Open Versus Laparoscopic Inguinal Herniotomy in Children: A Systematic Review and Meta-Analysis Focusing on Postoperative Complications

Shaoguang Feng, MSc,* Lingling Zhao, MSc,† Zhenqi Liao, MSc,‡ and Xiaoming Chen, MD*  

**Purpose:** There is an ongoing debate about whether laparoscopic or open herniorrhaphy (LH or OH) is the best choice for inguinal hernia in children. The aim of this study was to compare both of the surgical strategies as regards operative time, recurrence rate, postoperative complications by means of a systematic review, and meta-analysis of the available literatures.

**Methods:** A systematic search for randomized clinical trials comparing OH and LH was conducted. Studies were reviewed for quality, inclusion and exclusion criteria, operative time for bilateral and unilateral hernias, recurrence, and complications.

**Results:** Five randomized clinical trials with a total of 553 children (OH 278, LH 275) fulfilled the inclusion criteria and were analyzed in this review. Compared with OH, shorter operative time for unilateral hernias was noted in extraperitoneal approaches’ group (95% confidence interval (CI), –6.71 to –3.71; F = 0%) as well as for bilateral hernias (95% CI, –12.18 to –3.79; F = 82%). Besides, less total postoperative complications was found in LH group, especially for major postoperative complications in male children (95% CI, 0.01-0.78; F = 0%). However, no significant difference was observed between LH and OH in patients’ recurrence.

**Conclusions:** This meta-analysis favors LH in the repair of unilateral hernias and for unilateral hernias in extraperitoneal approaches’ group. Total postoperative complications were significantly reduced in LH, especially for major postoperative complications in male children.

**Key Words:** pediatric, inguinal herniotomy, meta-analysis, complications  
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As one of the most frequently performed surgical procedures in infants and children, herniotomy is the standard procedure for pediatric inguinal hernia (PIH) because of its high success rate and low rate of complications. Open herniotomy has been regarded as a standard treatment of repairing PIH as it was first introduced >50 years ago because of its lower mortality and lower rates of recurrence. However, recently, with the advancement of technology and instrumentation, laparoscopy and many other video-assisted surgical procedures are emerging in PIH. Laparoscopic hernia repair is a conventional technique performed in many pediatric surgery centers and there are plenty of reports representing various laparoscopic techniques. Numerous techniques and their modifications for ligation of the patent processus vaginalis (PPV) are widely applied in repairing PIH in recent years. According to the approaches to repair of the internal ring, the repairs can be classified into 2 broad categories: intraperitoneal and extraperitoneal approaches. The former contains intracorporeal looping or suturing, whereas the latter is performed by extracorporeal knotting/suturing.

As a new surgical procedure of repairing PIH, laparoscopic herniorrhaphy (LH) is considered as a relatively safe and effective technique due to its better cosmesis, faster recovery, less postoperative pain, and the ability to discover contralateral PPV hernias. However, it is still unclear whether LH can truly reduce the operative time, postoperative complications, and recurrence. Here, we performed a meta-analysis on total published randomized controlled trials (RCTs) to assess whether LH is superior to open herniorrhaphy (OH) in repairing PIH.

**METHODS**

**Data Sources**

We systematically searched PubMed for relevant studies reported from 2005 to 2014 with the keywords “laparoscopic herniorrhaphy”, “pediatric inguinal hernia,” and “open herniorrhaphy.” Total reference lists of selected articles were also included. We limited our searches to the publications written in English.

**Study Selection**

Our search was restricted to RCTs. Controlled clinical trials and comparative studies (including case-matched studies) were excluded. Eligibility criteria included total available studies comparing LH with OH for the repair of PIH. The children were younger than 18 years when they underwent LH or OH. The postoperative complications include postoperative vomiting, hydrocele, recurrence, iatrogenic ascent of the testis, testicular atrophy, scrotal edema, stitch granuloma, ugly scar and some of the complications are unique in male such as iatrogenic ascent of the testis and testicular atrophy. Two reviewers (S.F., Z.L.) screened the citation identified by the search strategy.
Data Extraction and Quality Assessment

The first author independently extracted data from the included studies. Details of publication (type of repairing the internal ring, trocars, and follow-up duration), inclusion and exclusion criteria, and demographics of the enrolled patients were collected and collated. Quality of the RCTs was assessed, including randomization, method of blinding, and allocation concealment.

Statistical Analysis

Review Manager (RevMan) software, version 5.3 was used for data statistical analysis. Weighted mean differences and odds ratios were used for the analysis of continuous and dichotomous variables, respectively. The confidence interval (CI) was established at 95%. Statistical heterogeneity in the meta-analysis was assessed with the $I^2$ test and the $F$ index. If the $F$ value was <50%, then a fixed-effects meta-analysis was applied; if the $F$ value was $\geq 50\%$, then a random-effects approach instead of a fixed-effect analysis would be undertaken.27

RESULTS

The initial search strategy identified 249 citations and 14 of them were retrieved for full-text review. Five trials met the total inclusion criteria and had no exclusion criteria (Fig. 1): Chan et al.28 Koivusalo et al.29 Celebi et al.30 Shalaby et al.31 and Saranga et al.32 The 5 selected trials included 553 participants. Two hundred and seventy-eight patients received OH and 275 received LH. Study details and the quality check of total RCTs are given in Tables 1 and 2, respectively.

Three of the 5 trials reported the operative time for children treated with unilateral laparoscopic and open inguinal herniotomy. The pooled data showed that there was no significant difference in operative time for children treated with unilateral hernias between laparoscopic and open group with unacceptably statistical heterogeneity ($F = 94\%$) (95% CI, −9.08 to 5.50; with 119 in the laparoscopic and 123 in the open group; Fig. 2A). However, in the subgroup where only RCTs used extraperitoneal approaches, the operative time for children treated with unilateral was significantly reduced in the laparoscopic group compared with the open group (95% CI, −6.71 to −3.71; $F = 0\%$; Fig. 2B). Three of the 5 trials reported the operative time for children treated with bilateral hernias, analysis of the pooled data revealed that the operative time of LH for bilateral hernia was significantly decreased compared with the open group (95% CI, −12.18 to −3.79; $F^2 = 82\%$; Fig. 3A), the results were consistent with the subgroups of RCTs of intraperitoneal approaches group versus open inguinal herniotomy in bilateral hernias (95% CI, −7.46 to −4.31; $F = 0\%$; Fig. 3B).

Total of 5 trials described the postoperative complications. The common postoperative complications of patients who underwent LH or OH included hydrocele, scrotal edema, erythema, testicular atrophy, iatrogenic ascent of the testis, recurrence, and so on. The pooled data showed that there was significant difference in total postoperative complications between laparoscopic and open

### TABLE 1. Study Details of Total Randomized Clinical Trials

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<th>Study Details of Total Randomized Clinical Trials</th>
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<td>Saranga et al</td>
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<td>Extraperitoneal approaches</td>
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FIGURE 1. Diagram of workflow in the systematic review.
group with acceptable statistical heterogeneity ($I^2 = 47\%$) (95% CI, 0.24-0.86; Fig. 4).

Two of the 5 trials reported the major postoperative complications for male patients treated with laparoscopic and open inguinal herniotomy such as scrotal edema, iatrogenic ascent of the testis, and testicular atrophy. The pooled data showed that there was significant difference in major postoperative complications for male patients between laparoscopic and open group (95% CI, 0.01-0.78; $I^2 = 0\%$; Fig. 5).

Total 5 trials compared the recurrence rate between LH and OH. The pooled data showed that there was no significant difference in postoperative recurrence rates between LH and OH (95% CI, 0.15-3.24; $I^2 = 2\%$; Fig. 6).

**DISCUSSION**

Inguinal hernia is a common problem among children, and herniotomy constitutes a major portion (> 15%) among pediatric surgical practice. Open herniotomy has been an excellent method of repair in pediatrics. However, the potential risks of it cannot be ignored, such as the injury of spermatic vessels or vas deferens, hematoma formation, iatrogenic ascent of the testis, testicular atrophy, and so on. In the recent years, LH has been emerged as a minimally invasive technique for PH. In our systematic review of high-level evidence, LH was found to be superior to OH with respect to a shorter time for unilateral hernias in extraperitoneal approaches group and for bilateral hernias. Despite no significant difference was observed regarding the recurrence, LH can be accepted as the standard of care as long as total postoperative complications was substantially reduced, especially for major postoperative complications in male children.

With the rapid development of laparoscopic techniques, minimally invasive procedures are becoming more and more popular in surgery. The number of minimally invasive procedures performed is still increasing with more hospitals in developing countries are adopting laparoscope in pediatric surgery. Advantages of LH may include excellent cosmesis, the ability to repair of contralateral PPV and reduction of potential harm to the vas deferens and testicular vessels, and decreased operative time especially in recurrent and obese children. However, Alzahem stated in his meta-analysis that he is unable to come to any clear conclusions about the comparison between LH and OH except for reduction in the development of metachronous hernia and shorter operative time for bilateral hernias.

Recently, a systematic review and meta-analysis was conducted by Yang et al who compared operative time, rate of metachronal contralateral hernia, and outcomes of LH and OH in infants with inguinal hernia. However, in our opinion, there are some shortcomings in their results. First, 2 comparative studies, 1 prospective and 1 retrospective studies were included, while there were 3 RCTs. Although, the study by Tsai et al was a prospective study, it was not randomized and is therefore at higher risk of bias. However, these studies did not change the results of the comparison of total complications between the OH and LH groups. Second, laparoscopic techniques may differ depending on the approach...
FIGURE 3. A, Forest plot comparing operative time for children treated with bilateral laparoscopic versus open inguinal herniotomy. B, Forest plot comparing operative time for the subgroups of randomized clinical trials of which intraperitoneal approaches’ group versus open inguinal herniotomy in bilateral hernias. CI indicates confidence interval.

![Forest plot comparing operative time for children treated with bilateral laparoscopic versus open inguinal herniotomy.](image)

![Forest plot comparing operative time for the subgroups of randomized clinical trials.](image)

FIGURE 4. Forest plot comparing total postoperative complications for children treated with laparoscopic versus open inguinal herniotomy. CI indicates confidence interval.

![Forest plot comparing total postoperative complications.](image)

FIGURE 5. Forest plot comparing major postoperative complications for male patients treated with laparoscopic versus open inguinal herniotomy. CI indicates confidence interval.

![Forest plot comparing major postoperative complications.](image)

FIGURE 6. Forest plot comparing recurrence rate for children treated with laparoscopic versus open inguinal herniotomy. CI indicates confidence interval.

![Forest plot comparing recurrence rate.](image)
(intraperitoneal or extraperitoneal) to repair of the internal ring and the number of ports, Chan et al., Koivusalo et al., and Celebi et al. adopted intraperitoneal approaches to repair of the internal ring and 3 trocars were applied in all the intraperitoneal approaches groups, whereas Shalaby et al. and Saranga et al. used extraperitoneal approaches to repair of the internal ring with a varying number of trocars. These are sources of bias that may weaken the results. Besides, it is important to note that every study has different standardized protocols for the time to resume full activity, which makes an objective comparison difficult. Furthermore, to our knowledge there is no systematic review or meta-analysis that described major postoperative complications in male children, which should be regarded as serious complications in male children.

In this systematic review we summarized total RCTs available in the pediatric surgical literature, focusing on operative time, postoperative complications, and recurrence. Our results show that LH is superior for the inguinal hernia repair in children, with shorter operative time for unilateral hernias in extraperitoneal approaches group as well as for bilateral hernias. Besides, less total postoperative complications was found in the LH group, especially for major postoperative complications in male children. Yet there is no significant difference regarding recurrences. However, on one hand, because of the limited number of patients and studies, more RCTs need to be conducted to confirm these findings; on the other hand, the learning curve in the 5 RCTs may play an underestimated role in the study, which may weaken the results of the comparison.

REFERENCES
