

The role of laparoscopic procedure against inguinal hernia comparing with open procedure

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Abstract

Background

Laparoscopic approach, especially laparoscopic percutaneous extraperitoneal closure (LPEC) for inguinal hernia (IH) is widely spread but few studies have compared its invasiveness with that of conventional approach (OPEN). This study compared the role and postoperative early phase symptoms of LPEC with OPEN at our institute.

Methods

The records of 940 IH patients from 2014 to 2019 were analyzed on the basis of age, sex, method of surgery, pre- and post-operative diagnosis, postoperative symptoms, and complications.

Results

The OPEN group comprised 393 males, of which 44 were diagnosed with contralateral hernia (7.1%). In the LPEC group, 158 males had an average age of 3.88 years. The contralateral patent processus vaginalis (CPPV) was identified in 148 patients during operation. OPEN operation time for patients aged <1 year was 42.7 minutes, vs 33.4 minutes for LPEC. The two groups experienced comparable paces of fever and first oral intake time; however, pain and recurrence rate were greater in the LPEC group.

Conclusion

LPEC can be performed to avoid contralateral occurrence; surgical time is reduced for patients aged <1 year. However, the reduced invasiveness of LPEC compared to that of OPEN did not minimize postoperative symptoms or complications.

Background

Herniorrhaphy is one of the most conventional surgical procedures against inguinal hernia (IH) for pediatric surgeons [1]. Traditionally, open surgery has been performed for IH [2]; however, laparoscopy is currently being explored [3] as a treatment option [3-6]. Laparoscopic percutaneous extraperitoneal closure (LPEC) was first reported in 1995, and has gained popularity as being the standard treatment procedure for IH [7-10]. Its benefits are: 1) confirming the contralateral patent processus vaginalis (CPPV), indicating contralateral side recurrence in the future, and 2) the cosmetic result of the process. LPEC has the disadvantage of a higher recurrence rate than in the open method [11]; however, it has great benefits and, therefore, it is widely used.

Minimally invasive surgery (MIS) describes either a small incision or an approach not involving cutting tendons or splitting muscles. The benefits include reduced pain, rapid resumption of routine activities, and lesser tissue damage compared to traditional surgeries [12]. In pediatric surgery, LPEC is included under MIS. Comparative studies have been performed between LPEC and conventional open surgery [8-

10]; few papers have been analyzed with respect to the invasiveness that of postoperative early phase symptoms of the procedure. For the evaluation of the postoperative invasiveness, various factors have been investigated, such as operation and anesthesia times, and postoperative pain. This study aims to compare the role and invasiveness of LPEC with conventional open surgery for pediatric IH.

Methods

Study design

This multi-center study included a retrospective review of 940 patients who underwent IH repair between January 2014 to December 2019 from two independent hospitals (Showa University Koto Toyosu Hospital Children's Medical Centre, Showa University Northern Yokohama Hospital Children's Medical Centre) consecutively. The conventional method was employed for open surgery (OPEN), and LPEC was adapted to laparoscopy. In both centers, the techniques of OPEN and LPEC against IH, were presented to patients with respect to their pros and cons, who determined the method of operation. Medical records were reviewed with respect to age, sex, operative method and time, average period of the oral intake, and pre and postoperative symptoms, diagnosis and complications.

The post-operative early phase symptoms indicating the invasiveness of the operation and anesthesia were classified as "fever up" (over 38 degrees Celsius), "pain" (needing additional painkiller administration), and "vomiting" (post-surgery) within 3 hours after operation. All patients who underwent operation against IH were indirectly diagnosed. When the patients complain the pain postoperatively, the NSAIDS was administrated via oral or rectum. Criteria for enrollment included indirect IH and associated hydrocele. Patients who underwent other procedures, like umbilicoplasty or orchidopexy, simultaneously as herniorrhaphy, were excluded. Patients were permitted oral intake at least 3 hours after operation; this was adjusted according to the condition by the nursing staff. Patients were followed up in the outpatient clinic at 1 week, 1 month and 3 month postoperatively, to assess the prevailing conditions and wound healing, clinical symptoms of recurrence and/or contralateral metachronous inguinal hernia (CMIH) such as inguinal swelling. When recurrence and/or CMIH were doubtful, ultrasound examination were provided to assessment. No cases were loss for follow up.

Statistical analysis and ethics

The distribution of continuous data was evaluated using the student's *t*-test, and categorical variables with the Chi-square test. A *p*-value less than 0.05 was considered statistically significant.

There are no conflicts of interest to declare. This study protocol was approved by the Ethical Committee at Showa University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Surgical procedures

General anesthesia

All operative procedures were performed under general anesthesia with an intra-tracheal intubation. During the operation, 4–6 µg/kg of Fentanyl was administered intravenously. For the OPEN group, local anesthesia comprising of 1.5–2 mg/kg of Ropivacaine was applied by the surgeon. For LPEC, Rectus Sheath Block was preoperatively applied using 1.5–2 mg/kg of Ropivacaine.

OPEN procedure

Open method for IH was performed as described by Potts et al [2]; this is high ligation and removal of hernia sac. A skin incision was made on the lower abdominal wall, measuring approximately 1.5 cm. The external oblique aponeurosis was incised, as the fiber direction and muscle layer were split. The hernial sac was identified and divided from the testicular vessels and spermatic cord in males. High ligation was performed by the double transfixation of absorbable suture materials of size 3-0. The uterine cord was ligated together in females. The hernial sac on the distal side was explored and opened. The closure of the fascia and skin was carried out, and the incision was covered by tape and glue.

LPEC procedure

Laparoscopic method for IH was performed, as described by Takehara et al [7]. The 3-mm trocar was inserted through the umbilicus for laparoscopy; a 2-mm trocar was inserted on the right side of the abdomen for the active port using grasping forceps. Pneumoperitoneum was maintained at a pressure of 8 mmHg, with a CO₂ flow rate of 1-3 L/min. Plying a unique needle (19G LAPAHER CLOSURE[®], Hakko Medical Co., Nagano, Japan), the internal inguinal ring was secured by a 2-0 non-absorbable suture, avoiding any peritoneal gap and injury of the testicular vessels and spermatic cord in males. This procedure was applied independently of the size of inguinal ring. In case the CPPV had been marked, closure should have been done at the same time. Closure of the peritoneum and fascia was performed for the umbilicus wound. Skin incision was covered by glue. In patients with hydrocele, the puncture procedure was added to the scrotum.

Results

Patient demographics are shown in Table 1. OPEN was performed on 612 patients, whereas LPEC was performed on 328. In the OPEN group, there were 393 males with an average age of 4.05 years. Patients aged < 1 year comprised 5% of the group. In the LPEC group, there were 158 males, with an average age of 3.88 years. Patients aged <1-year-old were 6%. The differences of gender and age distribution between OPEN and LPEC had no significant differences. Preoperatively, unilateral IH was diagnosed in 583 patients (96%) in the OPEN and 307 (93%) in LPEC groups. Bilateral IH was diagnosed preoperatively in 29 patients (4%) in OPEN and 21 (6%) in LPEC. Postoperatively, the diagnosis was unchanged in the OPEN group with 96% unilateral hernia, against 48% in the LPEC group (p<0.05); bilateral measured 4% in the OPEN group against 52% in the LPEC group, respectively (p<0.05). Therefore, 148 (45%) patients were confirmed with CPPV during operation; prophylactic ligation was performed in the LPEC group. It was

found that 44 patients (7.1%) developed contralateral metachronous inguinal hernia (CMIH) in the OPEN group and none did in the LPEC group. No procedure conversion took place.

The operation time comparison for each age group is shown in Table 2. The mean operation time for patients aged <1 year was 42.7 minutes in the OPEN group, and 33.4 minutes in the LPEC group ($p<0.05$). Other age groups showed no significant difference of operation time between OPEN and LPEC. The anesthesia time comparison in each age group is shown in Table 2. The mean anesthesia time for patients aged 1–5 years and 6–10 years were 75.6 min and 69.8 min in the OPEN group, against 83.5 min and 76.9 min in the LPEC group, respectively ($p<0.05$). In addition, the mean anesthesia time was 74.6 min in the OPEN group, and 81.8 in the LPEC group ($p<0.05$).

The postoperative symptoms is indicated in Table 2. There was no significant difference of the postoperative time with respect to the oral intake in total, and in each age group between OPEN and LPEC. In the <1 year group, 21% and 10% of patients suffered fever up in the OPEN and LPEC groups, respectively ($p<0.05$). In the patients aged 1–5-years, 11% suffered from fever up in the OPEN group, and 18% did in the LPEC group, respectively ($p<0.05$). There was no significant difference of fever up patients in other age groups between OPEN and LPEC. In the patients aged 6–10-years, 16% suffered pain in the OPEN group, and 25% did in the LPEC group, respectively ($p<0.05$).

In total, 6.6% suffered pain in the OPEN group, and 18% did in the LPEC group, respectively ($p<0.05$). There was no significant difference in patients suffering vomiting in various age groups between the OPEN and LPEC groups.

The postoperative complications are shown in Table 3. Wound infections were observed in 0% patients in the OPEN group, and in 1.2% in the LPEC group ($p<0.05$). The recurrence rate was 0.8% in the OPEN group, and 1.8% in the LPEC group ($p<0.05$). Hematoma in wound, scrotum swelling, and cryptorchidism were dominantly observed in the OPEN group.

Discussion

The principle of surgical treatment for pediatric IH remains high ligation of the hernia sac at the internal inguinal ring. Open herniorrhaphy is considered the gold standard and the most performed surgical procedure in pediatric IH. Several laparoscopic IH repairs have been reported over the last decade. The advantages include a clear operative field, prophylactic surgery of the contralateral side, and the prevention of injuries for vessels and the spermatic cord [13,14]. Comparing the methods between open and laparoscopic surgery, Alzahem reported meta-analysis in 2011 using 10 comparative studies [15]. Laparoscopic techniques were associated with a trend towards a higher recurrence rate, variable operative time for repairs, and a reduction in metachronous hernia development [15]. LPEC was reported in 1995, and has gained popularity as the standard procedure for IH [7]. Operative times were found to be shorter in LPEC [8,9]. Modified LPEC displayed a longer operative time than the open method, but no statistically significant difference was found in the recurrence rate [10]. We classified our data as per the age group; infant (<0 year), toddler (1 to 5 years old), school child (6 to 10 years old), and adolescents

(>11 years old); operative easiness, tissue weakness, and expression of invasiveness affect the results in each group. No significant difference was reported in the operative time of the one-year-old group, but infants displayed a shorter operative time with LPEC than with OPEN. In infants, during OPEN procedure, the adipose tissue interferes with the distinct operative field; the peritoneal hernia sac is so weak and thin that the dissection from the testicular vessels and spermatic cord require concentration rather than age. On the other hand, LPEC shows an identical operative field and management independently of age. In the present study, the anesthesia time was significantly longer in the toddler and school child groups. Pneumoperitoneum at LPEC pressure of 8-10 mmHg requires deep sedation rather than OPEN; this prompts lengthier postoperative recovery.

Another benefit of the laparoscopic method is confirming CPPV [9,10]. There is a 5–20% chance of developing a contralateral hernia in pediatric patients [3]. Data suggest that the incidence of the contralateral metachronous inguinal hernia (CMIH) was significantly higher in the OPEN group than in the LPEC group. The propriety of this benefit is vague as CPPV is not always predictive of symptomatic CMIH. Studies reveal the risk of developing symptomatic IH with asymptomatic patent processus vaginalis [16,17]. These rates are relatively low; however, further studies in elderly individuals diagnosed with indirect hernia with CPPV in childhood are required.

MIS represents a term that describes either a small incision or an approach not involving cutting tendons or splitting muscles. Some centers employing laparoscopic method for IH believe this procedure is less painful, resulting in earlier recovery and improved appearance [18]. Many papers describe the surgical invasiveness using intraoperative blood loss, size of skin incision, the length of operation [19]. Brio et al describes pUSIS score using surgical access, magnitude of targeted organ, and associated factors such as blood loss and the location and number of inserted drainages; however, these scores evaluate the invasiveness of each surgical approach [20]. In the procedure for pediatric inguinal hernia, many studies have been carried out comparing conventional open surgery and LPEC; however, few papers have compared for circumstantial invasiveness [15]. We measured the invasiveness of operation and general anesthesia that of postoperative early phase symptoms by (1) mean hours to first oral intake, (2) fever up, (3) pain, and (4) vomiting. In our results, no significant difference was observed in the mean hours to the first oral intake and vomiting after operation. This means the recovery from general anesthesia is equal in both groups. In fever up, the longer operation time in infants should cause a significantly vaster effect of fever up in the OPEN group. LPEC had significant defects on fever up in the toddler group and pain in the school age group. As this evaluation of symptoms is indirect and not quantitative, a more direct and quantified method should be utilized further, such as visual analogue scale. Comparing the postoperative complications in our data, wound infection, especially in the umbilicus port site, was appealing in patients with LPEC. Miyake et al indicated the umbilicus lesion in LPEC contains much greater bacterium than the inguinal skin wound in patients with OPEN [10]. This would be improved by sterilization before incision. Hematoma, scrotum swelling, and cryptorchidism are dominant in the OPEN group. These are reasonable because LPEC never touches the scrotum; the peritoneum from testis vessels and spermatic cord are separated sufficiently. Taylor et al describes the risk factors of recurrence in pediatric IH with a nationally representative cohort study. The incidence rate was the highest among

children who underwent initial primary repair at the age of <1 year [21]. Comparing the recurrence of IH between open and laparoscopic surgery, many papers indicate a higher recurrence rate for laparoscopy [14,22,23]. However, Parelkar et al indicated technical modifications that they were capable of reducing the recurrence rate from 2.9% to 0% [24]. Modified LPEC has a low recurrence rate, equivalent with the open method [9]. Our data suggests a higher recurrence rate for laparoscopic repairs. Further development of the laparoscopic procedure will reduce the incidence of recurrence in future.

Conclusion

LPEC can be performed to avoid contralateral recurrences; surgical time is reduced for patients aged < 1 year. However, the reduced invasiveness of LPEC compared to that of POTTS did not minimize postoperative symptoms or complications.

Abbreviations

LPEC: laparoscopic percutaneous extraperitoneal closure for inguinal hernia

IH: inguinal hernia

OPEN: conventional approach for inguinal hernia

CPPV: contralateral patent processus vaginalis

CMIH: contralateral metachronous inguinal hernia

Declarations

Conflict of interest disclose main author: Hideaki Sato

In relation to this manuscript, there is no COI to be disclosed.

Ethics approval and consent to participate

This study protocol was approved by the Ethical Committee at Showa University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent for publication

Not Applicable

Availability of data and material

The datasets generated and analyzed during the current study are not publicly available to protect the privacy of the study participants but are available from the corresponding author on reasonable request.

Competing interests

In relation to this manuscript, there is no COI to be disclosed.

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Authors' contributions

HS: SP: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing- Original Draft, Visualization JY: Review & Editing AS: Investigation, Resources TN: Investigation, Resources YW: Review & Editing, Supervision, Project administration, Guarantor. All authors have read and approved this manuscript.

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Tables

Table 1. Patient's Characteristics

		OPEN n=612	LPEC n=328	Significance <i>p</i>
Gender	Male	393(65%)	158(48%)	<i>NS</i>
	Female	219(35%)	170(52%)	<i>NS</i>
Mean age at surgery (year)		4.05	3.88	<i>NS</i>
Age distribution	Under 1	33 (5%)	20 (6%)	<i>NS</i>
	1 to 5	423 (69%)	219 (66%)	<i>NS</i>
	6 to 10	141 (23%)	78 (23%)	<i>NS</i>
	Over 11	15 (2.4%)	11 (3%)	<i>NS</i>
Pre operative diagnosis	Unilateral	533 (96%)	307 (93%)	<i>NS</i>
	Bilateral	29 (4%)	21 (6%)	<i>NS</i>
Post operative diagnosis	Unilateral	533 (96%)	159 (48%)	<i><0.05</i>
	Bilateral	29 (4%)	169 (51%)	<i><0.05</i>
Contralateral metachronous inguinal hernia		44 (7.1%)	0 (0%)	<i><0.05</i>

Table 2. Operation time and Postoperative symptoms

	Operation Time (min)			Anesthesia Time (min)			Average Hours to first oral intake			Fever Up			Pain			Vomit		
	OPEN	LPEC	Significance	OPEN	LPEC	Significance	OPEN	LPEC	Significance	OPEN	LPEC	Significance	OPEN	LPEC	Significance	OPEN	LPEC	Significance
Under 1	42.7	33.4	<i>p</i> <0.05	84.1	82	NS	3.02	3.09	NS	7(21%)	2(10%)	<i>p</i> <0.05	0(0%)	0(0%)	NS	2(6%)	1(5%)	NS
1 to 5	37.3	38.2	NS	75.6	83.5	<i>p</i> <0.05	3.11	3.2	NS	52(11%)	40(18%)	<i>p</i> <0.05	14(3%)	17(7%)	NS	25(2%)	17(8%)	NS
6 to 10	31.8	34.7	NS	69.8	76.9	<i>p</i> <0.05	3.15	3.08	NS	6(4%)	1(1%)	NS	23(16%)	20(25%)	<i>p</i> <0.05	19(13%)	8(10%)	NS
Over 11	43.5	37.2	NS	78.2	80	NS	3.16	3.15	NS	0(0%)	0(0%)	NS	2(13%)	2(18%)	NS	1(6%)	0(0%)	NS
Total	36.2	37.4	NS	74.6	81.8	<i>p</i> <0.05	3.12	3.17	NS	65(10%)	43(13%)	NS	41(6%)	39(11%)	<i>p</i> <0.05	47(7%)	26(8%)	NS

Table 3. Complications

	OPEN	LPEC	Significance
Wound Infection	0 (0%)	4 (1.2%)	<i>p</i> <0.05
Recurrence	5 (0.8%)	6 (1.8%)	<i>p</i> <0.05
Contralateral Swelling	44 (7%)	0 (0%)	NS
Hematoma	5 (0.8%)	0 (0%)	NS
Scrotum Swelling	13 (2%)	0 (0%)	NS
Testis Elevation	2 (0.3%)	0 (0%)	NS