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Extracorporeal and intracorporeal approaches of single-incision laparoscopic appendectomy in children: is one superior to another?

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ABSTRACT

Background: Single-incision laparoscopic surgery has been widely popularized for pediatric appendicitis. Various techniques have been proposed with two main approaches: extracorporeal and intracorporeal. The purpose of this study is to compare the result of different approaches in single-incision laparoscopic appendectomy (SILA) in children.

Material and methods: With IRB approval, patients less than 18 years of age who underwent SILA were enrolled from July 2012 to December 2015. The patients were divided into three groups based on surgical approach: extracorporeal (Extra), mixed (Mix), and intracorporeal (Intra) approaches. Parameters were retrospectively reviewed, including age, gender, white blood cell (WBC), operation time, operative findings, time to diet, length of hospital stay (LOS), and complications. Statistical analysis was performed separately for simple and complicated appendicitis.

Results: There were 32, 32, and 24 patients with simple appendicitis in Extra, Mix, and Intra respectively. There were 27, 15, and 31 patients with complicated appendicitis in the three groups, respectively. No significant difference was noted in the mean age, gender distribution, or WBCs between the different groups. A higher percentage of patients with complicated appendicitis received intracorporeal approach than those with simple appendicitis (42.5% vs. 27.3%, $p = 0.044$). In simple appendicitis, the LOS was significantly longer in Extra as compared to Mix ($p = 0.043$). Otherwise, the mean LOS, time to diet, and complications were not significantly different. The mean operation time was similar between groups of simple appendicitis (56.5 ± 19.5, 63.6 ± 23.5, and 70.1 ± 23.1 min, $p = 0.08$), whereas it was significantly shorter in Extra of complicated appendicitis (67.6 ± 16.4, 86.6 ± 19.0, and 89.9 ± 23.4 min, $p < 0.001$). Multivariate analysis showed that intracorporeal approach is an independent factor for prolonged operation time in both simple and complicated appendicitis.

Conclusions: Different approaches of SILA in children have similar outcomes for both simple and complicated appendicitis. Extracorporeal is the most time efficient; however, intracorporeal can be helpful to deal with complex situations.

Level of evidence: III

With the advent of minimally invasive surgery, laparoscopic appendectomy has evolved from three small incisions to a single invisible wound concealed deeply within the umbilicus. Pelosi et al. firstly proposed the one-trocar technique with an operative telescope. He is considered as the pioneer of single-incision laparoscopic surgery (SILS) [1]. Recently, the introduction of multichannel glove ports makes the application of single-incision laparoscopic appendectomy (SILA) feasible for more complex endoscopic manipulations [2–4].

Single incision laparoscopic appendectomy can be performed in many different ways. Generally, the technique can be described as extracorporeal, and intracorporeal. The extracorporeal method was performed by exteriorizing the appendix through the umbilical wound. It has been widely accepted owing to the benefits of shorter learning curve, shorter operative time, and being more cost effective [3–6]. To perform the intracorporeal method, higher technical expertise is needed because of the parallel arrangement of instruments. However, favorable outcomes have been reported [2,7,8]. In the present literature, there are only limited data directly comparing these two different techniques, and also even less reported specifically with regards to complicated appendicitis.

Since July 2012, SILA has been considered as one of treatment choices for acute appendicitis in our hospital. Three different techniques were utilized, namely extracorporeal, intracorporeal, and mixed approaches. We hypothesized that the best way to achieve a good

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outcome was not to simply compare one technique to another, but rather for the surgeon to individualize the approach depending on the state of the inflamed appendix. The purpose of this study is to compare the results of different approaches of SILA for both acute simple and complicated appendicitis in children.

1. Material and methods

With institutional board approval, patients less than 18 years of age who received single-incision laparoscopic appendectomy in single institution between July 2012 and December 2012 were enrolled. Patients who underwent interval appendectomy or who were proven to have no appendicitis intraoperatively or pathologically were excluded. Medical records were retrospectively reviewed. Parameters collected comprised of age, gender, white blood cell count (WBC), bandemia, operation time, operative findings, peritoneal irrigation volume, time to diet, length of postoperative hospital stay (LOS), as well as complications, such as wound infection, adhesion intestinal obstruction, and intraabdominal abscess. Complicated appendicitis, which was not an exclusion criterion, was defined as a grossly gangrenous or perforated appendix, or the presence of purulent peritoneal ascites or abscess.

1.1. Grouping

The patients were classified into three groups based on the surgical approaches:

1.1 Extracorporeal Group (Extra): the appendix was delivered through the umbilical wound, where both the mesoappendix and the appendix were divided extracorporeally using conventional open instruments.
1.2 Mixed group (Mix): the mesoappendix was divided intracorporeally with metal clips, and the appendix was then delivered through the umbilical port and divided extracorporeally.
1.3 Intracorporeal Group (Intra): both the mesoappendix and the appendix were divided intracorporeally. The mesoappendix was divided by using metal clips, and the base of the appendix was tied by using endoloops.

1.2. Operative technique

Under general anesthesia, a vertical transumbilical incision was made through the skin and fascia into the peritoneal cavity by an open method. A flexible plastic wound protector (ALEXIS XS, Applied Medical, Taiwan) was inserted into the abdominal cavity, with its outer end attached to a No. 6 surgical glove (Fig. 1). Three of the five glove fingers were cut where three trocars were attached and fixed with rubber bands. A rigid, straight 5-mm telescope with a 30-degree lens and conventional straight 5-mm instruments were used.

During the operation, the choice of operative method was under the discretion of the surgeon. Whenever turbid ascites or blood clots were present, irrigation of the intraperitoneal cavity was performed with saline, and the volume was recorded. After surgery, time to diet was calculated between the end of surgery, and the actual time when patients started soft or full diet.

2. Calculation

Statistical analysis was performed with MedCalc software (11.32521.0) with Chi-square, independent t test, ANOVA, and multivariate regression analysis. A p value <0.05 represents statistical significance.

3. Results

Within the study period, a total of 161 patients with were included. The mean age was 11.7 ± 3.7 years. Overall female to male ratio was 54:107 with male predominance. Fifty-nine patients (36.6%) received extracorporeal method, 47 patients (29.2%) received mixed method, and 55 patients (34.2%) received intracorporeal method. Eighty-eight patients (54.7%) had simple appendicitis and 73 patients (45.3%) had complicated appendicitis. In patients with complicated appendicitis, significantly more number of patients received intracorporeal approach as compared to patients with simple appendicitis (42.5% vs 27.3%, $p = 0.044$) (Fig. 2).

3.1. Simple appendicitis

The demographic data for patients with simple appendicitis were summarized in Table 1. The mean age was 12.8 ± 3.5, 12.9 ± 3.3, and 11.6 ± 3.6 years in Extra, Mix, and Intra groups, respectively ($p =$

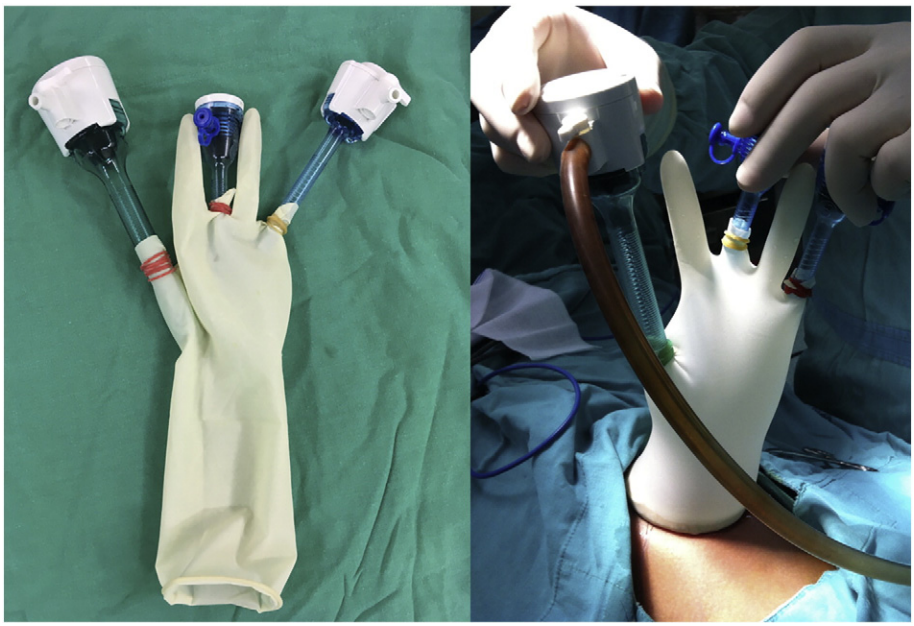

Fig. 1. A hand-made glove port.