

Teaching Single-Incision Laparoscopic Appendectomy in Pediatric Patients

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ABSTRACT

Introduction: Laparoscopic appendectomy is accepted as the gold standard technique for the treatment of acute appendicitis. Recently single-incision laparoscopic surgery (SILS) was tried in the pediatric population and was shown to be both feasible and safe. We describe our early experience in teaching the SILS procedure for appendicitis in a large community hospital center surgical residency program.

Methods: SILS appendectomy was performed in 40 consecutive patients with acute appendicitis who were admitted by a single surgeon from May 2011 to August 2011. All patients over the age of 4 y presenting with noncomplicated and complicated appendicitis (perforated) were offered SILS appendectomy. Execution of the technical aspects of 20 SILS operations done by 3 PGY III residents was evaluated.

Results: The average age of the patient was 11.1 y (range, 7 to 15). SILS was performed successfully in 19 out of 20 patients. Nineteen patients underwent emergent or urgent appendectomy, while 1 patient underwent an interval procedure. Nine patients were found to have perforated appendicitis, while the other 11 had noncomplicated acute appendicitis. One patient was converted to conventional 3-port laparoscopy due to difficulties during the procedure. The mean operative time was 73 min (range, 47 to 112). A significant learning curve to successfully execute the critical steps of the SILS procedure was noted in all residents evaluated.

Conclusion: SILS technology appears promising for the treatment of acute appendicitis. However, its successful incorporation into surgical training programs will depend on the development of innovative simulation strategies.

Key Words: SILS, Appendectomy, Simulation, Training.

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INTRODUCTION

Acute appendicitis is one of the most common surgical diagnoses in pediatric surgical practice, and appendectomy is one of the most frequently performed procedures in this age group. Since the introduction of laparoscopic surgery, laparoscopic appendectomy has superseded open appendectomy as the gold standard operation for the treatment of this condition, because of its obvious benefits, such as decreased postoperative pain, decreased hospital stay, and better cosmesis.^{1,2} Recently single-incision laparoscopic surgery (SILS), or laparoendoscopic single-site surgery, was introduced in the pediatric population and was shown to be feasible in various pediatric surgical procedures.^{3,4} Early reports of SILS outcomes have demonstrated an equivalent postoperative analgesic requirement and better cosmetic outcome in the pediatric population compared to multiport procedures.^{4,5} Currently, SILS is offered by a very select set of practitioners, as it is perceived as an advanced laparoscopic technique with a greater degree of difficulty compared to conventional multiport appendectomy (CLA). However, its wide acceptance in the surgical community will depend on the ability of surgical training programs to incorporate safe teaching methods of this technique and enable the new generation of general surgeons to confidently perform the procedure. We looked at our early experience in training residents in this technique and suggest the potential direction in which simulation programs could help develop the specific skill sets necessary to execute successfully the steps of SILS appendectomy.

METHODS

SILS appendectomy was performed in 40 consecutive patients with acute appendicitis admitted by a single surgeon from May 2011 to August 2011. All patients over the age of 4 y presenting with noncomplicated and complicated appendicitis (suppurative and perforated) were offered SILS appendectomy. Patients presenting with a well-defined phlegmon or abscess were treated with antibiotics and/or drainage and underwent a subsequent elective interval SILS appendectomy. Twenty of the operations, performed primarily by residents, were evaluated for satisfactory ex-

ecution of 5 designated critical steps in the operation by a single attending surgeon (**Table 1**).

Training in the SILS technique was imparted to 3 PGY III residents. Residents were well versed in the technique of CLA prior to learning SILS. They were also encouraged to practice basic laparoscopic skills on the laparoscopic trainer box during their clerkship. The 3 residents were selected as they had each been involved in at least 10 SILS procedures. Progressive improvement in technique was evaluated on the basis of successful completion of these key steps in a noncomplicated fashion without attending intervention. Secondarily, we looked at the incidence of intraoperative complications, operative morbidity, operative time, conversion to conventional open or laparoscopic procedure, and duration of hospital admission. Descriptive statistics were used because of the small study set.

Surgical Technique

The patient was placed in the supine position, and general anesthesia was induced. The operative site was prepped from the nipples to midhigh with 2% chlorhexidine and draped. The umbilicus was completely everted, and its margins were marked. A 1.2-cm incision was made in the umbilical cicatrix, and a single-incision trocar (Olympus Triport, Olympus, Inc., NC) was placed using the open Hasson technique. Pneumoperitoneum was obtained by gas flows at 4L per minute with intraabdominal pressure being maintained between 12 mm Hg and 15 mm Hg. A 5-mm 30°scope was used to provide “around the corner” vision, and a curved grasper and dissector specifically designed for the SILS technique were used to minimize instrument conflict in the linear working space. The appendix was mobilized with blunt and sharp dissection, and the meso-appendix was divided close to the appendicular wall in an antegrade fashion with the standard hook using electrocautery. Endo-loops were applied to

secure the base of the appendix, and the appendix was divided with endo-shears and retrieved through the wound protector system offered by the SILS trocar. The trocar site was closed with 0-Vicryl, and the skin was closed with an absorbable suture.

RESULTS

Three PGY III residents performed 20 SILS appendectomy procedures during their 2-mo rotations on the pediatric surgical service. There were 13 males and 7 females in the series with a mean body weight of 47.3 kg (range, 21 to 87). The average age of the patient was 11.1 y (range, 7 to 15). SILS was performed successfully in 19 out of 20 patients. Nineteen patients underwent appendectomy for an acute appendicitis, while 1 underwent an interval procedure. Nine patients were found to have perforated appendicitis, while the other 11 had noncomplicated acute appendicitis. The single patient who was converted to CLA failed initial nonoperative management and had a hostile abdomen that necessitated conversion. The mean operative time was 73 min (range, 47 to 112). There were no intraoperative complications. The mean duration of hospital stay was 4.2 d (range, 2 to 11). Four patients developed postoperative ileus, which improved with observation. One patient developed an umbilical wound infection. One patient developed an intraabdominal abscess in the postoperative period, which was successfully treated with antibiotics and did not require drainage. The ability of the residents to successfully execute the 5 key steps in this operation is illustrated in Table 1.

DISCUSSION

The SILS procedure has been successfully applied to conditions such as appendectomy, cholecystectomy, splenectomy, antireflux operations, and adrenalectomy in the pediatric population.^{4,6–8} Most of the reported series are small, single-surgeon experiences, and long-term results are yet to be validated. One very obvious benefit of this procedure is the superior cosmesis with no visible scarring. In the current era where a high premium is placed on cosmesis, it is likely that this technology will see an increased demand. Its sustainability as a craft, however, will depend on its long-term safety record and mastery of the technique by a large body of surgeons. The initial results with laparoscopic cholecystectomy were inferior to the open technique due to poor understanding of the technology and its applications.⁹ It is imperative that similar mistakes are not repeated when newer stealth surgical techniques like SILS and NOTES (Natural Orifice Translu-

Table 1.

Number of Cases Taken by Residents to Demonstrate Mastery of the Technique of Key Steps in the SILS Appendectomy Operation

Key Step	Resident 1	Resident 2	Resident 3
Access	2	2	2
Dissection	5	4	3
Endoloop Ligation	4	4	3
Retrieval of Specimen	2	2	2
Closure	1	1	1

minimal Endoscopic Surgery) are offered to the general population. Surgical training programs should take the lead in ensuring that new technology is safely and effectively taught to the new generation of trainees. In our series, residents proficient in conventional laparoscopic appendectomy had a substantial learning curve to perform a relatively simple procedure, appendectomy, using the SILS technique. The 30° cameras, energy source (electrocautery), meso-appendix dissection technique, and endoloop ligation of the appendix stump were exactly the same as the technique used in our conventional laparoscopic appendectomy procedures.

The SILS technique, while having a steep learning curve, can be performed with adequate mentoring and preparation on the part of the trainee. In our early experience, only 1 patient out of the 20 (5%) was converted to conventional multiport appendectomy. In previously published studies,^{3,10} this conversion rate has been shown to be between 4% and 20%. The resident mean operative time of 73 min was longer than the 35 to 55 min of attending operative time. The latter times were similar to those described in other recent studies that were performed by attending surgeons.^{3,11} The electrocautery dissection of the meso-appendix and endoloop ligation of the stump increases the duration of the SILS appendectomy as compared to studies that use endoscopic staplers. Manipulation of the endoloop to the appendico-cecal junction takes time to learn with the SILS technique. Our case mix was also more varied with a higher incidence of perforated appendicitis and fewer elective interval procedures. Some studies have noted a higher incidence of umbilical wound infections with this procedure.^{11,12} This is presumed to be secondary to the radial pressure on the surrounding tissues from manipulation of the instruments through a narrow working channel. With the development of trocars with built-in wound protecting specimen retrieval systems, the incidence of such infection may decrease. SILS instruments may be unwieldy for small infants, and we limited its applicability in our institution to children > 4 y of age. Angled laparoscope navigation and ergonomic movement of collocated camera and instruments are factors that will likely evolve with time and will make the procedure easy. Development of the flexible tip laparoscope is a step in this direction. In our early experience with this device (used in 2 of 20 cases), there appeared to be minimal conflict between the scope and the instruments as compared to the regular laparoscope.

The inability to successfully impart skill training in general surgical programs, as technology has evolved and work hour restrictions developed, has led to a

mushrooming of fellowship programs in various surgical subspecialties. The Halstedian apprenticeship model of surgical training depended on development of skill-, rule-, and knowledge-based behavior under the supervision of an expert surgeon.¹³ Novel teaching methods need to be developed to facilitate resident learning in this era where great importance is accorded to work-hour restriction, ethics, patient safety concerns, and surgical department economics. Imparting SILS skills may require designated simulator time, development of simulation technology to reinforce such skills, and devotion of slightly longer operating room times to resident education in surgical training programs. SILS skills should include an ability to work with crossed instruments, ambidextrous dissection, left-handed endoloop application, and angled-scope navigation.

In our experience, SILS technology appears to be promising for the treatment of acute appendicitis. The technique can be imparted satisfactorily to general surgery residents without advanced laparoscopic skills, with the caveat that the conclusion is not based on objective criteria that evaluate the resident performance of the key steps of the operation.

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