Pediatric Surgery International (2024) 40:56
https://doi.org/10.1007/s00383-024-05632-0

ORIGINAL ARTICLE

Comparison of the results of open repair and laparoscopic repair with the PIRS method in the treatment of hydrocele in children

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Accepted: 2 January 2024
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Abstract

Purpose Hydrocele is a result of intraperitoneal fluid filling into the scrotum through the patent processus vaginalis (PPV). While the traditional approach of pediatric hydrocele has been open repair (OR) for years, laparoscopic repair (LR) of hydrocele has been accepted worldwide after the proven efficacy of laparoscopy. The purpose is to compare the outcomes of both techniques in a single center.

Methods We retrospectively analyzed the clinical data of all the patients who underwent hydrocele repair from August 2016 to November 2022. In our center, the standard approach was OR in hydrocele until the November of 2021. Starting from this date, LR has begun to be preferred, as the experience has increased and its success has been observed. In the LR group, single-port percutaneous internal ring suturing technique was performed.

Results The data of 113 patients (OR 58.4% ($n=66$), LR 41.6% ($n=47$)) were collected. In preoperative examination, 12.4% ($n=14$) patients were diagnosed as communicating and 87.6% ($n=99$) non-communicating hydrocele. Intraoperatively, 65.5% ($n=74$) patients were communicating and 34.5% ($n=39$) were non-communicating. Total recurrence rate was 7% ($n=8$). The OR group experienced a recurrence rate of 10.6% ($n=7$), while the LR group experienced 2.12% ($n=1$).

Conclusion Laparoscopy may reveal intrabdominal connection of hydrocele better than open approach. It provides a high quality view of both inguinal rings and has the advantages of minimally invasive surgery.

Keywords Laparoscopy · Open surgery · Hydrocele · Child · Minimal invasive

Introduction

Hydrocele is one of the most common surgical pathologies in children [1]. Collection of fluid between parietal and visceral layer of tunica vaginalis is defined as hydrocele. Inguinal hernia (IH) and hydrocele are different clinical reflections of the same physiopathological process. They are both result of incomplete obliteration of patent processus vaginalis (PPV) [2]. As intra-abdominal organs protrude to hernia sac in IH, PPV allows fluid drainage to into these layers in hydrocele. Hydrocele can occur in two different ways: communicating hydrocele, with persistent connection between the abdomen and tunica vaginalis, and non-communicating hydrocele, when the connection is interrupted [2]. Spontaneous obliteration of PPV occurs in most of the children, but exact time of obliteration is still unknown [2]. If hydrocele is still persistent, surgery is recommended after 12–24 months of age [3, 4].

Traditional open inguinal approach is most common and reasonable procedure in pediatric hydrocele surgery. It is performed with high ligation of PPV. It is similar to open traditional IH repair. Over the past few years, laparoscopic hernia repair has become increasingly popular and has begun to be accepted as a standard procedure by some authors [5]. Best advantages of laparoscopic procedure are minimal invasive procedure, minimal/none dissection of spermatic cord and ability to observe contralateral internal inguinal ring [2, 6–8]. Although open surgery is successful, there is always a risk to damage spermatic cord and testicular vessels during dissection of the PPV. By the nature of non-obliterated PPV, surgical approaches of IH and hydrocele can be similar. Successful laparoscopic repair of hydrocele is shown in the literature [2, 9].

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Published online: 12 February 2024

In this study, it was aimed to compare the results of hydrocele patients treated with open and laparoscopic approaches.

Methods

The study group included 113 children who underwent open and laparoscopic hydrocele repair between August 2016 and November 2022. Ethical approval was obtained from the local ethics committee (Ethics committee application number: 2023000087-7). The patients were divided into two groups; group 1 included patients who underwent open surgery, and group 2 included patients who underwent laparoscopic surgery. All patients' demographic data, clinical and operative findings, and surgical complications were retrospectively reviewed.

In group 2 patients (laparoscopic group), 4 mm camera trocar was placed into the abdominal cavity using the Hasson technique over the umbilicus. A 30° angle camera was then inserted in the abdominal cavity. The CO_2 insufflation pressure in the peritoneal cavity was maintained between 6 and 12 mmH_2O depending on the age of the patients. Patients with an open inguinal canal (Fig. 1a) are diagnosed as communicating hydrocele. After detecting the patent inguinal canal, turning the operation table to the Trendelenburg position and to the opposite side before starting the procedure facilitates the visualization and allows the intestines to move away from the area. Percutaneous access was then performed from the area previously determined laparoscopically on the lateral side of the internal ring of open inguinal canal with a 24G needle. Then PIRS (Percutaneous Internal Ring Suturing) technique was applied with 2/0 prolene sutures under laparoscopic vision. The internal ring perimeter suture was placed up to half of the ring and the loop was formed (Fig. 1b). Then, with a second percutaneous access from the same point, the surrounding suture was completed (Fig. 1c). The second suture was placed inside the first loop and then the first loop was pulled out (Fig. 1d). The created perimeter suture was changed with 2/0 ethibond by passing through the extracorporeally formed loop, and the knot was tied extracorporeally. After checking that the inguinal canal was completely closed laparoscopically, the procedure was terminated (Fig. 1e). Finally, transluminescence was created in the scrotal hydrocele sac by the aid of a light source, then the hydrocele fluid was drained by puncturing non-testicular safe part of scrotum gently with a syringe

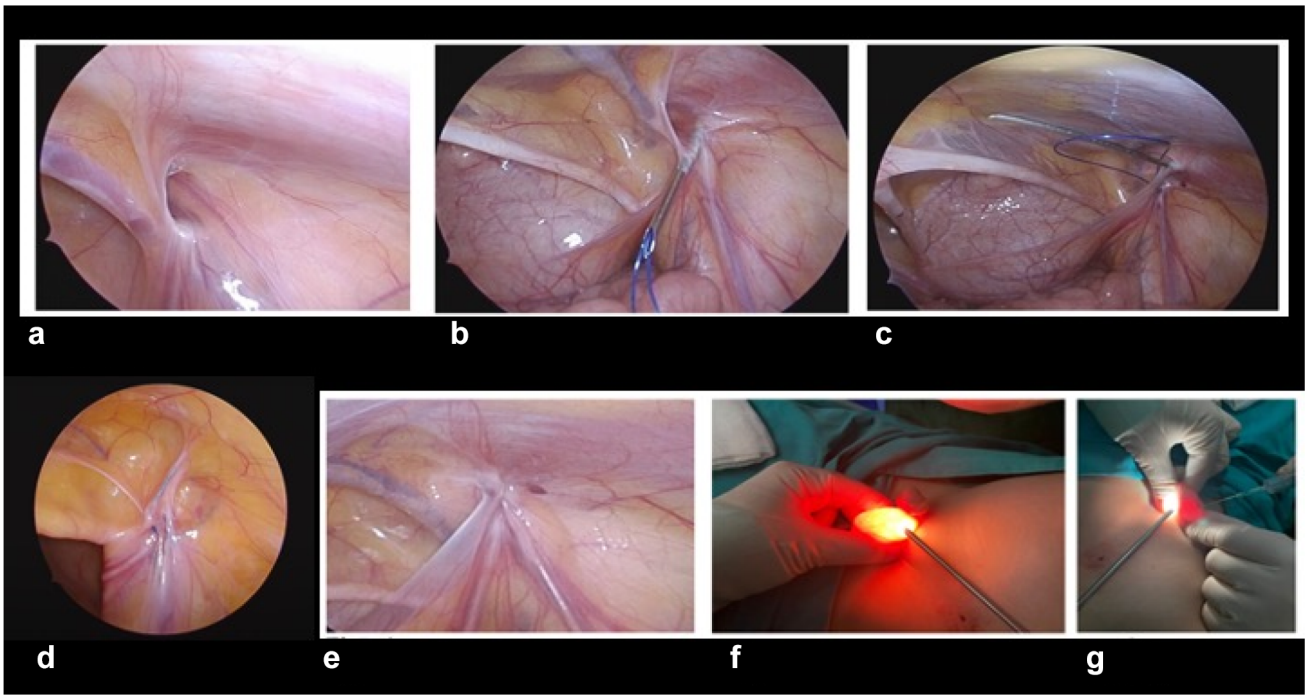


Fig. 1 Intraoperative pictures in laparoscopic hydrocele repair. Patients with an open inguinal canal diagnosed as communicating hydrocele (**a**). Percutaneous access was then performed from the area previously determined laparoscopically on the lateral side of the internal ring of open inguinal canal with a 24G needle. The internal ring perimeter suture was placed up to half of the ring and the loop was formed (**b**). With a second percutaneous access from the same point, the surrounding suture was completed (**c**). The second suture was placed inside the first loop and then the first loop was pulled out (**d**). After checking that the inguinal canal was completely closed laparoscopically, the procedure was terminated (**e**). Transluminescence was created in the scrotal hydrocele sac by the aid of a light source (**f**). Hydrocele fluid was drained by puncturing non-testicular safe part of scrotum gently with a syringe needle (**g**)

needle (Fig. 1f, g). If a non-communicating hydrocele was detected laparoscopically, only scrotal aspiration was performed, considering that it would not recur since there was no connection with the intra-abdominal opening.

A method including dissection of the vas deferens and testicular vessels and high ligation of the hernia sac was applied to all children who underwent open surgery, defined as group 1. A 4 mm 30° angled scope was placed into the abdominal cavity through hernia sac during the contralateral PPV control and the opposite inguinal canal's patency was checked. Contralateral PPV investigation for open surgery is performed only in patients whose hernia sac is large enough for a 4 mm 30° angled scope to pass through. The same surgeons performed the surgeries in group 1 and group 2.

Statistical analysis

One hundred and thirteen children who applied to Ankara University Faculty of Medicine, Department of Pediatric Surgery between August 2016 and November 2022 due to hydrocele are included in the study. In this study, it is aimed to investigate the effectiveness of the laparoscopic approach instead of the inguinal or scrotal open approach in children, regardless of the type of hydrocele. In order to determine the difference between the recurrence rate in the inguinal or scrotal approach after surgical intervention and the recurrence rate in the laparoscopic approach with a power of 0.80 at a significance level of 0.05, the number of children to be included in the study was determined, and accordingly, 113 patients were included in the study. Sample size calculation was carried out with proportions: inequality, two independents groups test. As descriptive statistics, for quantitative variables, it is presented as mean ± standard deviation or median (minimum–maximum) according to conformity with normal distribution, and frequency (percent) for qualitative variables. Preoperative-intraoperative diagnosis percentage comparison between open and laparoscopic approach and approach was evaluated with Chi-square tests and McNemar–Bowker test, and it was investigated whether these rates make a significant difference. The recurrence rate between open and laparoscopic approach and approach was evaluated with Pearson Chi-Square, Continuity Correction, Fisher's Exact Test, Linear-by-Linear Association tests. Independent Two-Sample T Test or Mann–Whitney *U* Test was used according to the assumption of normality in the evaluation of operative time and intraoperative variables between the two approaches. Statistical significance level was accepted as 0.05 and Statistical Package for Social Sciences (SPSS, Version 15.0, Chicago, IL.) was used in the analysis.

Results

In the study, the data of 113 patients who were operated due to hydrocele in our center from 2016 to 2022 were examined. Open procedure was performed in 58.4% ($n=66$) of these patients, and these patients were classified as "Group 1"; the remaining 41.6% ($n=47$) patients who underwent laparoscopic procedure were classified as "Group 2". The mean age of the patients in group 1 was 50 ± 45 months (~4 years) and 44.5 ± 30 months (~3.5 years) in group 2. In group 1, the minimum age of operation was 2 months and in group 2, it was 7 months. In routine hydrocele follow-up, patients are followed up to 1 year of age before the operation, and this non-operative period may be shortened in patients with concurrent IH. In the preoperative examination, right-side hydrocele was observed in 54.8% ($n=62$) of the patients, left-side hydrocele in 37.4% ($n=42$) and bilateral hydrocele in 8% ($n=9$). Again in the preoperative examination, 12.38% ($n=14$) of these patients were diagnosed as communicating hydrocele and 87.6% ($n=99$) non-communicating hydrocele. Intraoperatively, the hydrocele rate was 49.55% ($n=56$) on the right side, 32.74% ($n=37$) on the left side, and 17.69% bilateral ($n=20$). Intraoperatively, 65.48% ($n=74$) of the patients had communicating and 35.7% ($n=39$) had non-communicating hydrocele. The mean follow-up period was 63 months in group 1 and 24 months in group 2. Since laparoscopic surgery is a relatively new approach, the follow-up period is rather shorter compared to the open approach, and it is still under constant surveillance today.

Preoperative and intraoperative diagnoses of group 2 patients for right-side hydrocele were compatible at the rate of 69.6%, and the left inguinal canal was also open in the remaining 30.4% patients. In addition, for left-side hydrocele patients, compatibility rate was 68.2% and the right inguinal canal was also open in 31.8% of the patients. In statistical tests performed, although group 2 patients were operated for unilateral hydrocele, it was found that the bilateral inguinal canal patency rate was significantly different compared to group 1 ($p=0.003$). Similarly, the comparison between intraoperative and postoperative accuracy of communicating and non-communicating hydrocele diagnosis is examined. In group 2 patients, preoperatively 38 patients are diagnosed as non-communicating and 9 as communicating. Nevertheless, in 78.9% ($n=22$) of the patients defined preoperatively as non-communicating, the inguinal canal was detected open intraoperatively and a communicating hydrocele was present. No diagnostic difference was observed in the open surgery group intraoperatively, as expected, still the rate of contralateral PPV detection for non-communicating

Table 1 Preoperative and intraoperative data for open (group 1) and laparoscopic (group 2) repairs of hydrocele

	Total		Group 1		Group 2	
	Preoperative evaluation (%)	Intraoperative evaluation (%)	Preoperative evaluation (%)	Intraoperative evaluation (%)	Preoperative evaluation (%)	Intraoperative evaluation (%)
Communicating	12.2 ($n=14$)	65.5 ($n=74$)	7.6 ($n=5$)	53 ($n=35$)	19.1 ($n=9$)	83 ($n=39$)
Non-communicating	86.1 ($n=99$)	34.5 ($n=39$)	92.4 ($n=61$)	47 ($n=31$)	80.9 ($n=38$)	17 ($n=8$)
p value			$p<0.01$		$p<0.01$	
Unilateral	92 ($n=104$)	80.9 ($n=93$)	89.4 ($n=59$)	92.4 ($n=61$)	95.4 ($n=45$)	68.1 ($n=32$)
Bilateral	8 ($n=9$)	17.4 ($n=20$)	10.6 ($n=7$)	7.6 ($n=5$)	4.3 ($n=2$)	31.9 ($n=15$)
p value			$p>0.05$		$p=0.03$	

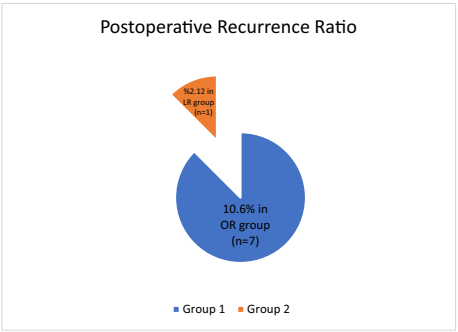


Fig. 2 Postoperative recurrence ratio. Recurrence was selected as the main complication and was observed in a total of 8 patients, 7 of which were detected after open repair and it consisted 10.6% of the group and 1 after laparoscopic repair and it consisted 2.12% of the group

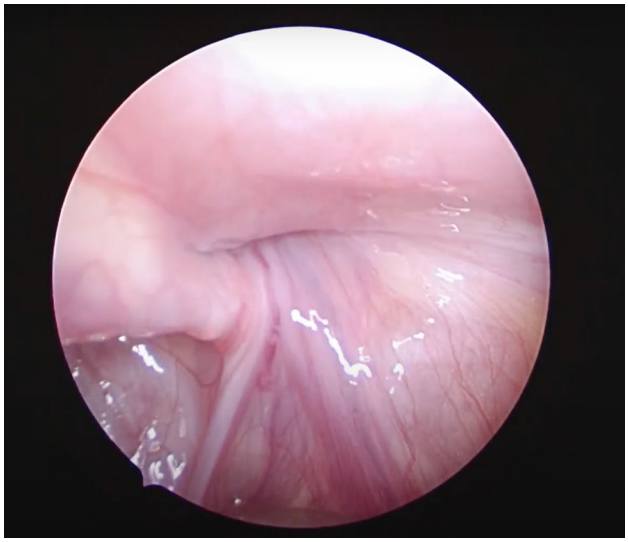


Fig. 3 Patent processus vaginalis in laparoscopic view

diagnosed patients was 4.5% ($n=3$). Contralateral PPV check is performed only in patients whose hernia sac is large enough for a 4 mm 30° angled scope to pass through ($n=16$) and PPV was detected in three patients and the repair for contralateral side is performed. According to the statistical tests performed, it was found that the rate of detecting communicating hydrocele was significantly different in favor of group 2, even if group 2 patients were operated for non-communicating hydrocele ($p<0.01$). Furthermore, in group 2 patients, as the result of only scrotal aspiration of hydroceles that were identified as non-communicating intraoperatively, no hydrocele recurrence has been reported in the follow-up to date. Results are summarized in Table 1.

The total recurrence rate was 7% ($n=8$). Recurrence was selected as the main complication and was observed in a total of 8 patients, 7 of which were detected after open repair and it consisted 10.6% of the group and 1 after laparoscopic repair and it consisted 2.12% of the group (Fig. 2). This difference was analyzed statistically, but no significant result was obtained due to the low amount of complications.

Discussion

The disadvantage of open surgery in hydrocele repair is inability to perform bilateral PPV patency control during the procedure. Hydrocele recurrence rates increase in cases where the presence of PPV is missed. In laparoscopic repair, even the smallest PPV can be detected and surgical intervention can be performed (Fig. 3). Therefore, in the presence of a possible opening in the inguinal canal, it is very unlikely to be missed in the laparoscopic group, even in the form of PPV. In our study, with the preoperatively non-communicating diagnosed patients, contralateral PPV detection rate of open surgery was 4.5%. As a result, the number of recurrences was observed much less in the laparoscopic group (10.6% group 1, 2.12% group 2).

Hydrocele and IH has similar pathogenesis. Both of them are result of incomplete obliteration of PPV. In group 1, the minimum age of operation was 2 months and in group 2, it was 7 months. Patients in standard hydrocele follow-up were followed until 1 year of age before surgery; however, in patients with symptomatic IH and giant tensioned hydrocele, this non-operative period may be shortened as this 2 and 7 month old children in our study. Laparoscopy in pediatric surgery is gaining wider acceptance all around the world. Although laparoscopic IH repair has become standard approach in most of the institutes, laparoscopic hydrocele repair has not gained this popularity yet. In this study, a comparison of open and laparoscopic hydrocele repair is presented.

In our center, 58.4% of the operations within the scope of the study were operated by open surgery, and 41.6% by laparoscopic procedure. During the study period, open surgery was mostly preferred in the early period and laparoscopic surgery increased gradually in the following years. Today, only laparoscopic surgery is used for hydrocele repair in our center.

Hydrocele is operated on through an inguinal incision during open surgery. Dissection and high ligation of PPV are performed to avoid fluid drainage to the hernia sac. Although most of the pediatric surgeons use the inguinal approach, there is always a risk to damage spermatic cord, testicular vessels and nearby structures [2]. The PPV, a translucent membrane, is situated in the inner front of the spermatic cord during open surgery. In children with hydrocele, the PPV wall is often thin, and the cremaster surrounds the tendril-shaped venous plexus in front of the spermatic cord, which includes the vas deferens and arteries. Due to its small size, the PPV can occasionally be challenging to locate during surgery, making it simple to inadvertently harm the vas deferens, cremaster, and other spermatic cord blood vessels. Following the procedure, there may be scar adhesions, localized bleeding, and swelling. In extreme situations, testicular atrophy may also occur [2, 10]. The laparoscopic lens can also be used for magnification. In order to protect the surrounding tissue, the operator can easily distinguish between the spermatic vein and the vas deferens in the abdominal cavity. Laparoscopy will also avoid the error of incorrectly ligating PPV at a low location, as Liu J. et al. noted that when the adhesion surrounding the PPV was evident, it was challenging for the operator to detach it to a higher position [11]. Our research revealed that laparoscopic hydrocele surgery has a lower risk of long-term complications and damage to these tissues (the testicular arteries, spermatic cord, and surrounding structures), and that none of the patients had any signs of cord or testicular vascular injury in our study. To distinctly illuminate this condition, though, larger patient populations in prospective trials are required.

Laparoscopic surgery has well known advantages against open surgery, like better cosmesis, less postoperative pain and faster recovery [7]. One of additional the advantage of laparoscopy in this regard is the ability to visualize contralateral inguinal ring. Ho et al. [2] and Owings et al. [12] reported that 3–30% of patients who were operated for unilateral hydrocele presented with contralateral symptomatic hydrocele or IH during follow-up [2, 12]. It is possible to perform the operation for contralateral side concomitantly when the contralateral PPV patency is observed under laparoscopic vision. Thus, the patient and family will be prevented from recurring anesthesia and surgical stress in the future. In our study, contralateral PPV was observed intraoperatively in 30% of patients with a preoperative unilateral diagnosis. Laparoscopic repair of hydrocele is superior to open repair in terms of detection of contralateral PPV.

Hydrocele can be divided into two subgroups as communicating and non-communicating. Communicating hydrocele is defined as a non-obliterated PPV and communicating hydrocele is defined as a obliterated PPV with fluid between layers of tunica vaginalis. In this study, it was found that vast majority ($n=22$, 78.9%) of preoperatively diagnosed non-communicating hydrocele were connected to the abdominal cavity via an open inguinal ring. Yang et al. observed 187 open PPV under laparoscopic visualization of 188 patients with prediagnosis of non-communicating hydrocele [8, 13]. Wang et al. observed only 5 of 164 non-communicating hydrocele patients without PPV [8]. It is now understood that PPV is the basis of the pathology and if the PPV is closed intraoperatively, and only fluid drainage between the tunica layers will be sufficient for the treatment of the pathology. Laparoscopic evaluation is the most effective method of diagnosis and treatment of PPV.

In a systematic review by Jin et al., recurrence rates after laparoscopic hydrocele repair were found to be 1.4–3.52% [6]. When open and laparoscopic methods were compared in terms of recurrence, no significant difference was found [7, 13, 14]. However, the incidence of other complications was shown to be less in the laparoscopy group [13, 14]. In our study, recurrence was observed in eight patients in total (7%). One (2.12%) recurrence occurred on the third month in the laparoscopic group and seven (10.29%) in the open group. The majority of recurrences were found in the first 2 years ($n=6$; 3, 3, 9, 17, 20, and 24 months, respectively), which was equal to Group 2's follow-up duration, despite the fact that group 1 had a longer follow-up duration (63 months). In the fifth postoperative year, just one patient in group 1 experienced a recurrence. When the rates are evaluated, it is seen that laparoscopy has lower rates of recurrence, although there is no statistically significant difference due to the low recurrence rate and number.

PIRS is a worldwide accepted standard operation technique that has demonstrated its effectiveness and advantages

in IH repair. Since the developmental pathophysiology of hydrocele and IH is similar, it is thought that the results of hydrocele repair will also be better with the same technique. The limited number of patients and the retrospective design of the study are the most important disadvantages of the study. However, similar results were obtained with the results of publications with higher patient amounts in the literature.

Conclusion

It has been shown that laparoscopic hydrocele repair does not change the recurrence and complication rates compared to open. It has been shown to be superior to open surgery in diagnosing communicating and non-communicating type and in evaluating the contralateral inguinal ring. The surgical technique described in this study, in which PIRS procedure and percutaneous drainage are applied together, is safe and feasible.

Author contributions UA: writing and supervision. EE: study design, literature research, analysis, and writing. EE: writing and supervision. FS: study design, literature research, analysis, and writing. Dİ: literature research and data collecting. PK: literature research and data collecting. HM: literature research and data collecting. GG: supervision. MBK: supervision. AMC: supervision.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations

Conflict of interest None.

Ethics approval Ethical approval was obtained from the local ethical committee. (Ankara University Faculty of Medicine Ethics committee application number: 2023000087-7).

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