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Original Article

Comparison of efficacy and safety between various operations in treating pediatric inguinal hernia

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Abstract: *Objective:* The objective of this study was to compare the clinical efficacy and safety of three kinds of laparoscopic percutaneous high ligation of sac in treating pediatric inguinal hernia, including double-port sledge-shaped Kisschner pin loop method (LPDL-2k), single-port sledge-shaped K isschner pin loop method (LPDL-k), and single-port water injector loop method (LPDL-p). *Methods:* A total of 396 children with inguinal hernia treated in our pediatric department from January 2013 to April 2015 were enrolled in the study. Among them, 114 patients underwent LPDL-2k, 135 LPDL-k, and 147 LPDL-p. The operation time, intraoperative condition, incidence of postoperative complications, and relapse rate of three groups were compared. *Results:* For the children with the same gender and the same type of unilateral and bilateral hernia, there was no difference in operation time (P>0.05). About the use of knot pusher in operation, the LPDL-p group had higher using rate than that of the other two groups, with a statistically significant difference (P<0.05). Furthermore, the increase rate of intraoperative trocar of the LPDL-p group was largely less than that of the other two groups, with statistical differences (P<0.05). The incidence of postoperative complications and relapse rate of the children of the LPDL-p group was greatly lower than that of the LPDL-2k group and LPDL-k group, and the difference was statistically significant (P<0.05). *Conclusion:* LPDL-p has advantages in treating pediatric inguinal hernia than LPDL-2k and LPDL-k, deserving widespread use in the clinic.

Keywords: Inguinal hernia, laparoscopic operation, single-port, clinical efficacy, safety

Introduction

Pediatric inguinal hernia is a common congenital dysplasia, among which indirect inguinal hernia is the most common, rarely direct hernia, and it mostly presents in the infants within 1 year old [1]. Theoretically, pediatric inguinal hernia is a self-healing disease. However, due to the age of the patients, it is likely to become into incarcerated at any time or even threaten the patients' live. So waiting for self-healing is not desirable [2]. Currently, hernia repair is the most commonly used treatment method in clinic, including traditional high ligation of sac and laparoscopic operation [3]. Since 2010, our hospital has carried out laparoscopic operations. Referring to the advanced surgical techniques at home and abroad and based on the clinical experience of the professional physicians in our department, we have repeatedly modified laparoscopic operation. In order to minimize the incision, reduce tissue damage, and decrease relapse rate, we have develop a laparoscopic percutaneous of hernia sac through single-port with sledge-shaped Kirschner pin (LPDL-k) and laparoscopic percutaneous of hernia sac through single-port with water injector (LPDL-p), achieving a better therapeutic effect. Through comparing the clinical efficacy and safety of these two methods with the double-ports sledge-shaped Kirschner pin loop method (LPDL-2k), the study provides reliable support for LPDL-p in treating pediatric inguinal hernia. The details are following.

Materials and methods

Clinical materials

The study involved 396 children with inguinal hernia who underwent treatment in our pediatric department from January 2013 to April 2015. There were 323 males, 73 females, aged from 3 to 43 months, with a mean age of (13.74±8.99) months. All of them were diagnosed with inguinal hernia via physical exami-

Table 1. Analysis on the general materials of three groups

Group	Number (n)	Mean age (month)	Sex (n)		Weight (kg)	Unilateral hernia	Bilateral hernia
			Male	Female			
LPDL-2k	114	14.11±9.76	96	18	9.25±3.86	97	17
LPDL-k	135	13.52±6.98	111	24	8.84±4.17	116	19
LPDL-p	147	13.75±7.82	116	31	9.09±4.31	128	19
t/F	-	0.874	1.765		1.208	2.005	
P	-	0.115	0.097		0.176	0.063	

nation and laparoscopy. There were 341 children with unilateral hernia and 55 with bilateral hernia. According to the random number table, the patients were divided into double-ports laparoscopic percutaneous high ligation of hernia sac group (LPDL-2k, n=114), single-port laparoscopic percutaneous high ligation of hernia sac group (LPDL-k, n=135), and single-port laparoscopic percutaneous water injection high ligation of hernia sac group (LPDL-p, n=147). Comparison of the three groups showed that there was no statistical difference in the children's clinical materials as shown in **Table 1**. The study acquired approval of local Ethics Committee.

Inclusion criteria

If the patients had been diagnosed with inguinal hernia through clinical manifestations and laparoscopy, and if the patients had obvious surgical indication and complete clinical data, and if their families signed the informed consent, they would be eligible for the study.

Exclusion criteria

If the patients did not agree with the inclusion criteria, and if the patients also had hydrocele, incomplete testicular descent, and testicular cysts, and if the patients had a history of inguinal surgery, and if the patients suffered from reoccurred inguinal hernia, or if the patients had operatic contraindications, they were ineligible for the study.

Treatment methods

Preoperative preparations: The children fasted for 6 hours before operation. With marked affected site for surgery, they were given glycerol enema for urination and defecation half an hour before operation.

Anesthesia methods: The children lied on their back, in foot-high and head-down position. Their affected sides were ensured in a higher position to expose the affected internal inguinal ring. They were given general anesthesia via inhalation or endotracheal intubation.

LPDL-2k [4]: The 5 mm puncture cannulas were inserted from the incisions below the umbilicus, near the ipsilateral abdominal wall and the contralateral abdominal wall, respectively, to build up an artificial CO_2 aeroperitoneum. A laparoscope and two auxiliary operation clamps were placed in, to observe the size and shape of the ipsilateral hernia sac and the condition of contralateral processus vaginalis, estimating the difficulty in suture of hernia sac. A 20 ml syringe needle was used to puncture the abdominal wall, avoiding inferior epigastric vessel and nerve injury. A sledge-shaped Kirschner pin with loop thread was perpendicularly inserted to the extraperitoneal space through skin and abdominal wall. Then the Kirschner pin was turned to the medial side of inguinal ring, and simultaneously, the deferent duct and spermatic vessel were separated from the abdominal wall with surgical forceps, making the Kirschner pin insert into peritoneal cavity through the space, to preventing the damage of deferent duct and spermatic vessel. The top of the noose thread was fixed with a surgical forceps, making the loop end retain in peritoneal cavity, with the sledge-shaped Kirschner pin removed. The above operations were repeated, making the Kirschner pin through the loop. The loop thread was then tightened, followed by pulling the Kirschner pin out of the body again. The double ligatures were cut off and tied separately. Without bleeding, the laparoscopy was withdrawn from the abdomen, the pneumoperitoneum was emptied, and the incision was closed.

LPDL-1k [5]: The 5 mm puncture cannula was inserted from the incisions below the umbilicus, to build up an artificial CO_2 aeroperitoneum. A laparoscope was placed in, to observe

Table 2. Comparison on the operation time of three groups ($\bar{x} \pm s$)

Group	Number (n)	Boy		Girl	
		Unilateral	Bilateral	Unilateral	Bilateral
LPDL-2k	114	13.41±3.26	24.78±4.34	10.98±1.96	15.46±2.27
LPDL-k	135	13.39±4.05	24.46±3.99	9.98±2.03	14.95±2.46
LPDL-p	147	13.52±3.87	25.02±3.65	10.63±1.82	15.11±1.98
t	-	0.869	1.156	0.935	1.024
P	-	0.141	0.054	0.097	0.071

Table 3. Comparison on the operation of the three groups (n, %)

Group	Number (n)	Number of hernia repair (times)	Use of knot pusher	Additional auxiliary incision
LPDL-2k	114	168	2 (1.19)	0
LPDL-k	135	191	1 (0.52)	19 (9.95)
LPDL-p	147	209	18 (8.61)	4 (1.91)
χ^2	-	-	4.869	7.835
P	-	-	0.041	0.027

Table 4. Comparison on surgical complications of the three groups (n, %)

Group	Number (n)	Hematoma at inguinal ring	Knot-like granuloma	Relapse	Hydrocele	Pain in knot site	Iatrogenic cryptorchidism	Orchiatrophy
LPDL-2k	114	4 (3.51)	5 (4.39)	1 (0.88)	2 (1.75)	4 (3.51)	1 (0.88)	0
LPDL-k	135	5 (3.70)	5 (3.70)	3 (2.22)	2 (1.48)	4 (2.96)	0	1 (0.88)
LPDL-p	147	1 (0.68)	0	0	0	0	0	0
F	-	1.872	2.023	2.851	1.394	2.273	1.353	1.353
P	-	0.047	0.038	0.023	0.049	0.031	0.049	0.049

the size and shape of the ipsilateral hernia sac and the condition of contralateral processus vaginalis, estimating the difficulty in suture of hernia sac. LPDL-k was different from LPDL-2k. In its process, it was unnecessary to use other incision to insert operation clamps, but a 20 ml syringe needle was directly used to puncture abdominal wall. A sledge-shaped Kirschner pin was used to isolate the deferent duct and spermatic vessel from extraperitoneal space, then directly went through the space, and entered the peritoneal cavity through ligation ring. In order to make a loop-like structure, the Kirschner pin was slightly retreated. The laparoscopic lens was aligned with the loop and inserted into the loop to prop the lateral abdominal wall. After ensuring that the laparoscope was fixed, the lens was moved. The loop thread end was placed into peritoneal cavity, and then the sledge-shaped Kirschner pin was pulled out. The other operations were basically consistent with those of LPDL-2k.

LPDL-p [6]: The water hernia needle with loop thread was used for puncturing instead of sledge-shaped Kirschner pin. When the needle went through the extraperitoneal space, 5-10 ml of saline was injected into the area of deferent ducts and spermatic vessels via needle tube, so as to separate them from peritoneum and the following operations were similar with those of LPDL-k.

Observation indexes

The operation time, the use of knot pusher, the increase of assistant incision, and surgical complications were recorded.

Statistical analysis

All data were processed by software SPSS18.0. The measurement data are expressed by mean ± SD ($\bar{x} \pm s$), and independent samples t-test and Fisher's test were used for comparison

between groups. The enumeration data were expressed by ratio and compared by χ^2 test and analysis of variance was used to compare the means of multiple groups. When P was less than 0.05, the difference was statistically significant.

Results

Comparison on the operation time of three groups

All surgeries for the children in the three groups were successfully completed, and no children transited to laparotomy. Comparison of the children with same gender and same hernia type, showed that there was no difference in operation time (P<0.05) as shown in **Table 2**.

Comparison on the operation of the three groups

The three groups underwent 168, 191 and 209 repairs of hernia, respectively. There were only two children in the LPDL-2k group and on child in the LPDL-k group who used flat needle-like knot pusher in surgery, but the using rate of knot pushed in the LPDL-p group was 8.61%, higher than other two groups. Also, the difference was significant (P<0.05).

LPDL-2k was operated with conventional auxiliary operation ports and in the LPDL-k group, there were 19 children (9.95%) who needed additional auxiliary operation ports. In the process of LPDL-p, hydrodissection was used to isolate deferent ducts and spermatic vessels from peritoneum, the demand for auxiliary ports decreased to 1.91%. Compared three groups, there was statistical difference (P>0.05) as shown in **Table 3**.

Comparison of surgical complications of the three groups

The incidences of hematoma at inguinal ring, knot-like granuloma and infection, and relapse rate induced by LPDL-2k and LPDL-k were higher than those induced by LPDL-p, and so did the incidences of postoperative hydrocele and pain in knot site. Additionally, the difference was statistically significant (P<0.05) as shown in **Table 4**.

Discussion

Inguinal hernia repair is one common pediatric surgery and mostly occurs in the boy within 1 year. Premature children in particular have a higher incidence, which is associated with congenital patent processus vaginalis of newborns [7]. At birth, a majority of newborns have patent processus veginalis. With development, the processus vegnalis closes and becomes normal gradually within six months. However, when they are older than 1 year, there is still a small part of the children with unclosed processus veginalis. They are at high risk of inguinal hernia. Even though congenital patent processus vaginalis is the pathological base of inguinal hernia, other factors also play a role in its occurrence, such as undescended testes, bladder exstrophy, seroperitoneum, and cystic fibrosis [8, 9]. The increase of abdominal pressure induced by crying, constipation, and cough is the predisposing factor for hernia. With growth, some children's hernia may disappear after conventional therapy. However, some children over 2 years still have suffered from hernia. Theoretically, inguinal hernia is a self-curing disorder. However, because of the age of the children, any condition is not under control, and incarceration can happen anytime and a serious one can endanger the child's life. Therefore, according to the clinical manifestations and surgical indications of the child, it is recommended that surgery should be performed as soon as possible [10]. In recent years, with the development of medical level in our hospital, apart from the newborns with 3 months and the children with congenital heart disease or other complications, inguinal hernia repair usually belongs to day surgery in outpatient clinic, without hospitalization.

In the past, open operation has been the traditional method of surgery, including lower abdominal internal ring horizontal incision and the outer ring horizontal incision [11]. However, the high ligation of hernia sac in whatever way is limited to treat the ipsilateral hernia, being unable to probe the contralateral inner ring with or without occult hernia. In additional, it leads to a big trauma, because it is necessary to cut off the spermatic cord and bluntly separate the deferent tube and spermatic vessel on the hernia sac. The normal tissues in the groin are greatly damaged, which may impact on the physiological and reproductive functions. Furthermore, the testis needs to be pulled away from the normal position in the surgery and the spermatic cord is adjoined after surgery, which may give rise to iatrogenic cryptorchidism and

other postoperative complications [12, 13]. In the last century, as laparoscopic surgery has been widely carried out in various specialized treatment fields, many pediatric surgeons have gradually introduced laparoscopy into pediatric surgical treatment. However, due to the difficulty in operation and long operation time, laparoscopic surgery has been gradually generalized in pediatric department of the major hospitals in China in recent ten years. With the advance in medical standards and operation instruments, laparoscopic surgery reduces to two ports from three ports step by step. In recent years, many hospitals have mastered the single-port technique. In China, the double-ports laparoscopic surgery is first used for treating pediatric inguinal hernia by Li YZ and his fellows who come from Guangzhou First People's Hospital, achieving an excellent therapeutic effect. In the double-port laparoscopic surgery, the laparoscopic auxiliary operation clamp is used to pull peritoneum and suture thread, and other hernia sac suture and ligations are conducted outside the body, largely decreasing the surgical difficulty and shortening the operation time. Our LPDL-2k is modified based on this method. In the process of LPDL-2k, avoiding the normal anatomy of groin, the Kirschner pin is punctured through the abdominal wall, and the hernia sac is isolated at the inguinal ring and high ligated. Furthermore, whether the contralateral inguinal ring has patent processus vaginalis or not is detected routinely, and if the processus vaginalis is unclosed, it should be ligated. The double-ports method shortens the operation time, but it still has the risk of hurting abdominal viscera. In 2005, Harrison MR and his partners [14] invited single-port method on the basis of double-ports method, in which laparoscopic auxiliary operation instruments are not needed. However, this surgery also has some shortages, such as incomplete inguinal ring ligation, two inguinal puncturing sites, and high postoperative relapse rate. In 2008, Bharathi et al. [15] proposed a single-port hydrodissection technique based on single-port laparoscopic surgery, preventing the recurrence caused by mis-ligation of the hernia sac of the inner ring and reducing the possibility of tension at the ligation and detachment of the knot. Through absorbing advanced technologies and based on rich clinical experience, pediatric surgeons carry out the surgery with a sledge-shaped Kirschner pin instead of the usual one. The sledge-shaped Kirschner pin has a smooth end, being beneficial to blunt separation. Its flat fore-end is good for passing through the space, with a hole in the end, it can carry double ligatures. The sledge-shaped Kirschner pin has some advantages in bluntly isolating deferent ducts and spermatic vessels attached to the hernia sac, but it has some difficulties in the separation for some children with adhesion of hernia sac, deferent duct, and spermatic vessel or those with more folds of visceral peritoneum. In the light of this, the surgeons in our department try to use water injection to replace the sledged-shaped Kirschner pin in the operation. Normal saline is injected into the extraperitoneal space at the deferent duct and spermatic vessels to isolate them, shortening the separation time, and greatly reducing the intraoperative injuries.

In conclusion, LPDL-p has advantages compared with LPDL-2k or LPDL-k in treating pediatric inguinal hernia. It cuts down the operation time, avoids the damage of normal tissues in the surgery, achieves better ligation, and results in lower incidence of postoperative complications and relapse rate, deserving widely spread application in the clinic.

Disclosure of conflict of interest

None.

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