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A comparison between totally laparoscopic hydrocelectomy and scrotal incision hydrocelectomy with laparoscopic high ligation for pediatric cord hydrocele

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Abstract
Background The purpose of this study is to report clinical characteristics and to investigate the feasibility and safety of totally laparoscopic hydrocelectomy (TLH) compared to scrotal incision hydrocelectomy with laparoscopic high ligation (SIH) for pediatric cord hydrocele (CH).
Methods From September 2011 to February 2016, 148 patients underwent SIH, and 342 patients underwent TLH for CH. In the TLH group, a large hydrocele that could not pass through the internal ring was removed after percutaneous syringe aspiration. Age, laterality of hydrocele, inguinal comorbidities, operation time, surgical complications, and recurrences were evaluated.
Results All the patients had spermatic cord cysts and patent processus vaginalis in proximity to hydrocele (mixed type). The mean age of CH patients was 34.1 ± 22.1 months. CHs are more common on the right side (61.0%) than on the left (35.7%). Bilaterality occurred in 3.3%. Comorbidities such as hernia (8.6%) and cryptorchidism (1.2%) were observed. There were no complications except for two cases of wound hematoma in SIH group. There was one (0.7%) case of recurrence appeared in communicating hydrocele in SIH group. There were no significant differences in the age, laterality of hydrocele, inguinal comorbidities, operation time, complications, and recurrences between TLH and SIH groups. However, TLH for unilateral cord hydrocele had significantly shorter operation time compared to SIH. The mean operation time in TLH group was 15.6 ± 5.96 min and there was no conversion to open surgery.
Conclusions TLH for pediatric CH is a feasible and safe procedure without additional incisions. Therefore, TLH can be one of the surgical options for pediatric CH especially in mixed type.

Keywords Hydrocele · Cord hydrocele · Pediatric · Laparoscopy

Cord hydrocele (CH) is a disease with fluid accumulation along the spermatic cord above the testicle, resulting from aberrant closure of the processus vaginalis [1]. The traditional method of hydrocele repair in children is the open hydrocelectomy and additional high ligation procedure in case of patent processus vaginalis (PPV) [2]. With the advent of a minimally invasive surgery, laparoscopy has become increasingly popular as the treatment for various pediatric diseases. There are a lot of clinical studies on the laparoscopic herniorrhaphy of pediatric inguinal hernia. The benefits of laparoscopy compared to conventional methods are reported by many authors [3–5]. Janetschek et al. [6] first reported the application of laparoscopy for hydrocele treatment. However, since then there have not been many studies reported. Report regarding laparoscopy for cord hydrocele is even rarer.

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In our hospital, cord hydrocele is treated via laparoscopy. In the beginning of our study, scrotal incision hydrocelectomy (SIH) with laparoscopic high ligation was performed. Then we switched the method to totally laparoscopic hydrocelectomy with high ligation (TLH). The aim of this study is to report clinical characteristics of pediatric cord hydroceles and compare TLH and SIH as a treatment for pediatric cord hydrocele in terms of feasibility and safety.

Materials and methods

This is a retrospective study for 490 male pediatric cord hydrocele patients between September 2011 and February 2016. All operations were performed by a highly experienced surgeon (Lee SR, over 1500 laparoscopic operation per year). Operative indications in this study are as follows: (1) If the hydrocele persists in patients older than two years old, (2) If a child has other inguinal comorbidities (inguinal hernias or cryptorchidism) on the same side of the hydrocele that require surgery regardless of age. Diagnosis of cord hydrocele was determined by the patient's history, physical examination, ultrasonography, and was confirmed via laparoscopy.

Prior to the surgery, parents of the patient were informed about the advantages and disadvantages of the laparoscopic surgery and gave consent to the surgery. Age, laterality, comorbid ipsilateral inguinal diseases, operation time, postoperative complication, and recurrence rate were analyzed.

The operation was performed under general anesthesia in supine position. For laparoscopic system, a 0°, 2.9 mm laparoscopy (Stryker, Kalamazoo, MI, USA) and 2.7 mm rigid instruments (Karl Storz, Tuttlingen, Germany) were used. A transumbilical longitudinal incision was made and a 3-mm Endopath® bladeless trocar (Ethicon, Cincinnati, OH) was inserted. Pneumoperitoneum was established and two stab incisions were made on the lateral abdominal wall parallel to the umbilicus after laparoscopic inspection. Two 2.7 mm laparoscopic instruments were inserted through separate stab incisions in the lateral abdomen without trocars.

The procedure of SIH is as follows: After the visualization of the internal ring, high ligation of patent processus vaginalis was performed with 3-0 Mersilk (Ethicon Ltd. Edinburgh, UK). Unlike the TLH procedure, separate 1 cm sized vertical incision was made on the scrotum, and then hydrocelectomy was performed (Fig. 1)

The procedure of TLH is as follows (Figs. 2, 3): After identifying the internal ring, we could find a bulging hydrocele through the internal ring when we pressed the skin of inguinal area externally. For large hydroceles that were difficult to pass through the internal ring, percutaneous syringe aspiration was performed to reduce the size before hydrocelectomy. When hydrocele was pulled into the abdominal cavity with a grasper, distinct dissection plane between the hydrocele, and the peritoneum can be identified. As the hydrocele is continuously pulled into the peritoneal cavity, the peritoneum which is attached to the hydrocele pushes away in the opposite direction of pulling the cyst. Through this process, the vas deferens and spermatic vessel become far enough away from the hydrocele that they will not be damaged during surgery. As the dissection progresses, the hydrocele is gradually drawn into the peritoneal cavity. Finally, the distal part of the hydrocele is resected within the abdominal cavity after confirming that the vas deferens or spermatic vessel is not adjacent. After intracorporeal hydrocelectomy, high ligation of processus vaginalis was performed with a 3-0 Mersilk (Ethicon Ltd. Edinburgh, UK). The needle was inserted directly through the lower abdominal wall. The procedure was performed with caution to avoid damaging the vas deferens and spermatic vessels. The resected hydrocele was removed through the right lateral incision. After the incision was closed, the surgical bond (Dermabond; Ethicon Inc., Somerville, NJ, USA) was used for covering the incision.

Unless there was any postoperative problem, the patients could be discharged from hospital on the same day of the surgery. Follow-up at 1 week, 1, and 3 months were performed after surgery, and telephone interview was performed to monitor for the three subsequent years.

Statistical analyses were performed using the SPSS statistics 23 standard for medical service (IBM Co., Armonk, NY, USA). For categorical variables, the Fisher's exact test or χ^2 test was used. The t test was used to test for the normality of the continuous variables. A p value threshold of 0.05 was chosen; any p value below or equal to 0.05 was considered statistically significant.

Results

The data of whole cord hydrocele patients are shown in Table 1. Cord hydrocele was mostly unilateral (96.7%), and unilateral hydrocele occurred more often on the right side (61%). Bilateral cord hydrocele (3.3%) was also observed. Among the comorbidity of cord, inguinal hernia was most common (8.6%) and cryptorchidism (1.2%) was also observed. In our study, all the patients with cord hydrocele detected by laparoscopy had proximally patent processus vaginalis, and the cysts of hydroceles were not communicating with the peritoneal cavity.

Comparison of results between SIH and TLH are shown in Table 2. Demographic information such as age,

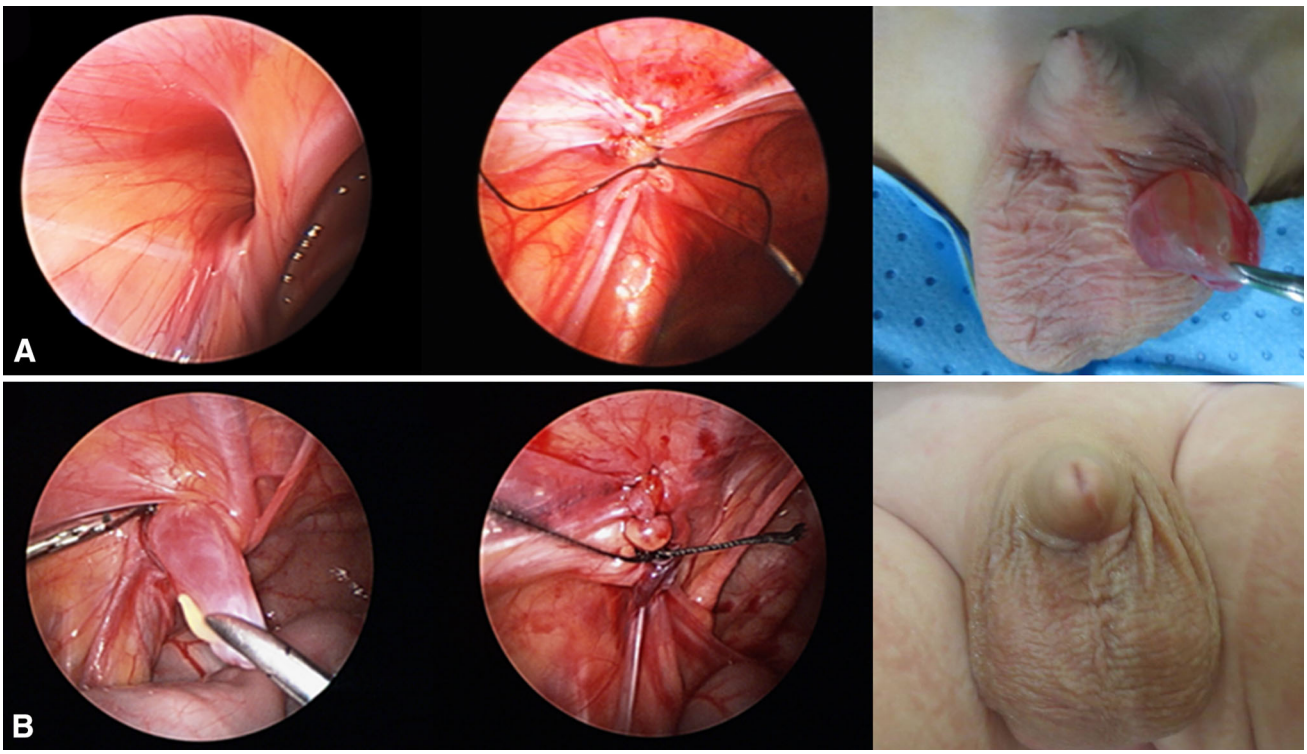

Fig. 1 Comparison of operative procedure between scrotal incision hydrocelectomy (SIH) and totally laparoscopic hydrocelectomy (TLH). **A** SIH procedure: Patent processus vaginalis is observed (*left*). High ligation was performed first (*middle*). Then hydrocelectomy was performed via scrotal incision unlike the TLH procedure (*right*), **B** TLH procedure: The hallmark of the TLH procedure is that all the procedures (hydrocelectomy (*left*) and high ligation (*middle*)) are done intracorporeally. Therefore, there was no additional incision on the scrotum (*right*)

laterality, comorbidity showed no differences between TLH and SIH group. Operative results such as operation time, postoperative complication, and recurrence showed no differences. However, complications and recurrences were observed in SIH group and not in TLH group. There was no complication other than two wound hematoma in SIH group. The recurred patient in SIH group developed a communicating hydrocele after cord hydrocele surgery. In terms of operation time, there was no difference between two groups for bilateral cord hydroceles, while TLH group had significantly shorter operation time than SIH group for unilateral cord hydroceles.

Both group required no conversion to open surgery, and no intraoperative or immediate postoperative problem was observed. All the patients in this study were discharged the same day.

Discussion

The frequency of cord hydroceles in pediatric patients is reported to be about 5.7% [7]. However, clinical features of cord hydroceles are not readily available and reports about laparoscopic approach to cord hydrocele are even rarer. Martin et al. [1] categorized types of cord hydroceles into funicular type (the peritoneal diverticulum communicating with the peritoneal cavity at the internal inguinal ring) and encysted type (the cyst not communicating with the peritoneal cavity or processus vaginalis). Chang et al. [8] categorized cord hydroceles that do not belong either funicular or encysted type as mixed type. In mixed variety, the cyst is not communicating with peritoneal cavity but has a proximally patent processus vaginalis. However, all the cord hydroceles we observed in this study were mixed type, and neither funicular nor encysted type were observed. One study of laparoscopic hydrocelectomy reported 97.7% of hydroceles were patent around the internal inguinal ring: 59.1% narrow patent processus vaginalis covered with peritoneal veil, and 38.6% widely open patent processus vaginalis [9]. Another study reported that 75% of cord hydroceles have patent processus vaginalis [8]. Our study is restricted to cord hydrocele, and the sizes of PPVs were not recorded. However, all the processus vaginalis observed in this study were patent.

Study regarding the laterality of cord hydrocele is rare as well. One study for hydrocele reported that right unilateral hydrocele is the most common (60%), but 7% bilaterality is also observed [7]. In the case of mixed

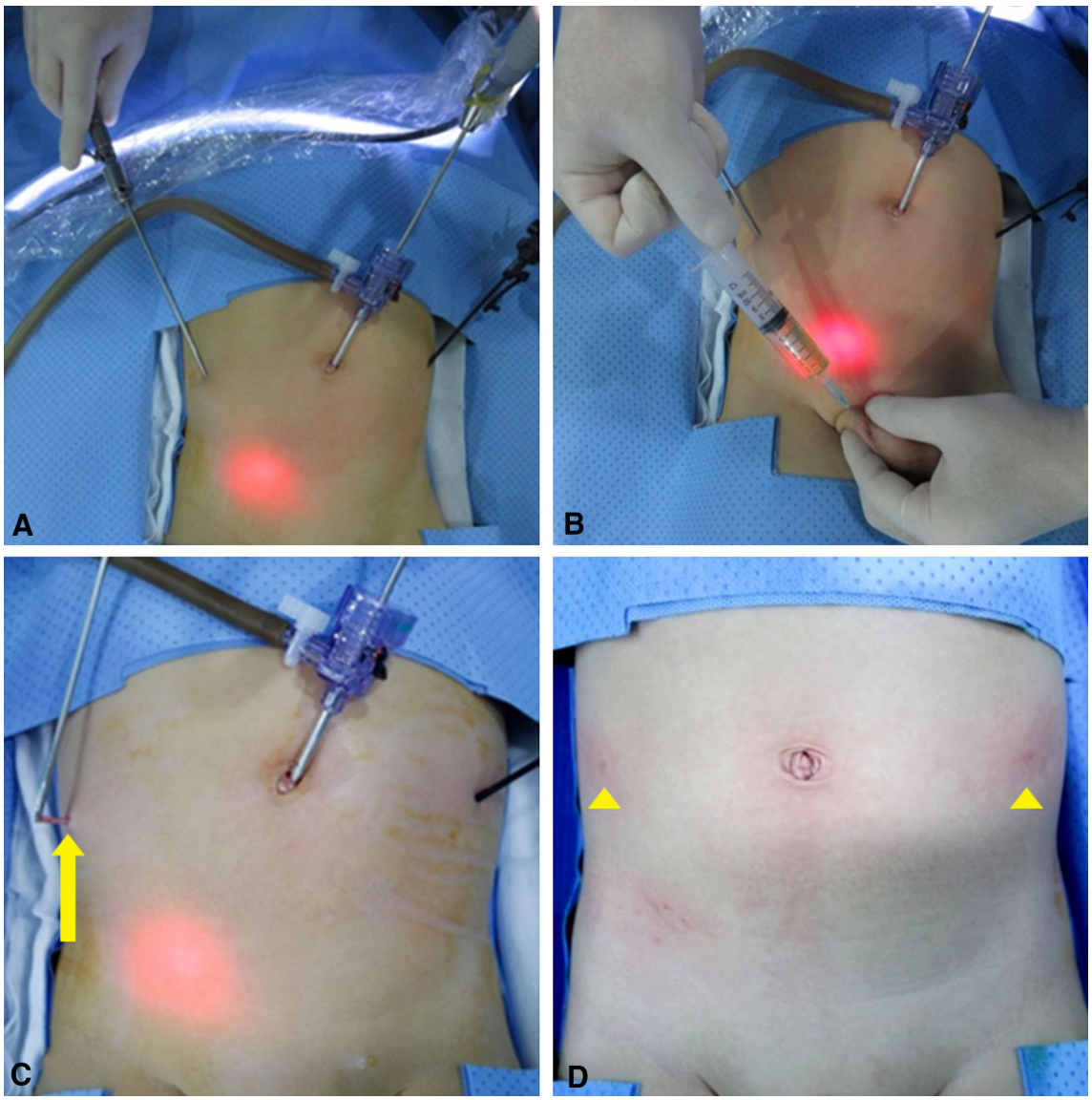

Fig. 2 External view of the totally laparoscopic hydrocelectomy procedure: **A** Port placement**, B** Syringe aspiration before hydrocelectomy, **C** Removal of the hydrocele through the right lateral incision (*yellow arrow*: collapsed hydrocele), **D** Postoperative wound (*yellow arrow head*: where the instrument inserted) (Color figure online)

variety, a relatively small-sized study reported right and left side cord hydroceles occur at the similar rate [8]. However, the results of our study revealed right unilateral cord hydroceles (61%) were more common than left unilateral cord hydrocele (35.7%). Bilaterality (3.3%) occurred as well.

The proper timing of the repair for cord hydrocele is also controversial. The most PPV will spontaneously close within 1–2 years. Therefore, most surgeons may avoid hydrocele operation within 1–2 years of life unless hernia cannot be excluded [10, 11]. One study reported the hydrocele operation in the first year of life is only required if it is huge in size or associated with inguinal hernia [12]. This is because most of infantile hydroceles (89%) are spontaneously resolved within a year. In contrast, others reported that in the case of cord hydrocele (especially for mixed variety case), elective operation is recommended regardless of age since there is a high risk of hernia developed due to PPV [8]. However, surgical intervention for cord hydrocele at our institution is performed for an infant older than 2 year old. However, if comorbid ipsilateral inguinal hernia or cryptorchidism that requires surgery is observed, hydrocelectomy is performed at the same time even if patients are under 2 years old. This study included the patients only who received surgeries. So the rate of naturally resolved cord hydrocele is not identified. 8.6% of cord hydrocele accompanying inguinal hernia was observed, but complication such as incarceration was not

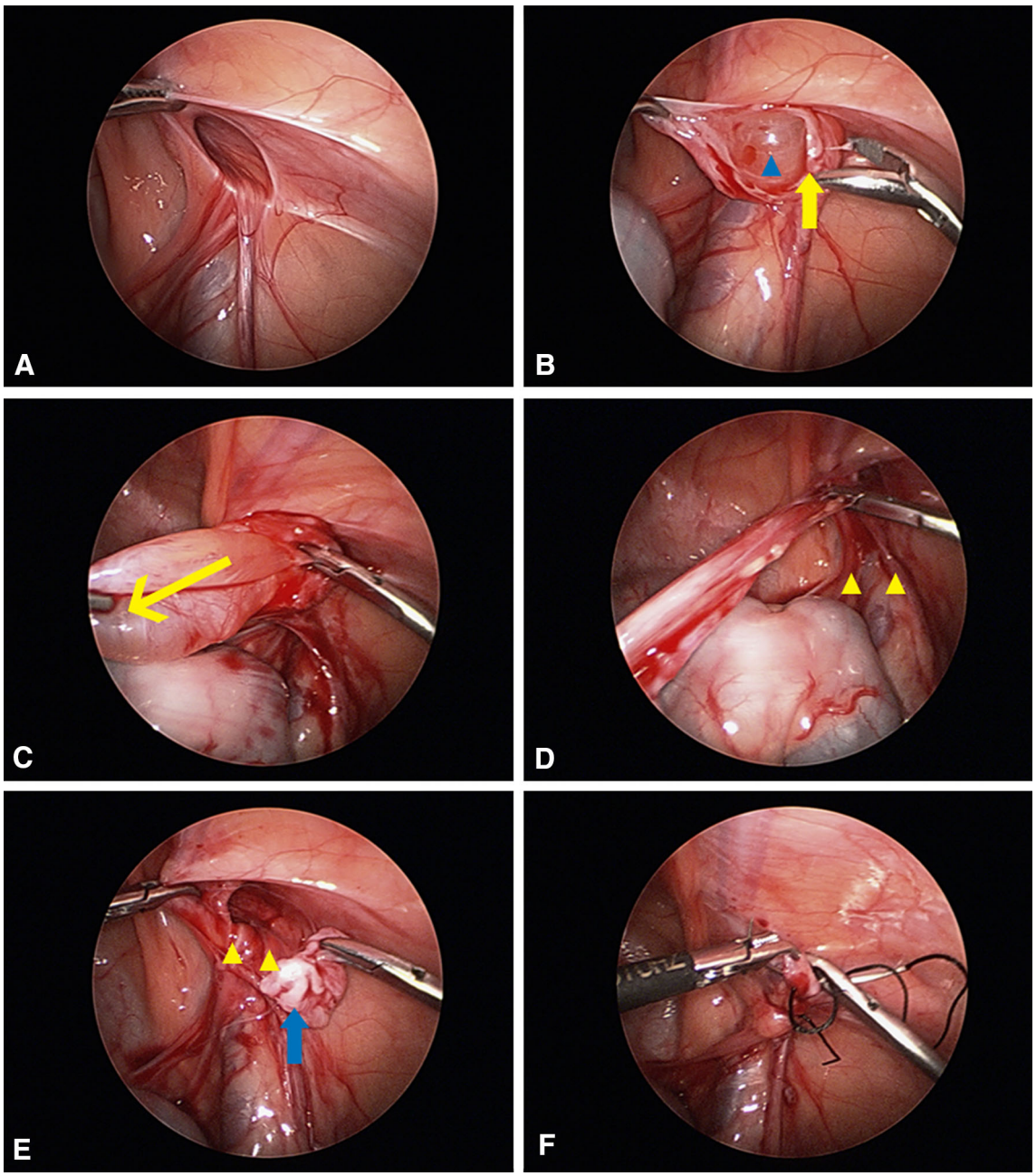

Fig. 3 Laparoscopic view of the totally laparoscopic hydrocelectomy procedure: **A** The hydrocele was not observed, **B** After external compression, a bulged hydrocele is observed through the internal ring (*short yellow arrow*: dissection plane between the hydrocele and the peritoneum), **C** As the hydrocele is continuously pulled into the peritoneal cavity, the peritoneum just adjacent to the dissection plane pushes away in the opposite direction (*long yellow arrow*: direction of pulling the hydrocele), **D** Only the distal portion of the hydrocele is attached just before dissection is complete. Vas deferens and spermatic vessels (*yellow arrow head*) are far enough away from the dissection site, **E** After removal of the hydrocele (*blue arrow*: removed hydrocele), the damage of vas deferens and spermatic vessel (*yellow arrow head*) is not seen, **F** High ligation (Color figure online)

observed. Even though further studies are required, the general 2 year-observation protocol for hydrocele patients can be applied to cord hydrocele patients without hernia and is considered safe.

There is no absolute laparoscopic treatment guideline for cord hydrocele, but in general, open surgery through inguinal incision is the standard procedure [2, 10, 11]. However, open approach has a risk to damaging vas deferens, spermatic vessel, or other inguinal structures [13]. Laparoscopic technique has been revolutionized, and application of laparoscopy to pediatric surgical fields is getting more and more popular. Benefits of laparoscopic

Table 1 Patient characteristics

	$N = 490$
Age (month)	34.1 ± 22.1 (1.0–192.0)
Laterality of hydrocele	
Bilateral	16 (3.3%)
Unilateral	474 (96.7%)
Left	175 (35.7%)
Right	299 (61.0%)
Inguinal comorbidity	
None	442 (90.2%)
Inguinal hernia	42 (8.6%)
Cryptorchidism	6 (1.2%)
Complication	
Hematoma	2 (0.4%)
None	488 (99.6%)
Recurrence	
Yes	1 (0.2%)
No	489 (99.8%)
Operation time	15.9 ± 5.64 (8.0–50.0)
Bilateral	16.9 ± 3.86
Unilateral	15.8 ± 5.69
Follow-up period	17.5 ± 12.0 (3.0–54.0)

Categorical variables are represented as number (%) and continuous variables as mean ± SD and ranges

approach to pediatric inguinal hernia include precise diagnosis with direct visualization and lower risk of damaging any important structures [4, 14]. However, in the case of the TLH procedure, there may be a concern about vas deferens or spermatic vessel damage, unlike hernia surgery, during removal of the hydrocele cyst. Our surgical procedure (As the hydrocele is continuously pulled into the peritoneal cavity, the peritoneum just adjacent to the dissection plane pushes away in the opposite direction) can avoid the damage of vas deferens or testicular vessel because the dissection plane is not close to these structures. Therefore, there was no damage of vas deferens or spermatic vessel during surgery.

Some authors claim that laparoscopy is an easier surgical method for pediatric cord hydrocele since cord hydrocele has a narrow PPV [13]. In this study, there was no significant difference in operation time between TLH and SIH group, while TLH group had significantly shorter operation time than SIH group for unilateral cord hydroceles. The average operation time in the TLH group was 15.6 ± 5.96 min. While there are no specific reports about the laparoscopic surgery of CH, there are some reports about open and laparoscopic surgery for communicating and non-communicating hydroceles [9, 13, 15]. The operation time of either TLH or SIH procedure was comparable to these reports.

Table 2 Patient characteristics according to the surgical method

	TLH group ($N = 342$)	SIH group ($N = 148$)	P value
Age (month)	35.3 ± 23.3 (1.0–192.0)	31.3 ± 18.7 (1.0–101.0)	0.061
Laterality of hydrocele			
Bilateral	11 (3.2%)	5 (3.4%)	0.965
Unilateral	331 (96.8%)	143 (96.6%)	
Left	121 (35.4%)	54 (36.5%)	
Right	210 (61.4%)	89 (60.1%)	
Comorbidity			
None	305 (89.2%)	137 (92.6%)	0.583
Inguinal hernia	32 (9.3%)	10 (6.7%)	
Cryptorchidism	5 (1.5%)	1 (0.7%)	
Complication			
Hematoma	0 (0.0%)	2 (1.4%)	0.091
None	342 (100.0%)	146 (98.6%)	
Recurrence			0.302
Yes	0 (0.0%)	1 (0.7%)	
No	342 (100.0%)	147 (99.3%)	
Operation time	15.6 ± 5.96 (8.0–50.0)	16.4 ± 4.80 (8.0–40.0)	0.176
Bilateral	16.9 ± 3.78 (13.0–25.0)	17.0 ± 4.47 (15.0–25.0)	0.913
Unilateral	15.6 ± 6.02 (8.0–50.0)	16.4 ± 4.82 (8.0–40.0)	0.003

Categorical variables are represented as number (%) and continuous variables as mean ± SD and ranges

TLH totally laparoscopic hydrocelectomy with high ligation, SIH scrotal incision hydrocelectomy with laparoscopic high ligation

There were only 2 postoperative complications in SIH group. These are wound hematomas that spontaneously resolved without any treatment. The recurrence rate after laparoscopic hydrocelectomy was reported to be 0–1.4% [13, 15, 16]. In our study, there was one (0.7%) recurrence in SIH group and the recurrence rate of the whole patients was 0.2% which is not higher than reported rate for hydrocele repair. In this study, follow-up was performed at 1 week, 1, and 3 months by visiting the hospital. After this period, telephone interview was performed annually for three years. However, the study period of this study is not long, and some of the patients with follow-up period shorter than 3 years were included. Hence, average follow-up period was 17.5 ± 12.0 months. There will be additional reports on the long-term outcome of the surgery, such as recurrence, through continued follow-up of these patients. Also we have a separate team dedicated to follow-up and management of patients after surgery, and maintain ongoing contact via phone/e-mail. Therefore, there was no follow-up loss among the subjects.

As it is mentioned earlier, the surgical methods in this study were changed from SIH to TLH. Some may think that learning curve of the procedure might influence the difference in operation times or complications between two groups. However, the operator is an expert in pediatric laparoscopic surgery, and has many years of experience for laparoscopic herniorrhaphy and hydrocelectomy. Also, since the surgical methods of cord hydrocele are similar to laparoscopic inguinal hernia repair which includes intraperitoneal high ligation of hernia sac and occasional removal of cord lipoma, the learning curve of the operator is not thought to influence the operative outcomes.

However, this study has some limitations. Firstly, this is a relatively short-term retrospective study at a single hospital. Second, since our hospital only offers laparoscopic hydrocelectomy as a treatment of cord hydrocele, the surgical outcome of laparoscopic hydrocelectomy cannot be compared with that of conventional open surgery.

Conclusion

All of cord hydroceles had PPV so high ligation was required. The result of SIH was comparable with other literature. The result of TLH was also comparable without increased complication rate or operation time even though there was no additional incision. TLH for unilateral cord hydrocele, in particular, had significantly shorter operation time compared to SIH. Hence, when performed by a surgeon, who is expert at laparoscopic surgery, TLH could be one of the options for pediatric CH, especially for mixed type.

Compliance with ethical standards

Disclosure Byung Seo Choi, Geon Young Byun, Seong Bae Hwang, Bum Hwan Koo, and Sung Ryul Lee have no conflict of interest or financial ties to disclose.

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