patients	411	292	
Age (y)	12.2 ± 3.8 (2.8-21.5)	11.2 ± 4 (1.2-19.6)	$p < 0.05$
Males (%)	253 (61.6%)	177 (60.6%)	$p = 0.81$
Weight (kg)	48.6 ± 20.2 (10–134)	45.9 ± 20.7 (9.8-125)	$p = 0.09$
Follow up	267 (65%)	198 (67.8%)	$p = 0.47$

Age and weight presented as mean ± standard deviation (range).