

Received: 2019.01.29  
Accepted: 2019.02.24  
Published: 2019.06.16

# Single-Site Laparoscopic Percutaneous Extraperitoneal Closure of the Internal Ring Using an Epidural Needle for Children with Inguinal Hernia

Authors' Contribution:  
Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

BCDEF **Jian-qin Zhang\***  
BCDEF **Qi-liang Zhang\***  
BCD **Liu Chen**  
BCD **Yu Lin**  
BCD **Yun-jin Wang**  
BCD **Dian-ming Wu**  
ABCDEF **Chao-ming Zhou**

Department of Pediatric Surgery, Fujian Provincial Maternity and Children's Hospital, Fuzhou, Fujian, P.R. China

\* Jian-qin Zhang and Qi-liang Zhang contributed equally to this study and share first authorship  
Chao-ming Zhou, e-mail: [sfyzhouchaoming@163.com](mailto:sfyzhouchaoming@163.com)  
Departmental sources

**Corresponding Author:**  
**Source of support:**

**Background:** This study evaluated the safety and effectiveness of single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle for children with inguinal hernia.





**Material/Methods:** We retrospectively analyzed clinical data of 542 children with inguinal hernia who underwent single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle at our hospital from June 2014 to June 2017.

**Results:** All patients successfully underwent surgery and none were converted to conventional surgery. Abdominal vascular injury, vasectomy injury, testicular vascular injury, umbilical hernia, iatrogenic cryptorchidism, testicular atrophy, hydrocele, hernia recurrence, and scrotal edema were not reported during the perioperative period. A follow-up of these patients was performed for 12–24 months. During the follow-up period, umbilical hernia, iatrogenic cryptorchidism, testicular atrophy, and hydrocele were not noted, but 3 cases of hernia recurrence were found.

**Conclusions:** The single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle for children with inguinal hernia is safe and effective, and this procedure has the advantages of minimal trauma, no scarring, and good cosmetic effect.

**MeSH Keywords:** **Hernia, Inguinal • Laparoscopy • Surgical Procedures, Minimally Invasive**

**Full-text PDF:** <https://www.medscimonit.com/abstract/index/idArt/915430>

 2350  4  —  25



## Background

Inguinal hernia is a common disease in pediatric surgery, and is usually treated with either traditional open surgery or laparoscopic surgery [1]. The traditional high ligation of the hernia sac was the standard method to treat pediatric indirect hernia. The surgical technique was simple and the effect was accurate, but the surgical wound was large, the scar was obvious, and there were many complications [2–5]. With the maturity and progress of surgical techniques and the development of surgical instruments, as well as the needs of patients for aesthetic incision and early postoperative recovery, minimally invasive surgery has become increasingly popular in various fields [3–8]. In recent years, single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle has been widely and successfully applied in China and elsewhere, and good therapeutic effect has been obtained [9–13]. However, the literature contains few large clinical controlled studies. The present study retrospectively analyzed the clinical data of 1102 patients with inguinal hernia treated in our hospital from June 2014 to June 2017, in order to summarize the clinical experience and evaluate the safety and effectiveness of high ligation of single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle.

## Material and Methods

This study was approved by the Ethics Committee of our university and strictly adhered to the tenets of the Declaration of Helsinki. All patients' guardians signed an informed consent form before the operation.

### Patients

We retrospectively analyzed the clinical data of 1102 children with inguinal hernia. According to the operation mode, the patients were divided into 2 groups: a single-site laparoscopic group (group A, n=542) and a conventional operation group (group B, n=560). All preoperative clinical data are shown in Table 1. There were no statistically significant differences in gender, unilateral or bilateral, age (median and range, group A: 1.8 years, 11 months to 8.5 years, group B: 1.7 years, 10 months to 9.0 years), and body weight (group A: 12.0 kg, 8.0 to 19.6 kg, group B: 13.2 kg, 7.8 to 21.2 kg) distribution among these 3 groups, indicating that the 2 groups were homogeneous and comparable. According to the clinical manifestation and physical examination, all patients were positively diagnosed with an inguinal hernia. A routine clinical examination was performed before the operation, including an electrocardiogram, chest radiography, and blood examination. All patients were followed up for 12 to 24 months, with a median follow-up time of 15 months.

**Table 1.** Comparison of preoperative clinical data in both groups.

Item	Group A	Group B	P value
Number of patients	542	560	
Age (years)	2.0±1.3	2.1±1.6	0.735
Boys/girls	452/90	458/102	0.951
Body weight (kg)	12.8± 2.6	13.5±3.2	0.854
Unilateral/Bilateral	352/190	435/115	0.943

Patients met the inclusion criteria if they presented with an isolated inguinal hernia. Patients were excluded from this study if they: 1) had other congenital deformities, such as cryptorchidism or hydrocele; 2) had an incarcerated hernia; 3) had a recurrent inguinal hernia; or 4) refused to sign the consent form for surgery or refused to comply with the follow-up schedule.

### Single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle

After anaesthetization, the patient was placed in a supine position with the waist slightly raised using a cushion, and then we routinely disinfected and draped the surgical area. The umbilical skin was incised approximately 0.5 cm layer by layer, and a 5-mm trocar was placed directly into the abdomen to establish a pneumoperitoneum (12 mmHg). Then, we explored whether the bilateral inguinal canal was closed. Under the guidance of a laparoscope, the skin was punctured at the unclosed side of the skin by the needle of a No. 12 syringe, and the epidural puncture needle with double-stranded 2-0 thread was punctured into the anterior wall of the inguinal tube through the anchor point. We performed a sharp separation of the outer half-circle of the inner ring mouth at the extraperitoneal space and pulled the puncture needle out after the coil was pressed by the laparoscope. The epidural puncture needle was pierced into the front wall of the inguinal tube again through an anchor point with a double-stranded 2-0 thread. After sharply separating the inner half-circle of the inner ring mouth at the extraperitoneal space, the epidural puncture needle was pierced through the center of the original coil. We also used the laparoscope to press the coil and remove the puncture needle before tightening the front coil. The pierced coil was removed to bring out the second one. One of the double strands was drawn out, and then we gradually tightened the coil with the inner ring until it closed under the laparoscope. Finally, we tied a knot under the skin. If neither side of the inner ring was closed, the other side was treated the same way. After closing the inner ring, we carefully checked the abdominal cavity for bleeding, released the peritoneal gas, and removed the trocar before suturing the umbilical incision.

If the abdominal cavity was very deep or there were many peritoneal folds at the inner orifice and it was difficult to puncture over the deferent duct, we injected normal saline through the puncture needle to increase the gap between the peritoneum and the deferent duct. Alternatively, a 3-mm incision can be made next to the umbilical cord to place grasping forceps for assistance. Eighteen cases were assisted by hydrodissection and 39 cases were assisted by grasping forceps.

### Conventional operation

After anaesthetization, the patient was placed in supine position with the waist slightly raised using a cushion. A 1.5- to 2-cm incision parallel to the inguinal ligament was made at the midpoint of the inguinal ligament. The skin and subcutaneous tissue were cut layer by layer, and the aponeurosis of the ventral oblique muscle was opened and dissociated and then separated to the outer ring. After opening the outer ring and finding the hernia sac, we cut the anterior wall of the hernia sac. If there were no contents, we transected the posterior wall, and then striped the tissue around the proximal hernia sac to the extraperitoneal fat. We ligated the hernia sac twice and sutured it once with No. 1 thread to perform high ligation of the hernia sac. After hemostasis, the surgical incision was sutured layer by layer.

### Statistical analysis

Continuous data are presented as mean  $\pm$  standard deviation and range. Clinical parameters between the 2 groups were compared with the independent-samples t test and the  $\chi^2$  or Fisher's test for categorical variables. A p value of  $<0.05$  was defined as statistical significance.

## Result

All patients successfully underwent surgery and none were converted to conventional surgery. The operation time was 14 to 45 min (unilateral  $20.4 \pm 5.2$  min, bilateral  $31.2 \pm 4.8$  min). The amount of bleeding was 1 to 3 ml ( $1.2 \pm 0.2$  ml). The duration of hospital stay was from 1 to 2 days ( $1.1 \pm 0.3$  days).

Of the patients who underwent single-site laparoscopic surgery, some experienced minor complications, including poor wound healing and pain or discomfort in the groin area. These complications were treated via medication or resolved spontaneously. No abdominal vascular injury, vasectomy injury, testicular vascular injury, umbilical hernia, iatrogenic cryptorchidism, testicular atrophy, hydrocele, hernia recurrence, or scrotal edema were reported during the perioperative period. The overall follow-up period ranged between 1 and 2 years, and during the follow-up period, no cases of umbilical hernia,

**Table 2.** Comparison of perioperative clinical data in both groups.

Item	Group A	Group B	P value
Operative time (min)			
Unilateral	20.4 $\pm$ 5.2	19.3 $\pm$ 4.7	0.874
Bilateral	31.2 $\pm$ 4.8	29.1 $\pm$ 5.2	0.851
Amount of bleeding (ml)	1.5 $\pm$ 0.3	2.1 $\pm$ 0.6	0.614
Postoperative hospital stay (d)	1.1 $\pm$ 0.3	1.3 $\pm$ 0.3	0.961
Hospital costs (1000 RMB)	8.1 $\pm$ 1.8	5.0 $\pm$ 1.6	0.048
The incision length (cm)	0.6 $\pm$ 0.2	2.3 $\pm$ 0.8	0.030
Transfer to conventional surgery	0		

**Table 3.** Postoperative complications comparison between 2 groups.

Item	Group A	Group B	P value
Abdominal vascular injury	0	0	
Vasectomy injury	0	0	
Testicular vascular injury	0	0	
Testicular atrophy	0	0	
Umbilical hernia	0	0	
Iatrogenic cryptorchidism	0	0	
Scrotal edema	0	0	
Hydrocele	0	18	0.000
Hernia recurrence	0	0	
Poor wound healing	2	5	0.274
Pain and discomfort in groin area	2	13	0.005

iatrogenic cryptorchidism, testicular atrophy, hydrocele were noted, but 3 cases of hernia recurrence appeared.

Table 2 shows the high successful closure rate in both groups, with no significant difference among the clinical parameters between the 2 groups ( $P > 0.05$ ), indicating that the surgical outcomes of the 2 surgical procedures were similar. Although the cost of hospitalization in the laparoscopic group was higher than with the traditional operation group, the incision length was significantly shorter ( $P < 0.05$ ). As shown in Table 3, there were no cases of abdominal vascular injury, vasectomy injury,

**Table 4.** Follow-up period comparison between 2 group of patients.

Item	Group A	Group B	P value
The length of scar (cm)	0.1±0.1	2.4±0.7	0.022
Occult hernia on contralateral side	0	10	0.002
Hernia recurrence	3	5	0.507
Umbilical hernia	0	0	
Testicular atrophy	0	0	
Iatrogenic cryptorchidism	0	0	
Scrotal edema	0	0	

testicular vascular injury, umbilical hernia, iatrogenic cryptorchidism, testicular atrophy, hydrocele, hernia recurrence, or scrotal edema after surgery in either group. In the conventional operation group, there were more scrotal edema and groin traction pain, and the difference was statistically significant ( $P < 0.05$ ). Table 4 shows that there were no significant differences during the follow-up time evaluations between the 2 groups ( $P > 0.05$ ), indicating that significant between-group differences did not exist with regard to early and mid-term efficacy. The incidence of surgical scarring and contralateral occult hernia was significantly higher in the conventional surgery than in the laparoscopic surgery ( $P < 0.05$ ).

## Discussion

Inguinal hernia is one of the most common congenital diseases of children, occurring in 1% to 2% of mature infants and in up to 30% of preterm infants [14,15]. Surgical methods include traditional open surgery and laparoscopic surgery. The traditional operation requires dissecting the inguinal canal, which has many problems, such as injury to the spermatic vessels, deferent duct, nerves, and levator muscles, and the incidence of complications such as scrotal edema and poor wound healing is high after the operation due to the free spermatic cord and hernial sac [2–5]. Perlstein reported that 2.3% to 15% of patients have testicular dysplasia, atrophy, or even iatrogenic cryptorchidism [16]. However, laparoscopic surgery does not require dissecting the inguinal canal and free hernia sac, which helps ensure physiological integrity of the inguinal canal, and the laparoscopic visual field is clear and magnified, which can clearly expose the inner ring and its surrounding tissue, avoiding injury to the spermatic cord and deferent duct during surgery [17–19]. In the present study, although there were no complications of deferent duct injury, testicular vascular injury, iatrogenic cryptorchidism, or testicular atrophy in the traditional

surgery group, the incidence of edema of scrotum and poor wound healing was significantly higher in the traditional surgery group than in the single-hole laparoscopic group ( $P < 0.05$ ).

Bilateral hernia and occult hernia in children are very common, and the incidence of occult hernia was 21% according to Zhou [20]. Steinau reported that 5% to 10% of children with unilateral hernia have a contralateral oblique hernia after surgery [21], and Shalaby and Bertozzi both reported that about 10% to 20% of patients diagnosed with unilateral inguinal hernia before surgery were found to have a contralateral occult hernia during the laparoscopic operation [22,23]. In the present study, 46 patients in the laparoscopic group who were diagnosed with a unilateral inguinal hernia before surgery were found during the exploration to have a contralateral inner ring that was not closed, and 10 patients in the conventional group were found to have an occult hernia on the contralateral side during the follow-up period, which required a second operation. Laparoscopic surgery can simultaneously explore the situation of the bilateral inner ring, so the children with contralateral occult hernia could be treated simultaneously without the need of additional surgical instruments and costs. The injury to children was also very small and had no effect on postoperative recovery, which avoided the injury and cost of a second operation. Hernia recurrence is a complication of conventional surgery and laparoscopic surgery, and it is reported that the recurrence rate of hernia in conventional surgery and laparoscopic surgery is 0% to 6% [24]. High ligation of the hernia sac is an effective method for treating pediatric inguinal hernia, and the therapeutic effect was closely related to the high degree of ligation. Laparoscopic high ligation of hernia sac was performed at the orifice of the inner ring, which realized the true sense of high ligation. The causes of recurrent hernia after laparoscopic surgery include incomplete peritoneal ligation and accidental slippage of the ligation knot [25]. Therefore, the position of the ligation must be high enough, the ligation line must be complete for a circle, and the suture should be tightened securely so as to avoid recurrence of the hernia due to the remaining space.

Single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle only requires placing the laparoscope into the abdominal cavity and use simple puncture technology and knot, without special laparoscopic suture technology, which is very simple and easy to master. Although it is less invasive and easier to perform, the following guidelines should be followed during the operation. First, before the operation, patients should empty their bladder to avoid affecting the visual field exposure, the space for operation, and injury to the bladder. Second, make full use of the laparoscopic lens to push and press the peritoneum around the inner ring to assist proper placement of the needle, and this is key to a successful operation. Third, the needle must be placed between the abdominal transverse fascia and the peritoneum.

Fourth, squeeze out the gas and fluid in the hernia sac when tightening the suture to avoid accumulation of gas and fluid in the hernia sac after the operation. Fifth, pull the skin slightly when tying the knot to avoid ligation of the dermis, leading to a linear response after the operation. These guidelines will help obtain good clinical results. All the patients in the present study underwent laparoscopic surgery successfully, and none of them had to be converted to open surgery. No umbilical hernia, iatrogenic cryptorchidism, testicular atrophy, or hydrocele were found after the operation or during the early follow-up period. The single-site laparoscopic operation had the same safety and effectiveness as the conventional operation, and was superior to the conventional surgery in the cosmetic effect and the discovery and treatment of contralateral occult hernias. Although the cost of single-site laparoscopic operation is higher, it is still generally affordable to families.

Although this retrospective study had a large sample size, there are still several limitations. First, this was a single-center study, and more research from multiple centers is needed to assess the effectiveness and complications of this technique. Second, the follow-up period was short, and studies with longer follow-up are needed.

## References:

1. Lau WY: History of treatment of groin hernia. *World J Surg*, 2002; 26(6): 748–59
2. Steigman CK, Sotelo-Avila C, Weber TR: The incidence of spermatic cord structures in inguinal hernia sacs from male children. *Am J Surg Pathol*, 1999; 23: 880–85
3. Read RC: Recent advances in the repair of groin herniation. *Curr Probl Surg*, 2003; 40: 13–79
4. Chan KL, Hui WC, Tam PK: Prospective randomized single-center, single-blind comparison of laparoscopic vs. open repair of pediatric inguinal hernia. *Surg Endosc*, 2005; 19(7): 927–32
5. Parelkar SV, Oak S, Gupta R et al: Laparoscopic inguinal hernia repair in the pediatric age group experience with 437 children. *J Pediatr Surg*, 2010; 45(4): 789–92
6. Harrison MR, Lee H, Albanese CT, Farmer DL: Sub-cutaneous endoscopically assisted ligation (SEAL) of the internal ring for repair of inguinal hernias in children: A novel technique. *J Pediatr Surg*, 2005; 40: 1177–80
7. Patkowski D, Czernik J, Chrzar R et al: Percutaneous internal ring suturing: A simple minimally invasive technique for inguinal hernia repair in children. *J Laparoendosc Adv Surg Tech A*, 2006; 16: 513–17
8. Bharathi RS, Arora M, Baskaran V: How we “SEAL” internal ring in pediatric inguinal hernias. *Surg Laparosc Endosc Percutan Tech*, 2008; 18: 192–94
9. Uchida H, Kawashima H, Goto C et al: Inguinal hernia repair in children using single-incision laparoscopic-assisted percutaneous extraperitoneal closure. *J Pediatr Surg*, 2010; 45: 2386–89
10. Thomas DT, Gocmen KB, Tulgar S, Boga I: Percutaneous internal ring suturing is a safe and effective method for the minimal invasive treatment of pediatric inguinal hernia: Experience with 250 cases. *J Pediatr Surg*, 2016; 51: 1330–35
11. Yang XD, Wu Y, Xiang B et al: Ten-year experience of laparoscopic repair of pediatric hydrocele and the long-term follow-up results. *J Pediatr Surg*, 2015; 50: 1987–90
12. Shalaby R, Ismail M, Dorgham A et al: Laparoscopic hernia repair in infancy and childhood: evaluation of 2 different techniques. *J Pediatr Surg*, 2010; 45: 2210–16
13. McClain L, Streck C, Leshner A et al: Laparoscopic needle-assisted inguinal hernia repair in 495 children. *Surg Endosc*, 2015; 29: 781–86
14. Skoog SJ, Conlin MJ: Pediatric hernias and hydroceles. The urologist’s perspective. *Urol Clin North Am*, 1995; 22(1): 119–30
15. Wolak PK, Patkowski D: Laparoscopic inguinal hernia repair in children using the percutaneous internal ring suturing technique own experience. *Wideochir Inne Tech Maloinwazyjne*, 2014; 9(1): 53–58
16. Perlstein J, Du Bois JJ: The role of Laparoscopy in the management of suspected recurrent pediatric hernias. *J Pediatric Surg*, 2000; 35(8): 1205–8
17. Saranga, Bharathi R, Arora M, Baskaran V: Pediatric inguinal hernia: Laparoscopic versus open surgery. *JSL*, 2008; 1 2: 277–81
18. Niyogi A, Tahim AS, Sherwood WJ et al: A comparative study examining open inguinal herniotomy with or without hernioscopy to laparoscopic inguinal hernia repair in a paediatric population. *J Pediatr Surg Int*, 2010; 20: 387–92
19. Kuhry E, Van Veen RN, Langeveld HR et al: Open or total extraperitoneal inguinal hernia repair? A systemic review. *Surg Endosc*, 2007; 21: 161–66
20. Zhou X, Wang J, Bian HQ: [Classification and clinical significance of Laparoscopic indirect inguinal hernia.] *Chinese Journal of Pediatric Surgery*, 2005; 26(11): 583–85 [in Chinese]
21. Steinau G, Schlee J, Lambert M, Schumpelick V: Incidence of contralateral inguinal hernias in infancy and childhood. *Langenbecks Arch Chir*, 1997; 382(5): 252–56
22. Shalaby R, Ismail M, Samaha A et al: Laparoscopic inguinal hernia repair: Experience with 874 children. *J Pediatr Surg*, 2014; 49(3): 460–64
23. Bertozzi M, Melissa B, Magrini E et al: Laparoscopic herniorrhaphy in the pediatric age group: What about the learning curve? *J Endourol*, 2013; 27(7): 840–44.
24. Esposito C, St Peter SD, Escolino M et al: Laparoscopic versus open inguinal hernia repair in pediatric patients: A systematic review. *J Laparoendosc Adv Surg Tech A*, 2014; 24(11): 811–18
25. Xiang B, Jin S, Zhong L et al: Reasons for recurrence after the laparoscopic repair of indirect inguinal hernia in children. *J Laparoendosc Adv Surg Tech A*, 2015; 25(8): 681–83

## Conclusions

The single-site laparoscopic percutaneous extraperitoneal closure of the internal ring using an epidural needle for pediatric inguinal hernia is safe and effective, and this procedure has the advantages of minimal trauma and no scarring, and can simultaneously detect and treat the contralateral occult hernia.

## Ethics approval

This study was approved by the Ethics Committee of our university and strictly adhered to the tenets of the Declaration of Helsinki.

## Acknowledgements

We are very grateful to the participating doctors: Yi-fan Fang, Bing Zhang, Ming-kun Liu, Jian-cai Chen, Jian-xi Bai, Wen-chen Xu, and Yuan-bin He.

## Conflict of interests

None.