Laparoscopic extraperitoneal technique versus open inguinal herniotomy in children: historical controlled intervention study

Arada Suttiwongsing 1, Jirapon Khorana 2,3, Patchara Ruangwongroj 4,5, Korakot Niruttiwat 1

ABSTRACT

Objective To compare surgical outcomes of percutaneous extraperitoneal simple purse string method of laparoscopic hernia (LH) repair with a traditional open inguinal hernia (OH) repair in children with indirect inguinal hernia in a single center.

Methods This study is a historical-controlled intervention study of two groups of patients: patients in the controlled group had OH repair performed from January 2016 to December 2017, and patients in the study group had LH repair from January 2018 to December 2019 at a single institution. Outcomes of the OH and LH groups, in terms of operative time, recurrence, complications, incidence of metachronous contralateral inguinal hernia (MCIH) and contralateral patent processus vaginalis (CPPV) were analyzed.

Results Three hundred and five patients were enrolled in the study. Among them, 95 cases underwent laparoscopic percutaneous extraperitoneal closure herniotomy (LH group), and 210 cases underwent conventional open herniotomy (OH group). In terms of operative time, only unilateral herniotomy in females of the OH group was significantly less than that of the LH group (15.7±7.1 vs 20.5±7.4 min, p=0.004). No significant difference in overall complication was observed between the two groups of patients. The incidence of CPPV in the LH group was 15.7% (15/95), and MCIH in OH group was 10.9% (23/210).

Conclusions Laparoscopic herniotomy may prevent the need for a second operation of metachronous contralateral hernia. Both open and laparoscopic techniques are equivalent in pro and cons.

INTRODUCTION

Indirect inguinal hernia (IIH) is one of the most common surgical problems in infants and children. The incidence of right-sided hernia is more than two to three times that of left-sided hernia.1-3 Bilateral IIH can present with synchronous or metachronous contralateral inguinal hernia (MCIH). Incidence of MCIH ranges from 5% to 20%. In the past, many studies found that the risk factors for MCIH were preterm, gender (female) and initial left-sided IIH.4 Many pediatric surgeons performed exploration of the asymptomatic side in the high-risk group to avoid a second anesthesia and to reduce cost and chance of incarceration.5-9 However, negative exploration sometimes occurred, which was the potential risk of an unnecessary operation.

In 1990, laparoscopy was first used for diagnosis of contralateral IIH, and laparoscopic repair was introduced later with regard to intracorporeal repair in 1993 first described by Montupet and Esposito, as noted by Schier.10 11 The laparoscopic approach has been rapidly gaining popularity owing to its safety and efficacy. In addition, it also defines contralateral patent processus vaginalis (CPPV), which shows an open internal ring with an outpouching of peritoneum that

WHAT IS ALREADY KNOWN ON THIS TOPIC?

⇒ Many advantages of laparoscopic hernia repair were reported, and the greatest benefit of laparoscopy was to diagnose the presence of contralateral patent processus vaginalis accurately and then conduct repair in the same operation.

⇒ Laparoscopic surgery is known to be more costly due to the nature of the limited budget hospital; thus, is it worth doing laparoscopic surgery in pediatrict hernia repair?

WHAT THIS STUDY ADDS

⇒ The overall results of laparoscopic and conventional open hernia repair technique are equivalent. Both are good either way.

⇒ Most metachronous contralateral inguinal hernias occurred in the first 2 years after initial operation.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These results may help clinicians to provide information on surgical options for pediatric hernia repair and on a proper postoperative follow-up time for herniotomy.

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bulges into the inguinal canal on the asymptomatic side and allows repair of CPPV in the same operation. Many techniques of intracorporeal and extracorporeal repair have been developed. The extracorporeal techniques all involve the placement of a suture circumferentially around the internal ring and tying the knot using percutaneous technique, which is feasible with minimal dissection, with less complication and better cosmetic result compared with the traditional open approach.12-21

The aims of the current study were to compare surgical outcomes of percutaneous extraperitoneal simple purse string method of laparoscopic hernia (LH) repair with a traditional open inguinal hernia (OH) repair in children in a single center and to determine if doing LH repair in children is worthwhile.

METHODS

Study design

A historical-controlled intervention study was carried out in children aged less than 12 years who had gotten hernia repair operation from 1 January 2016 to 31 December 2019 in a single unit. Exclusion criteria included IH with undescended testis, irreducible incarcerated IH and strangulated IH. The patients were divided into two groups: (1) a historical-controlled group of patients who had an OH repair performed from 1 January 2016 to 31 December 2017, and (2) a prospective group of patients who had been undergoing laparoscopic extraperitoneal hernia repair from 1 January 2018 to 31 December 2019. Informed parental consent was obtained from the prospective groups.

Surgical procedure

All patients underwent standardized general anesthetic induction and maintenance. Some of the OH group had been inserted a laryngeal mask airway and/or had adjunct ilioinguinal nerve block. The anesthetic technique depended on an anesthesiologist. In the LH group, only the records of patients with ipsilateral pathology were reviewed to determine if MCIH occurred after 2 years postoperatively (they returned to have MCIH repairs at our hospital). All parents were advised to contact the department of pediatric surgery if there were any complications.

The medical records of all patients were analyzed by sex, age, initial side, presence of CPPV, presence of MCIH, operation time, recurrence and complications among the groups.

The measured outcomes were operative time, complications (such as wound infection, testicular atrophy and postoperative hydrocele), recurrence and incidence of MCIH in the OH group and CPPV in the LH group.

Sample size

The sample size of this study was calculated based on factors associated with significant outcomes (operative time) from previous studies22-24 using alpha=0.05 (two-sided test) and a power of 0.80, and the difference between two proportions. The study by Endo et al22 found that operative time of bilateral repair was shorter in the laparoscopic group (35.8±11.6 vs 46.7±17.7 min, p<0.001), which provided the number of approximate sample sizes in each group as 40.

Statistical analysis

Categorical data were reported as count and percent and were analyzed with Fischer’s exact probability test. Continuous data were reported as mean and SD or as median and IQR and were analyzed with the Student t-test or the Mann-Whitney U test as appropriate. The propensity score was generated as the probability of being assigned to laparoscopic or open herniotomy. It was calculated in the form of logit as a function of three factors (age, sex and bilaterality). The calculated propensity was then used by the inverse probability treatment...
weighting in the regression equation to identify the difference in operative time between the two treatment groups. A value of $p \leq 0.05$ was considered statistically significant.

**RESULTS**

**Patient characteristics**

Four hundred twenty-six patients were assessed for eligibility and were separated into two groups. In the OH group, 224 cases had hernia repair from 1 January 2016 to 31 December 2017, of which three were excluded based on the exclusion criteria and 11 received laparoscopic surgery. In the LH group, 202 cases had hernia repair operations during 1 January 2018 to 31 December 2019, of which 105 cases received open herniotomy, and 2 cases were excluded by exclusion criteria.

A total of 305 patients (210 cases in the OH group and 95 cases in the LH group) were then further analyzed. All patients in the LH group had successful laparoscopic surgery without conversion. In both groups, the median age at the time of initial operation was 3 years, and male gender was twice more than female gender. Distribution of right to left to bilateral hernia at time of initial presentation was 6:5:1 in the OH group and 4:3:1 in the LH group. Mean follow-up time was 33.1±5.7 months in the OH group and 23.7±0.7 months in the LH group, respectively. General characteristics were shown in **table 1**.

**Operative time**

Because of the referent group was the historical control, the propensity score weighting was done to reduce bias between groups. The result after the propensity score weighting methods showed that the mean of operative time in LH group was significantly longer than that in OH group in all cases ($p=0.013$). In the special group, the operative time of unilateral herniotomy in male and female patients was significantly longer in LH group than that in OH group (27.9±9.6 vs 24.5±11.5 min, $p=0.045$ and 20.5±7.4 vs 15.7±7.1 min, $p=0.004$, respectively). Although the mean operative time for bilateral hernia repair in male patients in LH group was quite less than that in OH group in practical terms, the difference was not statistically significantly (40.6±12.7 vs 43.3±7.9 min, $p=0.608$). The other group differences were also not significantly different.

**Postoperative complications and recurrence**

The OH group had complication rate of 1.9% (4/210) and 0% for recurrence, while those were 2.1% (2/95) and 1% (1/95), respectively, in the LH group ($p=0.681$ and $p=0.311$, respectively). Four cases in the OH group had complications, which were major complications as injury to spermatic element for one case and minor complication as mark swelling from seroma for 3 cases. Wound infection was not found in the OH group. For the LH group, two cases had complications—umbilical wound infection and development of postoperative hydrocele with spontaneous resolution. Recurrence was found in only one case in the LH group, while major complication as injury to the spermatic element was not found. Testicular atrophy was not found at all in both groups. However, there was no significant difference of overall complication and recurrence between the two groups.

**Metachronous IIH**

The incidence of MCIH in OH group was 10.9% (25/210), with 82.6% of MCIH occurring within 2 years after the initial side was diagnosed. A review of patient

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Laparoscopic group (n=95)</th>
<th>Open group (n=210)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), median (IQR)</td>
<td>3 (1–5)</td>
<td>3 (1–5)</td>
<td>0.856</td>
</tr>
<tr>
<td>Male gender, n (%)</td>
<td>62 (65.3)</td>
<td>146 (69.5)</td>
<td>0.507</td>
</tr>
<tr>
<td>Side, n (%)</td>
<td></td>
<td></td>
<td>0.444</td>
</tr>
<tr>
<td>Right</td>
<td>46 (48.4)</td>
<td>104 (49.5)</td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>37 (38.9)</td>
<td>89 (42.4)</td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>12 (12.6)</td>
<td>17 (8.1)</td>
<td></td>
</tr>
<tr>
<td>Complications, n (%)</td>
<td>2 (2.1)</td>
<td>4 (1.9)</td>
<td>0.681</td>
</tr>
<tr>
<td>Recurrence, n (%)</td>
<td>1 (1.0)</td>
<td>0 (0)</td>
<td>0.311</td>
</tr>
<tr>
<td>Operative time* (min), mean±SD</td>
<td>26.6±10.5</td>
<td>23.1±11.8</td>
<td>0.013</td>
</tr>
<tr>
<td>Unilateral herniotomy in male patient</td>
<td>27.9±9.6</td>
<td>24.5±11.5</td>
<td>0.045</td>
</tr>
<tr>
<td>Bilateral herniotomy in male patient</td>
<td>40.6±12.7</td>
<td>43.3±7.9</td>
<td>0.608</td>
</tr>
<tr>
<td>Unilateral herniotomy in female patient</td>
<td>20.5±7.4</td>
<td>15.7±7.1</td>
<td>0.004</td>
</tr>
<tr>
<td>Bilateral herniotomy in female patient</td>
<td>25.0±5.7</td>
<td>26.0±6.6</td>
<td>0.796</td>
</tr>
<tr>
<td>Follow-up time (min), mean±SD</td>
<td>23.7±0.7</td>
<td>33.1±5.7</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Operative time between laparoscopic group and open group after using the inverse probability treatment weighting of propensity score (propensity score created from the probability to choose the method of hernia repair with three parameters: age, sex and bilaterality).
records of MCIH developments 2 years after primary operation found that only female patients were returned to have MCIH repairs. The most likely predictors of developing MCIH were initial presentation with left sided IIH (p=0.007) and female gender (p=0.028). The characteristics of patients in the OH group who had MCIH are shown in Table 2.

### Table 2: Development of MCIH in open group

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients</th>
<th>Development of MCIH within 2 year</th>
<th>Development of MCIH total</th>
<th>Incidence of total MCIH (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>146</td>
<td>11</td>
<td>11</td>
<td>7.5</td>
<td>0.028</td>
</tr>
<tr>
<td>Female</td>
<td>64</td>
<td>8</td>
<td>12</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>Initial side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>104</td>
<td>6</td>
<td>6</td>
<td>5.8</td>
<td>0.007</td>
</tr>
<tr>
<td>Left</td>
<td>89</td>
<td>13</td>
<td>17</td>
<td>19.1</td>
<td></td>
</tr>
</tbody>
</table>

MCIH, metachronous contralateral inguinal hernia.

### Contralateral pathology

The incidence of CPPV in the LH group was 15.7% (15/95). The incidence of CPPV in patients who had initial presentation with left-sided IIH were found to be significantly higher than those who had right-sided presentation, (25.6% vs 10.9%, p=0.022). The characteristics of the patients in the LH group who had CPPV were shown in Table 3.

### Table 3: Presence of contralateral patent of processus vaginalis in laparoscopic group

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients</th>
<th>Presence of contralateral patent of processus vaginalis</th>
<th>Incidence (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>62</td>
<td>10</td>
<td>16.1</td>
<td>1.000</td>
</tr>
<tr>
<td>Female</td>
<td>33</td>
<td>5</td>
<td>15.2</td>
<td></td>
</tr>
<tr>
<td>Initial side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>46</td>
<td>5</td>
<td>10.9</td>
<td>0.022</td>
</tr>
<tr>
<td>Left</td>
<td>39</td>
<td>10</td>
<td>25.6</td>
<td></td>
</tr>
</tbody>
</table>

Contralateral inguinal hernia in children after unilateral repair ranges from 5.8% to 11.6%. The largest advantage of LH is to define and repair contralateral pathology while potentially preventing the need for a second operation that minimizes the likelihood of complications such as wound infection, hydrocele and testicular atrophy, were significantly higher in the OH group. However, there was no significant difference in overall complication rate between the two groups in our study. However, the accuracy of the result was limited by short follow-up time.
chance of incarceration of metachronous contralateral hernia.4–10,21 23–28

Before the era of LH repair, surgical management of contralateral groin remained controversial, and there were many studies about prediction of contralateral inguinal hernia in children.11–13 15–18 20–22 Contralateral exploration was a method to diagnose the presence of CPPV, but this technique may lead to spastic cord injury, testicular atrophy and wound infection. Contralateral laparoscopy could accurately diagnose the presence of CPPV. This study shows that incidence of presence of CPPV in the LH group is about 15% and that incidence of MCIH in the OH group is about 10%. However, the actual number of patients with MCIH development was unclear. The incidence was determined from medical records in only the cases who revisited for having MCIH repairs.

Regardless, many studies show that the incidence of developing MCIH is lower than that of CPPV.1 3 30 31 The relationship between presence of CPPV and subsequent development of contralateral inguinal hernia remains unknown, assuming that indirect hernias in adults start with asymptomatic peritoneal protrusion.32 33

We found the initial presentation with left-sided hernia to be a risk of presence of CPPV and development of MCIH. As regards gender, developing contralateral hernia was found to be significantly higher in females. We may interpret that in terms of preventing of developing a contralateral hernia, female patients who present with initial left-sided hernia are likely to benefit from LH more than other groups. But conversely, performing LH repair in unilateral disease in women may take longer operative time. Although the operative time was statistically different, it showed no more than 5 min in time different in every group, which had no clinical meaning.

Strengths of our study are to use extracorporeal techniques, which are uncomplicated but effective, and to apply equipment that is easy to find in basic operating room, which is feasible with minimal dissection with less complication so that patients in the LH group can have a successful laparoscopic operation without conversion. The study also has several limitations. There was some bias in the study design, and the groups were collected at different times and in different manners (retrospective vs prospective). To allow a reasonable comparison, we use the inverse probability treatment weighting of propensity score. The number of MCIH developments especially 2 years after the initial operation was reviewed in OH group from the records of patients who returned to have MCIH repairs which maybe inexact. The laparoscopic technique was performed by the same surgeon whose accumulated experience may have caused the one-sided result.

In the era of laparoscopic surgery, many operations have evolved from open technique to laparoscopic technique for a number of advantages. For pediatric hernia surgery, many studies reported that there is little difference in clinical outcomes23 24 28 29 between the two techniques. LH is still not clearly superior to OH. Therefore, the choice of surgical method depends on many factors, such as cost, endoscopic equipment availability of the hospital, and surgeon’s preference and expertise.

In conclusion, LH may prevent the need for a second operation of metachronous contralateral hernia. Both open and laparoscopic techniques are equivalent in pro and cons.

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Contributors AS contributed to conceptualization, methodology, resources, data curation, validation, formal analysis, data curation, software, investigation, writing (review), writing (original draft), project administration and editing and responsible for the overall content as the guarantor. PR contributed to formal analysis. KN contributed to the formal analysis and editing. JK contributed to writing (review), supervision and editing. All authors in the article contributed and approved the submission of the article.

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Competing interests None declared.

Patient consent for publication Written informed consent forms were taken from the parents of each participating child.

Ethics approval This study involves human participants and was approved by the ethical committee for research in human subjects of Chiangrai Prachanukroh Hospital (approval number: EC CRH 0038/62 ln).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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