Original Article



# Reasons and prevention strategies for recurrence of inguinal hernia in children after single-port laparoscopic percutaneous extraperitoneal closure

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**Background:** Postoperative recurrence of inguinal hernia in children is one of the most troublesome complications for surgeons, despite its low incidence rate. The aim of this study is to analyze the reasons for recurrence of inguinal hernia in children after single-port laparoscopic percutaneous extraperitoneal closure (SLPEC) and propose targeted prevention strategies.

**Methods:** A single-center, retrospective study was performed in children who were diagnosed with recurrent inguinal hernia and underwent laparoscopy between June 2016 and June 2023. Data collected included patient demographics, operative parameters and postoperative complications. The main outcomes of interest were to describe the reasons for recurrence of inguinal hernia in children after SLPEC and propose strategies to prevent postoperative recurrence.

**Results:** There were 21 males and 5 females, aged between 1 and 13 years old, with the recurrence occurred in 11 cases on the left side and 15 cases on the right, with a recurrence time of 20 days to 6 years after surgery. All patients were diagnosed with recurrent inguinal hernia after SLPEC and treated with laparoscopy again. The clinical manifestations of recurrence include 8 cases of inguinal hernia and 18 cases of hydrocele (hydrocele of the canal of Nuck). The reasons for postoperative recurrence include 7 cases of loose sutures, 17 cases of incomplete peritoneal ligation, 1 case of low ligation position and 1 case of expanded and weakened internal inguinal ring. Eighteen patients were treated with SLPEC again, and 8 patients were treated with SLPEC and additional medial umbilical flap reinforcement. All patients were followed up for 1 to 3 years after the second surgery and did not experience recurrence.

**Conclusions:** The recurrence rate of pediatric indirect inguinal hernia treated with SLPEC is low, but most of the recurrence reasons are avoidable. Improving surgical techniques and proficiency can reduce the postoperative recurrence rate of inguinal hernia treated with SLPEC.

**Keywords:** Inguinal hernia; children; recurrence; single-port laparoscopic percutaneous extraperitoneal closure (SLPEC)

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## Introduction

Laparoscopic high ligation of hernia sac is currently the main surgical method for the treatment of inguinal hernia in children, including laparoscopic intra-abdominal suture and ligation hernial ring and single-port laparoscopic percutaneous extraperitoneal closure (SLPEC) (1). The postoperative complications of inguinal hernia include bleeding, pain, and infection of the incision, edema or hematoma in the inguinal region, temporary hydrocele, rejection of sutures, and postoperative recurrence (2).

Postoperative recurrence of inguinal hernia is one of the most troublesome complications for surgeons, with a recurrence rate reported in literature of approximately 0.3% to 6.4% (3,4). Previous literature reported that the size of the inner ring diameter was an independent factor for the recurrence of inguinal hernia, and additional medial umbilical flap reinforcement was recommended to reduce the recurrence rate for huge internal rings (diameter >1.5 cm) (5).

In this study, the data of 26 patients diagnosed with postoperative recurrence of SLPEC admitted to the Department of Pediatric surgery, Qilu Hospital of Shandong University from June 2016 to June 2023 were analyzed, in order to explore the reasons for postoperative recurrence and propose targeted prevention strategies for postoperative recurrence. We present this article in accordance with the STROBE reporting checklist (available at https://ales.amegroups.com/article/view/10.21037/ales-25-3/rc).

### Highlight box

**Key findings**

- The reasons for recurrent inguinal hernia in children were identified with laparoscopy, and targeted prevention strategies were proposed.

**What is known and what is new?**

- It has been reported that the reasons for postoperative recurrence of inguinal hernia in children include loose suture and incomplete peritoneal ligation. Additional medial umbilical flap reinforcement was recommended to reduce the postoperative recurrence rate for huge internal rings.
- We found that low ligation position and expanded and weakened internal inguinal ring are also reasons for postoperative recurrence of inguinal hernia in children. Improving surgical techniques, such as redesigning ligation positions, improving knotting methods, and releasing pneumoperitoneum before knotting, can reduce the postoperative recurrence rate of inguinal hernia.

**What is the implication, and what should change now?**

- The majority of reasons for postoperative recurrence of inguinal hernia in children are avoidable human factors, and we should pay attention to surgical techniques and standardized procedures, in order to further reduce the postoperative recurrence rate.

## Methods

### *Study design*

This was a retrospective study of children diagnosed with postoperative recurrence of inguinal hernia and treated at the Department of Pediatric Surgery, Qilu Hospital (Qingdao) of Shandong University between June 2016 and June 2023. The laparoscopy was performed for all the patients with postoperative recurrence of inguinal hernia, identified the reasons of recurrence, and proposed targeted prevention strategies.

### *Clinical data*

Statistical data shows that a total of 1,729 children diagnosed with inguinal hernia treated with SLPEC in the Department of Pediatric Surgery, Qilu Hospital (Qingdao) of Shandong University between June 2016 and June 2023, with 26 patients of postoperative recurrence. The study was approved by the Ethics Committee of Qilu Hospital (Qingdao) of Shandong University (No. KYLL-KS-2023052). The study was conducted in accordance with the Declaration of Helsinki and its subsequent amendments, and individual consent for this retrospective analysis was waived. All patients were treated by surgeons from the same treatment group and similar surgical instruments and methods were used in the first surgery. We recorded videos during the first surgery of 25 patients, with at least two professional surgeons conducted video analysis to rule out significant operational errors before the second surgery.

### *Inclusion criteria*

All patients were treated with SLPEC in our department due to inguinal hernia in the first surgery. All patients were explored for bilateral processus vaginalis, and contralateral patent processus vaginalis was treated with simultaneous surgery. All patients were diagnosed as postoperative recurrence of SLPEC with physical examination and ultrasound examination. The clinical manifestation of recurrence was inguinal hernia or hydrocele (hydrocele of the canal of Nuck).

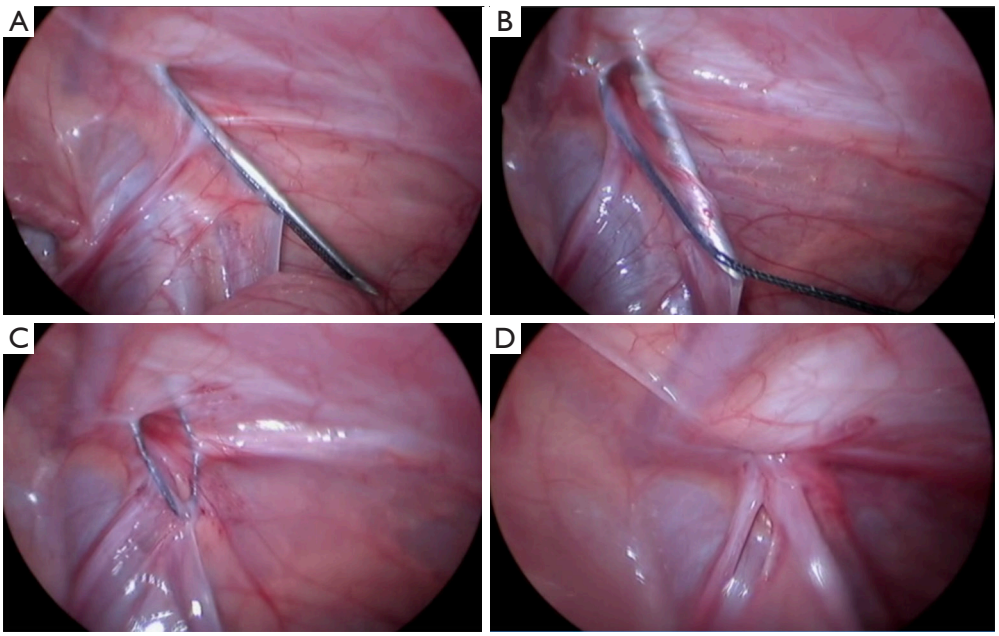


**Figure 1** Surgical procedure of single-port laparoscopic percutaneous extraperitoneal closure. (A) The hernia needle is punctured outside the peritoneum on the inner side of the inguinal ring, and then enters the abdominal cavity to loosen the suture. (B) The hernia needle is punctured outside the peritoneum on the external side of the inguinal ring and got into the abdominal cavity through the same puncture hole. (C) The closure suture is placed around the inguinal ring under the peritoneum. (D) Knot the suture and ligate the hernial ring.

### *Surgical procedure*

All patients were treated with SLPEC (*Figure 1*) in the first surgery. Only one 5-mm trocar was inserted through the umbilicus, and the diagnosis of inguinal hernia was confirmed by laparoscopy. We used only one hernia needle to operate.

The second surgery for all the 26 patients were laparoscopy, and the specific surgical procedure was determined based on the exploration results. A 5-mm trocar was inserted through the umbilicus, and the diagnosis was confirmed as postoperative recurrence of inguinal hernia. The reasons of the recurrence were analyzed. If the patient recurrent as hydrocele (hydrocele of the canal of Nuck) and the diameter of the inner ring was less than 1.5 cm, SLPEC will be performed again. If the patient recurrent as inguinal hernia or the diameter of the inner ring was more than 1.5 cm or the laparoscopy showed acquired inguinal hernia, additional medial umbilical flap reinforcement was recommended after SLPEC (*Figure 2*).

### *Follow-up and clinical evaluation*

During the follow-up, the duration of the surgery and surgical method were recorded. Symptoms such as incision bleeding, infection, pain, swelling of the surgical area, hydrocele, and postoperative recurrence were observed and recorded. One month after surgery, ultrasound examination was performed to determine the presence of hydrocele, recurrent inguinal hernia, or testicular abnormalities. Afterwards, all patients undergo regular outpatient or telephone follow-up every 6 months, with each patient being followed up for a maximum of 1 year after surgery. If there are surgical related complications, the patient or guardian will be informed to outpatient treatment timely.

### *Statistical analysis*

Categorical variables were presented as numerical values, fractions and percentages. We do not have a comparative analysis in this study.

## Results

There were 21 males and 5 females, aged between 1 and 13 years old, with the recurrence occurred in 11 cases on the left side and 15 cases on the right, with a recurrence

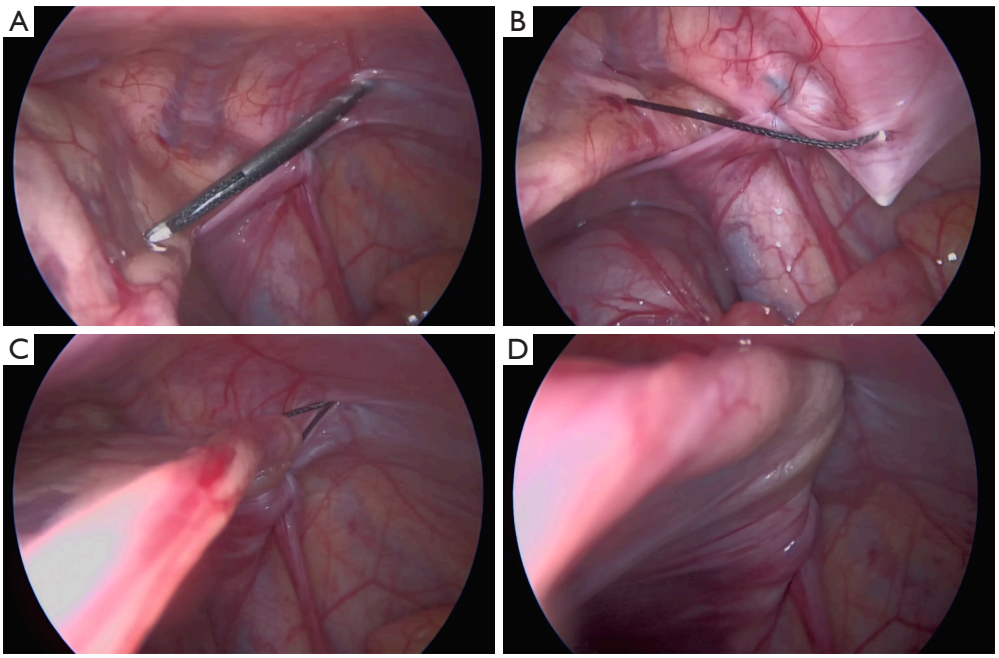


**Figure 2** Surgical procedure of medial umbilical flap reinforcement with hernia needle. (A) The hernia needle enters the abdominal cavity from the outer upper side of the ligated inguinal ring and punctures the medial umbilical fold. (B) The hernia needle enters the abdominal cavity from the outer lower side of the ligated inguinal ring and grabs the suture located on the inner side of the medial umbilical flap. (C) Pull the medial umbilical flap to cover the ligated inguinal ring. (D) Check the medial umbilical flap and the inguinal ring after knotting.

**Table 1** General clinical data of 26 patients

| Variables | Age (years) | | |
|---|---|---|---|
| | ≥1–<3 | ≥3–<6 | ≥6–≤13 |
| Gender | | | |
| Male | 6 | 6 | 9 |
| Female | 2 | 1 | 2 |
| First surgical site | | | |
| Left | 3 | 2 | 2 |
| Right | 2 | 3 | 5 |
| Bilateral | 3 | 2 | 4 |
| Recurrent site | | | |
| Left | 3 | 2 | 6 |
| Right | 5 | 5 | 5 |
| Postoperative recurrence time | | | |
| <3 months | 2 | 1 | 2 |
| 3 months–2 years | 4 | 6 | 7 |
| >2 years | 2 | 0 | 2 |

time of 20 days to 6 years after surgery (*Table 1*). All the 26 patients were diagnosed with postoperative recurrence of inguinal hernia after physical examination and ultrasound examination, and be treated with laparoscopy again. Patients with clinical manifestations of hydrocele (hydrocele of the canal of Nuck) were observed conservatively for at least 1 month, and continued while there was less fluid accumulation. If there was progressive increase in fluid accumulation or communicating hydrocele, surgery was recommended. In our statistics, one patient was diagnosed with recurrent inguinal hernia, but it was found to be a newly developed direct inguinal hernia during the second surgery, which was not included in the data of this study.

The clinical manifestations of recurrence include 8 cases of inguinal hernia and 18 cases of hydrocele (hydrocele of the canal of Nuck), and the reasons of recurrence include 7 cases of loose suture, 17 cases of incomplete ligation, 1 case of low ligation position, and 1 case of expanded and weakened internal inguinal ring (*Figure 3*).

The second surgery for all 26 patients was successful. Eight patients with inguinal hernia were treated with SLPEC and additional medial umbilical flap reinforcement, and 18 patients with hydrocele (hydrocele of the canal of

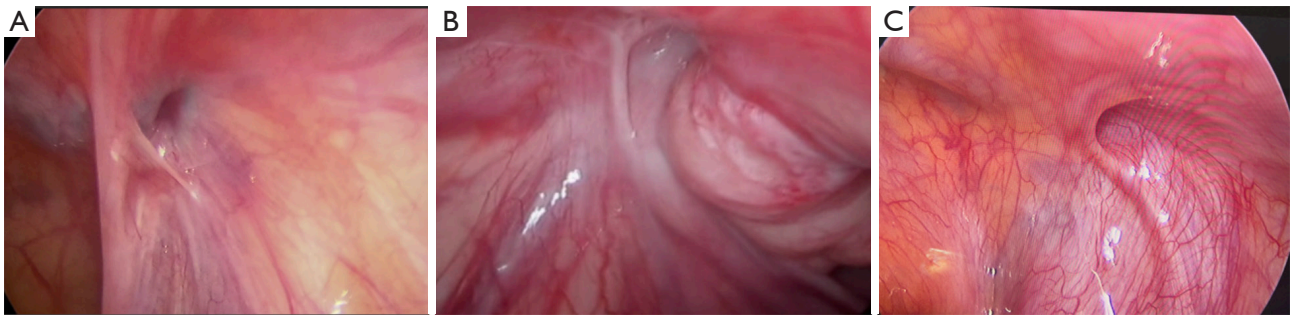


**Figure 3** Manifestations of recurrent inguinal hernia. (A) Recurrence caused by loose sutures. There is a complete ligation coil at the ligated inguinal ring, but there is a residual small inguinal ring at the center of the knot. (B) The manifestation of acquired inguinal hernia. A new hernia sac is formed next to the ligated inguinal ring, which enters the inguinal canal from the outer side of the inferior epigastric artery. (C) The position of the inguinal ring ligation is too low, resulting in small residual hernia sac.

Nuck) were treated with SLPEC.

All patients were followed up for 1 to 3 years after surgery without losing follow-up. Thirteen patients experienced mild pain at the puncture site during the 1-month postoperative follow-up, which improved significantly within 6 months. Nine patients developed temporary hydrocele after surgery, with a depth of less than 1 cm. Follow-up observations showed that the effusion was self absorbed within 6 months. All patients did not experience postoperative recurrence of inguinal hernia, no discomfort in the lower abdomen during urination, and no complications such as incisional hernia, incision infection, or rejection of sutures.

## Discussion

Due to the widespread use of hernia needle, SLPEC is currently mainly used to the treatment of pediatric inguinal hernia (6-8). We have been performing SLPEC except for partial incarcerated hernias and sliding hernias that accepting open surgery since 2016. Therefore, this article mainly analyzes the reasons for postoperative recurrence of inguinal hernia in children after SLPEC.

The clinical manifestation of recurrent hernia is recurrent inguinal or scrotal (labial) masses, with recurrence forms including inguinal hernia or hydrocele (hydrocele of the canal of Nuck). The recurrence rate reported in literature was approximately 0.3–6.4% (3,4). Within our statistics, 2 patients with recurrent hernia did not treat in our department for the second surgery, and the recurrence rate of SLPEC in our department between June 2016 and June 2023 was 1.6% (28/1,729).

In our cohort, the reasons of recurrent hernia include loose suture (7/26, 26.9%), incomplete peritoneal ligation (17/26, 65.4%), low ligation position (1/26, 3.8%) and expanded and weakened internal inguinal ring (1/26, 3.8%). The manifestation of loose suture is manifested as a complete ligation coil at the ligated inguinal ring, but there is a residual small inguinal ring at the center of the knot (9). It mainly occurs in obese children and high pneumoperitoneum pressure during surgery, which make it difficult to perform tension knotting. Seven patients with recurrence were due to this reason, all presenting as hydrocele (hydrocele of the canal of Nuck), including 6 patients with thick subcutaneous fat and 1 patient with excessive pneumoperitoneum pressure during surgery. Incomplete peritoneal ligation is mainly caused by the difficulty in separating the peritoneum from the vas deferens or by inexperienced operation (10). Part of the peritoneum is missed or torn, resulting in incomplete ligation of the inguinal ring. Ergun chose to skip partial peritoneum without ligation in the surgery for difficult separation of the vas deferens (11). Although the postoperative recurrence rate was similar to other literature, incomplete peritoneum ligation was the main reason of recurrence in the cases we analyzed, and this surgical procedure may not be advisable. The low ligation position is a human factor, and a small residual hernia sac may remain during surgery. One patient in our cohort experienced recurrence due to this reason, and recurrence after vigorous-intensity activities. The expanded and weakened internal inguinal ring may lead to acquired inguinal hernia, which mainly occurs in cases of huge inguinal ring. The hernial contents can protrude around the original ligation, particularly where there is a lack of muscle, and a new hernia sac is formed next to the ligated inguinal ring, which enters the inguinal canal from

the outer side of the inferior epigastric artery.

Direct inguinal hernia on the affected side may also be misdiagnosed as recurrent inguinal hernia, which is clinically rare, especially pantaloon hernia and direct inguinal hernia with a wide neck and shallow hernia sac, which are most easily overlooked (12). In our statistics, one patient was diagnosed with recurrent inguinal hernia, but it was found to be a newly developed direct inguinal hernia during the second surgery. Although this does not belong to postoperative recurrence of SLPEC, it suggests that we need to improve the understanding of pediatric direct inguinal hernia.

The learning curve of laparoscopic surgeons was found to be related to postoperative recurrence of inguinal hernia (13). The recurrence rate of SLPEC in our department was 3.6% (19/527) before 2019, and 0.74% (9/1,202) since 2019, which may be related to the implementation of this technology by three inexperienced surgeons. During the surgery, there were more cases of missing of partial peritoneal and loose suture, but the recurrence significantly decreased after a period of practice. Female patients who do not need to avoid the round ligament of the uterus during surgery can be selected in the early stage, and male or patients with complex inguinal hernia can be carried out after the technology is mature.

Improving surgical techniques is also an important measure to reduce the recurrence rate. Firstly, the position of the inguinal ring ligation can be slightly tilted upwards by 5-10 mm, which can avoid missing the peritoneum above the hernia ring and avoid recurrence caused by the low ligation position. Secondly, in order to avoid the damage to the vas deferens, auxiliary instruments or double hernia needles can be used for complex inguinal hernia, rather than pursuing single-port laparoscopic surgery. Haveliwala believes that the use of double hernia needles was a significant related factor in reducing postoperative recurrence rate (14). Thirdly, improve the method of tying knots. We suggest releasing the $CO_2$ pneumoperitoneum before knotting, and pressing the knot with fingertips or using a suitable knotter to tie the knot, which can avoid loose suture, and we can reestablish the pneumoperitoneum to check if the knot is firm at last. Fourthly, if the diameter of the inner ring was more than 1.5 cm, we can perform additional medial umbilical flap reinforcement after SLPEC, or use double suture ligation of the hernia ring. Yağız used a new laparoscopic direct ligation of the inner ring with the medial umbilical fold in 35 cases of pediatric indirect inguinal hernia, and the medial umbilical fold and most of the peritoneum at the inner ring were ligated simultaneously (15). Although no recurrence occurred, partial peritoneum was missed during the surgery, and the long-term effect needs further verification.

## Conclusions

Although the recurrence rate of inguinal hernia in children after SLPEC is low, the possible reasons of recurrence should still be taken seriously. Possible reasons of recurrence include improper intraoperative operation, insufficient understanding of surgical concepts, as well as non-human factors such as special types of recurrence, with the majority being avoidable. We should enhance our understanding of the surgical philosophy for inguinal hernia, pay attention to surgical techniques and standardized procedures, in order to reduce the recurrence rate of SLPEC. Personalized analysis should be conducted on cases diagnosed with postoperative recurrence of SLPEC, and the surgical method should be developed based on the reasons of recurrence.

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## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://ales.amegroups.com/article/view/10.21037/ales-25-3/rc

*Data Sharing Statement:* Available at https://ales.amegroups.com/article/view/10.21037/ales-25-3/dss

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was

conducted in accordance with the Declaration of Helsinki and its subsequent amendments. The study was approved by the Ethics Committee of Qilu Hospital (Qingdao) of Shandong University (No. KYLL-KS-2023052) and individual consent for this retrospective analysis was waived.



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