Minimally Invasive Surgery for Orchidopexy in Children with Cryptorchidism: Reducing the Need for an Inguinal Incision

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Research Article

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Abstract

Background:
This study was to summarize our experience with minimally invasive surgery in the treatment of boys with cryptorchidism.

Methods

A retrospective study of laparoscopic orchidopexy (group A = 29) and laparoscopic ligation of the patent processus vaginalis (PPV) plus trans-scrotal orchidopexy (group B = 78) was conducted between July 2018 and July 2021.

Results

Seven patients had to be converted to trans-inguinal surgery in group A. In the remaining 22 patients, successful laparoscopic orchidopexy was performed. The discharge rate on post-operative day 1 was 93.5%, but there was no difference between the two groups (p > 0.05). The operative time of group B in bilateral cryptorchidism was significantly shorter than group A (p < 0.05), but there was no difference in the case of unilateral cryptorchidism (p > 0.05). There was no testicular retraction, testicular atrophy, inguinal hernia, or hydrocele during the follow-up period in both groups. Although the incidence of post-operative fever and poor wound healing in group B was higher than in group A, this was not statistically significant (p > 0.05).

Conclusion

Laparoscopic and trans-scrotal surgery are safe and effective methods for patients with cryptorchidism, reducing the need for trans-inguinal surgery.

Background

Cryptorchidism is a common congenital malformation found in 1.1–45.3% of preterm and 1.0–4.6% of full-term male neonates. Nearly 30% of cases are bilateral.[1] In most cases, the testes spontaneously descend over time, but 1.0–2.0% of boys will still have cryptorchidism at six months of age.[2] Cryptorchidism is a recognized risk factor for testicular cancer, infertility/sub-fertility, and testicular injury.[3, 4] Early management of cryptorchidism is needed to avoid progressive degenerative changes in the testes and subsequent infertility.

It is generally accepted that for palpable undescended testes, surgeons may perform orchidopexy using either an inguinal or scrotal incision,[5, 6] but inguinal orchidopexy may lead to inguinal scars and post-
operative pain. For non-palpable testes (NPT), the recommendation is evaluation under anesthesia followed by inguinal orchidopexy if the testes are palpable, or diagnostic laparoscopy followed by the appropriate surgery.[7, 8] Laparoscopic orchidopexy is favored by patients because of less trauma, and pain, faster recovery, and better cosmetic appearance. For the surgeon, the procedure facilitates investigation of the contralateral inguinal canal, and simultaneous ligation of the patent processus vaginalis (PPV), if present.

Male neonates diagnosed with cryptorchidism should be monitored till six months of age for spontaneous descent and then referred to a urologist for further work-up and management[9]. Hormone therapy has been tried to promote testicular descent in some pediatric patients, however, it is not recommended as first-line therapy. On the other hand, the surgical success rate in boys with cryptorchidism is 80–100%. [10] Various surgical methods have been effectively used to treat cryptorchidism.[11] We retrospectively analyzed our clinical data on cryptorchidism and present our experience with minimally invasive surgery in the treatment of boys with this condition.

**Materials And Methods**

This is a retrospective study of patients with cryptorchidism admitted to the Urology Department of the Sixth Affiliated Hospital of Sun Yat-sen University between July 2018 and July 2021. Inclusion criteria were patients less than 14 years of age whose testes were not located in the scrotum. Exclusion criteria were patients who were operated by the Fowler-Stephens orchidopexy technique or those with a previous surgical history of orchidopexy.

A total of 107 patients were included for analysis. As per protocol, all patients are re-examined under anesthesia and re-classified into palpable and non-palpable cryptorchidism. Laparoscopic exploration is performed for non-palpable cryptorchidism and in the case of abdominal cryptorchidism, laparoscopic orchidopexy is performed (Fig. 1). If cryptorchidism is non-abdominal and the PPV has closed, then inguinal surgery is performed. In the case of palpable cryptorchidism, laparoscopic ligation of the PPV is performed first. In case of high or middle cryptorchidism, laparoscopic orchidopexy is performed. For cryptorchidism where the testes are in a low position, trans-scrotal orchidopexy is performed (Fig. 2). The flow chart of surgical method selected is shown in Fig. 3. The operative methods are shown in supplementary Table 1.

All patients are managed peri-operatively as per the “enhanced recovery after surgery” (ERAS) protocol (Supplementary Table 2) [12] and are operated by pediatric urologists with over 30 years of surgical experience. All procedures are done with the consent of the legal guardian. Consent is also obtained pre-operatively for possible orchidectomy in the event of finding testicular atrophy on exploration.[13]

At follow-up at three months, six months, one year, and every two years, patients are evaluated for the presence of the following: testicular atrophy, testicular ascent, PPV, hernia, hydrocele, and other complications. The positions and sizes of both testes are also evaluated by color Doppler ultrasound at each follow-up.
The following data were extracted from the electronic medical records: age, operative method used, operation time, time of food intake after the operation, time for ambulation after surgery, duration of hospital stay, post-operative complications, if any, and if discharged on first post-operative day. The findings at follow-up were also recorded.

The study protocol was approved by the Ethics Committee of the Sixth Affiliated Hospital of Sun Yat-sen University and strictly adhered to the tenets of the Declaration of Helsinki (Code of Ethical approval for scientific research project: 2019 Ethical Scientific Research Approval No. 2004). In addition, all patients’ guardians signed an informed consent form before the operation.

**Statistical analysis**

All statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY, USA). The Kolmogorov–Smirnov test was used to verify the normality of continuous data. Continuous data were summarized using mean ± standard deviation (SD) or median (range) and analyzed using the student’s t-test and the Mann-Whitney U test, as appropriate. Categorical data were expressed as numbers and percentages and analyzed using the chi-square test. A p value < 0.05 was considered statistically significant.

**Results**

The clinical data of all patients are shown in Table 1. A total of 107 patients were included. These included 29 patients who underwent laparoscopic orchidopexy (group A) and 78 patients who had laparoscopic ligation of the patent processus vaginalis (PPV) plus trans-scrotal orchidopexy (group B). There was no difference in age, type of cryptorchidism, and number of PPV in the two groups. In group A, seven of 29 patients (6.5%) were converted to trans-inguinal surgery. Of these seven patients, four patients underwent orchidectomy because of testicular atrophy, whereas three underwent trans-inguinal orchidopexy.
Table 1
Baseline and post-operative characteristics of patients.

<table>
<thead>
<tr>
<th>Clinical data</th>
<th>Group A</th>
<th>Group B</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 29</td>
<td>N = 78</td>
<td></td>
</tr>
<tr>
<td>Age (years), median (range)</td>
<td>1.58 (0.5–8)</td>
<td>2 (0.5–12)</td>
<td>0.092</td>
</tr>
<tr>
<td>Type of cryptorchidism</td>
<td></td>
<td></td>
<td>0.153</td>
</tr>
<tr>
<td>Left</td>
<td>11</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>5</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>13</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Operative time (hours)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral cryptorchidism</td>
<td>1.4 ± 0.5</td>
<td>1.4 ± 0.5</td>
<td>0.892</td>
</tr>
<tr>
<td>Bilateral cryptorchidism</td>
<td>2.1 ± 0.4</td>
<td>1.5 ± 0.5</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Time for resumption of food intake after operation (hours), median (range)</td>
<td>1.5 (0.9–3.5)</td>
<td>1.7 (0.2–4.6)</td>
<td>0.306</td>
</tr>
<tr>
<td>Time for ambulation after surgery (hours), median (range)</td>
<td>3.7 (1.5–5.5)</td>
<td>3.5 (1.3–7)</td>
<td>0.577</td>
</tr>
<tr>
<td>Post-operative hospital stay (hours)</td>
<td>18.8 ± 10.8</td>
<td>18.2 ± 12.5</td>
<td>0.837</td>
</tr>
<tr>
<td>Discharge rate on post-operative day 1</td>
<td>27 (93.1%)</td>
<td>73 (93.6%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Duration of follow-up (years), median (range)</td>
<td>2.73 (0.6–3.7)</td>
<td>1.65 (0.7–3.7)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

The operative time of group B was significantly shorter than group A (p < 0.05) in patients with bilateral cryptorchidism. For patients with unilateral cryptorchidism, there was no difference between the two groups in operative time (p > 0.05). The time for resumption of food intake, time for ambulation after surgery, the post-operative hospital stay, and discharge rate on post-operative day 1 were comparable in the two groups (p > 0.05). The discharge rate on post-operative day 1 was 93.5% (100/107).

The number of ipsilateral, contralateral, and bilateral PPV in the various types of cryptorchidism is given in Table 2. As shown in Table 2, there was a significant difference in the type of PPV resulting from the three different cryptorchidism types (p < 0.001).
Table 2
PPV in different types of cryptorchidism

<table>
<thead>
<tr>
<th></th>
<th>Left cryptorchidism</th>
<th>Right cryptorchidism</th>
<th>Bilateral cryptorchidism</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPV</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Left</td>
<td>5</td>
<td>0</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>2</td>
<td>12</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>11</td>
<td>5</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>

The duration of follow-up in group B was significantly shorter than in group A (p < 0.05). No patients had testicular retraction or testicular atrophy. There was no significant difference in the incidence of postoperative fever and poor wound healing in the two groups (p > 0.05) (Table 3).

Table 3
Comparison of postoperative complications between the two groups

<table>
<thead>
<tr>
<th>Postoperative complications</th>
<th>Group A</th>
<th>Group B</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>29</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>Testicular retraction</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Testicular atrophy</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Postoperative fever</td>
<td>2 (6.9%)</td>
<td>4 (5.1%)</td>
<td>0.519</td>
</tr>
<tr>
<td>Poor wound healing</td>
<td>0</td>
<td>1 (1.3%)</td>
<td>0.729</td>
</tr>
</tbody>
</table>

Discussion

Cryptorchidism is a common condition in boys. The testes may continue to descend till six months of age after which the chances of spontaneous descent are very low. Children with undescended testis at six months of age should be operated before a year of age. Undescended testis is a well-known risk factor for testicular injury, infertility/sub-fertility, and testicular malignancy. Therefore, early management and regular follow-up and assessment in adolescents are necessary.

Surgery is the mainstay of treatment for cryptorchidism. The traditional method is trans-inguinal orchidopexy which is effective, and suitable for high inguinal testes. But this surgery has many disadvantages such as post-operative wound pain, scars at the incision site, and a potential second operation. Therefore, laparoscopic surgery has been widely used due to the benefits of better visualization, and the simultaneous opportunity for exploring and ligating the PPV without cutting the outer inguinal ring. Also, it is possible to dissect the spermatic vessels and vas deferens under direct visualization and to preserve the blood supply of the testes, so that it can be brought down into the scrotum, tension-free. However, laparoscopic surgery is not suitable in cases where the PPV has
already closed. In our study, seven patients in group A (laparoscopic orchidopexy) had to be converted to trans-inguinal surgery due to non-palpable testis combined with closed PPV.

Patients with cryptorchidism had a high incidence of PPV. PPV may lead to hydrocele or inguinal hernia. Recently, a meta-analysis revealed that laparoscopic orchidopexy has a similar results as compared with conventional orchidopexy, but with the opportunity for contralateral exploration in the case of PPV.[22] In this study, the incidence of PPV in unilateral and bilateral cryptorchidism was 74.5% and 81.7%, respectively. We used a simple method of ligating the PPV using an 18-gauge intravenous indwelling needle with a suture. No hydrocele or inguinal hernia occurred during the follow-up period in these patients.

A meta-analysis compared the clinical effects of trans-scrotal and trans-inguinal orchidopexy, and concluded that though the treatment effects were similar, trans-scrotal orchidopexy had less post-operative pain, better cosmetic results, and shorter operative time and hospital stay.[23] In this study, the operative time in cases of bilateral cryptorchidism in group B was shorter than in group A (P = 0.001), but there was no difference in the operative time in cases of unilateral cryptorchidism.

ERAS, which might lead to a shorter hospital stay for patients with colorectal surgery, was proposed by Henrik Kehlet in 1997.[24] In recent times, the ERAS protocol has also been applied to pediatric surgery.[25, 26] ERAS not only reduces the hospital stay but relieves peri-operative discomfort.[27] Song et al[28] implemented the ERAS protocol in the peri-operative period of pediatric patients with inguinal hernia and concluded that ERAS could reduce hospital stay, physical and psychological discomfort, and the incidence of complications. A meta-analysis of the ERAS protocol in pediatric patients undergoing gastrointestinal surgery revealed that ERAS hastened the recovery of gastrointestinal function, and decreased peri-operative infusions and hospital stay.[29] We applied the ERAS protocol to every patient successfully. Our discharge rate within the first postoperative day was 93.5%. All patients showed early resumption of food intake, early ambulation, and could be discharged early.

Postoperative fever was seen in a total of six patients in our study, and the possible reasons were surgical stress reaction or tracheal intubation. A recent study showed that for patients older than six months, undergoing lower abdominal surgery of short duration, a laryngeal mask airway could be used instead of tracheal intubation.[30] The incidence of respiratory complications can be reduced by shortening the operation time and reducing the use of tracheal intubation. All procedures in this study were performed by experienced surgeons. No testicular retraction, testicular atrophy, hypercapnia, or subcutaneous emphysema occurred during the follow-up period.

Our study has certain limitations. Firstly, it was a single-center retrospective study with a small sample size. Secondly, our follow-up period was short. Well-designed randomized controlled trials with long follow-ups are required to study the efficacy of minimally invasive surgical techniques in cryptorchidism.

**Conclusion**
laparoscopic and trans-scrotal surgery are safe and effective methods for patients with cryptorchidism, reducing the need for trans-inguinal surgery. Moreover, laparoscopic surgery has the advantage of simultaneously dealing with PPV.

**Declarations**

**Ethics approval and consent to participate**

This study was approved by the Ethics Committee of the Sixth Affiliated Hospital of Sun Yat-sen University (2020ZSLYEC-136) and strictly adhered to the tenets of the Declaration of Helsinki (Code of Ethical approval for scientific research project: 2019 Ethical Scientific Research Approval No. 2004). In addition, all patients’ guardians signed an informed consent form before the operation.

**Consent for publication**

Written informed consent was obtained from the patients’ legal guardians for publication of clinical data.

**Availability of data and materials**

The datasets supporting the results of this article are included within the article and also the datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors' contributions**

Qiang Guo wrote the paper. Qiang Guo, Xia Li, and WenWen Zhong conceived, designed, coordinated, and performed the study. Lei Ye, Bing Yao, Bo Ma and Hu Qu, ZhongYang Wang collected and analyzed the data, and revised the paper. JianGuang Qiu and DeJuan Wang guided the writing and critically reviewed the article for intellectual content. All authors reviewed the results and approved the final version of the manuscript.

**Acknowledgments**

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References


**Figures**

**Figure 1**

Laparoscopic orchidopexy for abdominal cryptorchidism. (a) Position of the trocar. (b) Abdominal cryptorchidism. (c) Dissected spermatic cord vessel and vas deferens with adequate length. (d) The testis dragged into the scrotum through the Hesselbach triangle. (e-f) Ligation of the inner ring by trocar with suture.
Figure 2

Laparoscopic high ligation of the PPV plus trans-scrotal orchidopexy. (a) The projection of the ligature exiting the internal inguinal ring. (b-e) Trocar with suture for the ligation of the right PPV and the effect after ligation. (f) The trans-scrotal incision for orchidopexy.
Figure 3

A flow chart for the selection of surgical approach in the study.

Supplementary Files

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- Supplementary.docx