



Systematic review and meta-analysis of single-incision versus conventional laparoscopic appendectomy in children[☆]



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ABSTRACT

Background: Increasing evidence has indicated that single-incision laparoscopic appendectomy (SILA) is a safe procedure that has a comparable clinical outcome to conventional multiport laparoscopic appendectomy (CLA) in adult patients. Nevertheless, the use of SILA in pediatric patients is still controversial, and systematic reviews that compare SILA and CLA in children are lacking in the current literature.

Methods: A literature search in MEDLINE, EMBASE, Cochrane library, and ClinicalTrials.gov was performed to identify eligible studies that were conducted between January 1998 and September 2014. Primary outcome measures were total postoperative complications, wound infection, intra-abdominal abscess, ileus, and wound hematoma. Secondary outcome measures were operative time, length of hospital stay and the frequency of use of additional analgesics. The random effect model was used for the meta-analysis.

Results: The literature search identified 2 randomized clinical trials and 12 nonrandomized clinical trials that met the inclusion criteria for the meta-analysis. These studies included a total of 2249 patients: 744 who underwent SILA and 1505 who underwent CLA. No significant differences were observed between the groups with respect to the incidence of total postoperative complications, intraabdominal abscess, ileus, wound hematoma, length of hospital stay, or the frequency of use of additional analgesics. However, SILA was associated with a higher incidence of wound infection (OR = 2.25; 95% = 1.21–4.17; P = 0.01) compared with CLA and required a longer operative time (WMD = 5.73 minutes; 95% CI = 4.17–7.28; P < 0.00001).

Conclusions: SILA seems to be a relatively feasible and safe procedure without any superiority to CLA. Thus, SILA may not be a better approach for pediatric patients.

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Appendicitis is one of the most common causes of abdominal pain worldwide. The annual rate in the United States is 9.38 per 10,000 individuals, and the highest frequency of appendicitis was found in the 10–19 year age group [1]. Appendectomy is the primary therapeutic method used to treat appendicitis. Multiport laparoscopic appendectomy has been safely and widely used in children because of the benefits of lower incidence of postoperative wound infection, ileus, less pain, faster recovery of bowel function, shorter hospital stay, and better cosmetic outcome [2–4]. Over the years, surgeons have made great efforts to bestow more benefits on their patients by the reduction and eventually elimination abdominal incisions. Single-incision laparoscopic appendectomy (SILA), which is a potential feasible approach to reduce incision-related negative outcomes, has gained more and more popularity; this technique has been demonstrated to be comparable to the

conventional multiport procedure in adults according to numerous randomized controlled trials (RCTs) [5–8] and meta-analyses [9–18].

However, the comparability of SILA with conventional laparoscopic appendectomy (CLA) has not been established among the pediatric population, a group that has a relatively high frequency of appendicitis, owing to the limitation of a small number of RCTs and a lack of meta-analyses. In addition, children, who are still developing, may gain greater benefits from advanced minimally invasive techniques. Furthermore, evidence from adult patients may be not applicable to children because the smaller abdominal area of the latter may enhance the technical difficulties associated with SILA. This study aims to use a meta-analysis to integrate the results of RCTs and non-RCTs that compare SILA with CLA in pediatric populations to determine whether SILA is a feasible and safe alternative to CLA in children.

1. Materials and methods

1.1. Study selection

An electronic literature search was performed in MEDLINE, EMBASE, Cochrane library, and ClinicalTrials.gov, for all studies that were published between January 1998 and September 2014 that compare single-incision laparoscopic appendectomy with conventional

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laparoscopic appendectomy in a pediatric population; we placed no limitations on the language of publication. The following search terms were used: “appendicitis[Mesh]/appendectomy[Mesh]/appendectomy/appendicectomy/appendicitis/appendectomies,” “single incision/single site/single port/single access/single trocar/single wound/one incision/one site/one port/one access/one trocar/one wound/transumbilical/SILA/SILS-A/TULAA/SSLA/SPLA,” “adolescent[Mesh]/child[Mesh]/pediatrics[Mesh]/adolescent/children/child/paediatric/pediatric.” In addition, we reviewed the published abstracts from 2006 to 2013 from meetings of the International Pediatric Endo-surgery Group (IPEG), the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), and the European Association of Endoscopic Surgeons (EAES). The reference lists of the obtained studies were also reviewed to identify relevant citations. The abstracts or full texts of all potentially relevant studies were assessed independently by two reviewers, and any disagreements were resolved by discussion.

1.2. Inclusion and exclusion criteria

To qualify for this meta-analysis, studies had to (1) compare SILA and CLA in pediatric patients, (2) report on at least one of the outcome measures mentioned below, (3) contain a patient group that was not reported previously (if the sample group was reported in more than one article, we chose the most recent and informative article or merged information from the publications). Studies were excluded if (1) it was impossible to extract or calculate the necessary data with respect to the outcomes of interest from the published results and if there was no response to our attempt to contact the authors, (2) only the mean for continuous outcomes (length of operative and hospital time) was reported without standard deviation while the incidence and types of complications were also absent, and (3) the study was observational with a score below 5 in the Newcastle-Ottawa Quality Assessment Scale (NOS) [19].

1.3. Data extraction and quality assessment

The results from each study were extracted by two independent reviewers. To reach a final decision, any disagreement was resolved by discussion between the two reviewers or by discussion with a third reviewer when necessary. The following data were extracted: first author, year of publication, country where the study was performed, study type, sample size, characteristics of the study population, mean cost, severity of the appendicitis, the mode of division of appendix in SILA, conversion rate, complications during surgery and during the postoperative period, length of operation and hospital stay, postoperative pain, and cosmetic results. The Newcastle-Ottawa Quality Assessment Scale (NOS) was used as an assessment tool to evaluate non-RCTs. The scale varies from zero to nine stars, and studies with a score equal to or higher than seven were considered to have high methodological quality. The methodological quality of the RCTs was analyzed with the tools that are used to evaluate the risk of bias according to the Cochrane Handbook for Systematic Reviews of Interventions [20], as represented in Table 3.

1.4. Statistical analysis

Statistical analyses were performed with Review Manager 5.3 (Review Manager Version 5.3). Weighted mean differences (WMDs) with 95 % confidence intervals (CI) were calculated for the effect of SILA on continuous variables such as the duration of surgery, duration of hospital stay and the frequency of use of additional analgesics. Pooled odds ratios (ORs) were calculated for the effect of SILA on dichotomous variables such as total postoperative complications, wound infection, intraabdominal abscess, postoperative ileus and postoperative wound hematoma. The WMDs and ORs were both considered to be statistically significant when the P value was <0.05. The random effect model was

used for the meta-analysis. We used Cochrane's Q-statistic to evaluate the statistical heterogeneity between studies and considered significant heterogeneity to be present when the associated P value was below 0.10. We used the I^2 statistic to estimate the magnitude of the heterogeneity, and judged values less than 25% to be minimal, less than 50% to be moderate, and equal to or greater than 50% to be substantial [21]. Publication bias was assessed by a funnel plot.

2. Results

2.1. Literature search

A total of 345 studies were identified in the electronic searches. After the exclusion of duplicates, 272 articles remained, 242 of which were excluded for the following reasons: 138 were not relevant, 25 were not comparative studies, and 22 were reviews/letters/comments. The 30 articles under consideration were reviewed in depth, and a full examination of the text was conducted. Eight studies that were meeting abstracts were excluded because the data for the outcomes of interest were not reported in the publication and we failed to make contact with the authors to obtain the outcomes. Four studies [3,22–24] were excluded because they were subsequent follow-up questionnaire analyses of previously reported series. Finally, two [24,25], two [26,27], and three [28–30] studies were performed by the same author, respectively; therefore, we chose the most informative and recent article or merged information from multiple publications (different publications that used the same study sample). Eventually, fourteen studies [25,27,28,31–41] matched the selection criteria and were suitable for the meta-analysis. These included 9 retrospective studies [25,27,31,34,35,37,39–41], 3 prospective nonrandomized studies [28,32,36] and 2 prospective randomized studies [33,38], with a combined total of 2249 subjects. Out of these subjects, 744 (33%) underwent SILA and 1505 (67%) underwent CLA. A flow diagram that details the literature search is shown in Fig. 1.

2.2. Study characteristics

The characteristics of these studies are summarized in Table 1. The study design was retrospective in 9 [25,27,31,34,35,37,39–41], prospective nonrandomized in 3 [28,32,36], and randomized in 2 studies [33,38]. The included studies were conducted in the USA, Europe and Asia, and were published between 2008 and 2014. The sample size ranged from 39 to 684 patients. Severe cases, identified by the presence of perforation, gangrene or abscess, were not included in four studies [25,34,37,41]. In some studies [27,28,31,37,38,40,41], the surgeon divided the peritoneal attachments to the appendix and cecum during laparoscopy and mobilized the appendix to the umbilicus in SILA. Then, the inflammatory appendix was exteriorized and an extracorporeal appendectomy was performed. In the groups of subjects who underwent SILA in the other studies [25,32–34,36,39], the mesoappendix and appendiceal base were ligated and then resected during laparoscopy. Next, the appendiceal specimen was removed through the single port in the abdominal wall; a retrieval bag may have been used. The two methods used to resect the appendix (SILA) were defined as “extracorporeal” and “intracorporeal”, respectively, and are presented in Table 2. The insertion of additional ports (one or two) was required in 64 (8.6%) of 744 SILA procedures, and the cases of conversion to open procedure are also presented in Table 2.

2.3. Primary outcomes

2.3.1. Total postoperative complications

All fourteen studies [25,27,28,31–41] reported the total number of postoperative complications after appendectomy. The incidence of postoperative complications was 6.5% (48 of 743 cases) for the SILA group compared with 7.5% (112 of 1495 cases) for the CLA group. A

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