

Takaharu Oue · A. Kubota · H. Okuyama
H. Kawahara

Laparoscopic percutaneous extraperitoneal closure (LPEC) method for the exploration and treatment of inguinal hernia in girls

Accepted: 21 September 2005 / Published online: 19 October 2005
© Springer-Verlag 2005

Abstract We recently introduced the laparoscopic percutaneous extraperitoneal closure (LPEC) method for the treatment of girls with inguinal hernia. Using the LPEC method, 129 girls underwent laparoscopic herniorrhaphy. A 5 mm laparoscope was inserted via the umbilicus. A 3 mm “snake retractor” was advanced through the lateral abdominal wall to measure the length of the hernia sac and contralateral patent processus vaginalis (PPV), respectively. The hernia sac and PPV were closed at the level of the internal inguinal ring with a 2-0 non-absorbable purse-string suture using Lapaherclosure™, a special 19G needle that can hold a suture at the tip. The length of the hernial sac was significantly longer than that of contralateral PPV (mean 41 mm; range 18–70 mm; $P < 0.05$). There were no serious complications associated with the procedure. No recurrence of hernia or metachronous contralateral hernia has been identified so far. This approach enables us to perform contralateral exploration without any additional techniques, followed by immediate and accurate closure of the hernia sac and PPV. We conclude that the LPEC method is a safe and efficacious procedure with a low recurrence rate that should be viewed as an acceptable alternative to the traditional open approach.

Keywords Inguinal hernia · Children · Laparoscopic herniorrhaphy · Contralateral exploration

T. Oue (✉)
Department of Pediatric Surgery, Jichi Medical School,
3311-1 Yakushiji, Minamikawachi-machi,
Kawachi-gun, Tochigi, 329-0498 Japan
E-mail: oue@jichi.ac.jp
Tel.: +81-285-587371
Fax: +81-285-443234

A. Kubota · H. Okuyama · H. Kawahara
Department of Pediatric Surgery,
Osaka Medical Center for Maternal and Child Health,
840 Murodo-cho, Izumi, Osaka, 594-1101 Japan

Introduction

Recently, laparoscopic inguinal herniorrhaphy has been introduced as an alternative to conventional open repair in children [1–7]. In our institute, laparoscopic surgery in girls with inguinal hernia was started in 2001 and since then the use of laparoscopic procedures has increased rapidly. The laparoscopic percutaneous extraperitoneal closure (LPEC) method, which was originated by Takahara et al. [4], is employed. We perform the procedure using a new device called the “Lapaherclosure™” (Hakko Medical Co., Tokyo, Japan) to place a purse-string suture around the internal inguinal ring. This procedure easily allows contralateral exploration and immediate closure of the contralateral patent processus vaginalis (PPV) in only 5–10 min without the need for additional trocar. This can prevent a second operation and thereby reduce both economic burden and procedural risks to patients. In this study, we compared this laparoscopic procedure with conventional open herniorrhaphy and evaluated the utility, efficacy, and safety of this minimally invasive approach. Moreover, we measured the length of hernial sac and PPV using a “snake retractor” to elucidate the nature of contralateral development of hernias.

Materials and methods

Patients

Between March 2001 and December 2002, 129 girls with inguinal hernia received laparoscopic herniorrhaphy (laparoscopic group). Their mean age was 4 years and 4 months (range 4 months–13 years); 53 cases (41%) were left side, 62 (48%) were right side, and 14 (11%) displayed bilateral hernia. During the same period, 21 girls with inguinal hernia underwent conventional open herniorrhaphy (control group). The surgical method was chosen by the parents. Mean age was almost identical

between the laparoscopic group and the control group. Mean operational time, anesthesia time, complications, recurrence rates, and medical costs were compared between the two groups (Table 1).

Surgical method

The patients were placed in a supine position and received general anesthesia with tracheal intubation. A 5 mm trocar for a 5 mm laparoscope was inserted via the umbilicus. Following the establishment of pneumoperitoneum with a pressure of 8 mmHg, a 30° 5 mm laparoscope was inserted through the umbilicus, a 3 mm trocar was positioned via the lateral abdominal wall, and 3 mm grasping forceps were inserted to manipulate the peritoneum near the hernia defect (Fig. 1). The asymptomatic contralateral internal inguinal ring was routinely evaluated for a PPV. The length of the hernial sac and PPV were measured using a 3 mm flexible retractor (Diamond-Flex Snake Retractor™, Snowden Pencer, USA) to define the relation of age, side, and clinical signs of inguinal hernia. The retractor consists of multiple segments and a flexible tip and can therefore be inserted through both the internal inguinal rings to measure the length of the hernial sac or PPV (Fig. 2).

The internal orifice of the inguinal canal was closed with a purse-string suture of 2-0 non-absorbable suture thread using a Lapaherclosure™, a special needle that has a wire loop to hold the suture thread at the tip (Fig. 3). This needle, with an outer diameter of 1.5 mm, is inserted through the abdominal wall together with the 2-0 non-absorbable suture at the midpoint of the right or left inguinal line. One half of the purse string suture was begun extraperitoneally from the anterior to the posterior edge on one half of the internal inguinal ring. After that, the suture thread was removed from the needle and the opposite half of the rim of the internal ring was closed with a purse-string suture using the same technique. The Lapaherclosure was then removed from the abdomen together with the suture thread. The purse-string suture was tied extracorporeally, and the internal inguinal ring was then completely closed (Fig. 4). If the contralateral processus vaginalis was open, it was closed using the same approach. Patients were admitted in the morning and discharged the afternoon of the same day (outpatient or “day care” surgery).

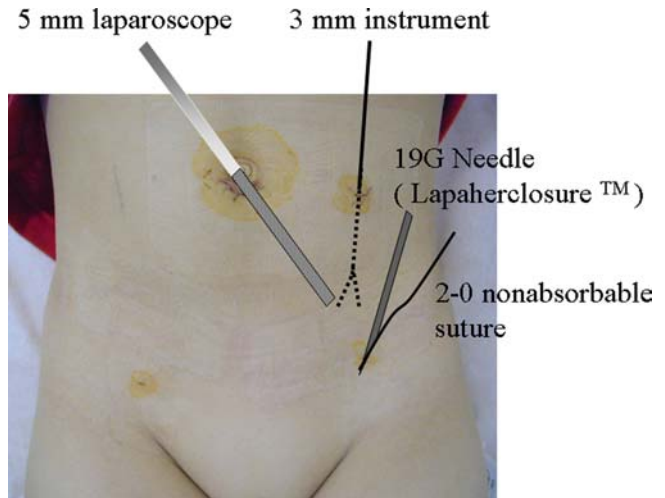


Fig. 1 Laparoscopic herniorrhaphy. A 30° 5 mm laparoscope was inserted through the umbilicus, while a 3 mm trocar was placed via the lateral abdominal wall with insertion of 3 mm grasping forceps. A special needle (Lapaherclosure™) with suture is passed at the level of the inguinal ring to place the purse-string suture around the internal inguinal ring

Results

The mean operating time for laparoscopic herniorrhaphy was 48 ± 15 min (range: unilateral 45 ± 16 min, bilateral 54 ± 13 min), while anesthetic time was 92 ± 17 min (range: unilateral 88 ± 17 min, bilateral 96 ± 15 min). With experience, the time gradually decreased. At present, a skilled operator can perform a laparoscopic bilateral herniorrhaphy within 30 min. Operating and anesthetic times were significantly longer than those of conventional open herniorrhaphy ($P < 0.05$; Table 1).

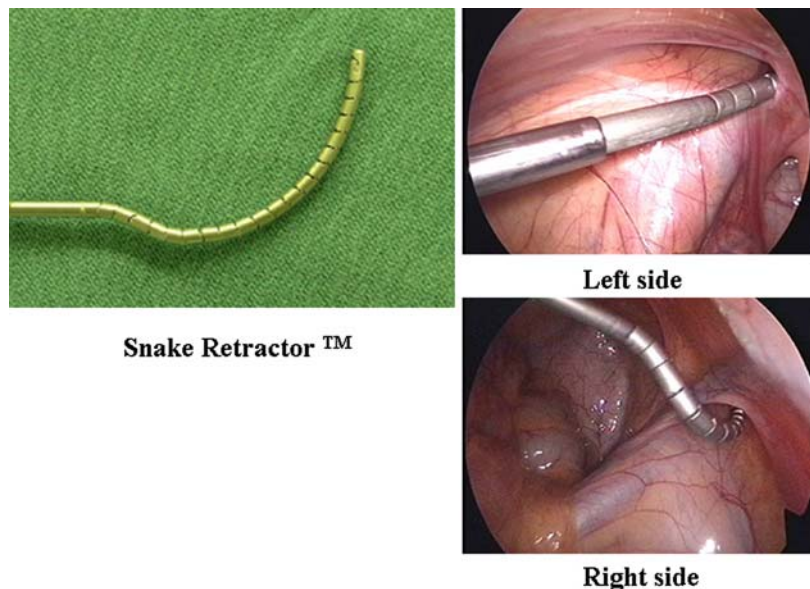
The average medical cost of laparoscopic herniorrhaphy was about 3,140 euros, whereas that of conventional herniorrhaphy was about 1,240 euros in unilateral hernias and 1,970 euros in bilateral cases. Except for minor bleeding from peritoneal vessels, there were no major intra- or post-surgical complications observed in either laparoscopic or conventional herniorrhaphy.

Contralateral asymptomatic PPV was observed in 21 of 62 (33.9%) right-side and 19 of 53 (35.8%) left-side hernias. Therefore contralateral PPV was present in

Table 1 Operative time, anesthetic time, and hospital days

	LPEC (n = 129)	Control (n = 21)
Age	4 years 4 months (4 months–13 years)	4 years 7 months (1 year 4 months–11 years)
Operative time	48 ± 15 min	21 ± 5 min
Unilateral	45 ± 16 min	20 ± 5 min
Bilateral	54 ± 13 min	27 ± 5 min
Anesthetic time	92 ± 17 min	51 ± 10 min
Unilateral	88 ± 17 min	49 ± 8 min
Bilateral	96 ± 15 min	64 ± 11 min
Hospital days	Outpatient procedure	Outpatient procedure

Fig. 2 Measurement of hernia sac/PPV. The length of the hernial sac/PPV was measured using a 3 mm flexible retractor (Diamond-Flex Snake Retractor™). The retractor consists of multiple segments and a flexible tip and can be inserted through both the internal inguinal rings to measure the length of the hernial sac or PPV



Snake Retractor™



Lapaherclosure™

Fig. 3 Lapaherclosure. The internal orifice of the inguinal canal was closed with purse-string sutures of 2-0 non-absorbable suture thread using a Lapaherclosure™, a special needle that has a wire loop to hold the suture thread at the tip

34.8% (40 cases) of the 115 patients who showed clinical evidence of unilateral inguinal hernia. In those patients, we performed prophylactic laparoscopic closure of the opened processus vaginalis. The laparoscopic approach leaves a very small scar with excellent cosmetic results. The average follow-up time of patients was 28 months (range 12–48 months), and there was no recurrence or subsequently developed contralateral inguinal hernia.

Measurement of the length of the hernial sac and PPV (Table 2) has proven that the hernial sac (5.5 ± 1.3 cm; $n = 65$) was significantly longer than the contralateral asymptomatic PPV (4.0 ± 1.9 cm; $n = 13$) ($P < 0.05$). There was no significant difference between the left side (5.4 ± 1.6 cm; $n = 43$) and right side (5.0 ± 1.5 cm; $n = 40$). The minimum length of a symptomatic hernia sac was 27 mm. There was no significant relationship between the length of the hernia sac or PPV and age (Fig. 5).

Discussion

The initial use of laparoscopy in the pediatric hernia patient was to examine the contralateral groin, either through a port or the opened hernia sac, during open unilateral hernia surgery [8–11]. Recently, the use of laparoscopic herniorrhaphy in pediatric surgery has jumped due to improvements in laparoscopic techniques [1–7]. Reported excellent outcomes in large studies have confirmed that laparoscopic herniorrhaphy in children is an acceptable alternative to the traditional open approach.

Reported advantages of laparoscopic herniorrhaphy include minimizing dissection as well as reducing trauma to the inguinal canal and spermatic cord. There is no longitudinal skin incision in the abdominal wall, leading to better cosmetic results, and the risk of infection is less compared with the traditional open approach. We use 3 mm instruments, which are inserted through 3 mm trocars, leaving virtually no scar. Bilateral hernia can be repaired with the same wound. In addition to these advantages, we believe that the greatest benefit from this technique is the opportunity to evaluate the contralateral side. The incidence of contralateral hernia after unilateral herniorrhaphy is reported to be 8.8–11.6% [12–14]. In our experience, prior to the introduction of laparoscopic herniorrhaphy, contralateral hernia was

Table 2 Length of the hernia sac/PPV (cm)

Side	No.	Length	Range	<i>P</i> value
Left	43	5.4 ± 1.6	2.0–7.5	<i>P</i> < 0.01
Right	40	5.0 ± 1.6	1.8–7.5	
Hernia sac	65	5.5 ± 1.3	2.6–7.5	
Contralateral PPV	18	4.0 ± 1.9	1.8–7.0	

PPV persistent processus vaginalis, NS not significant

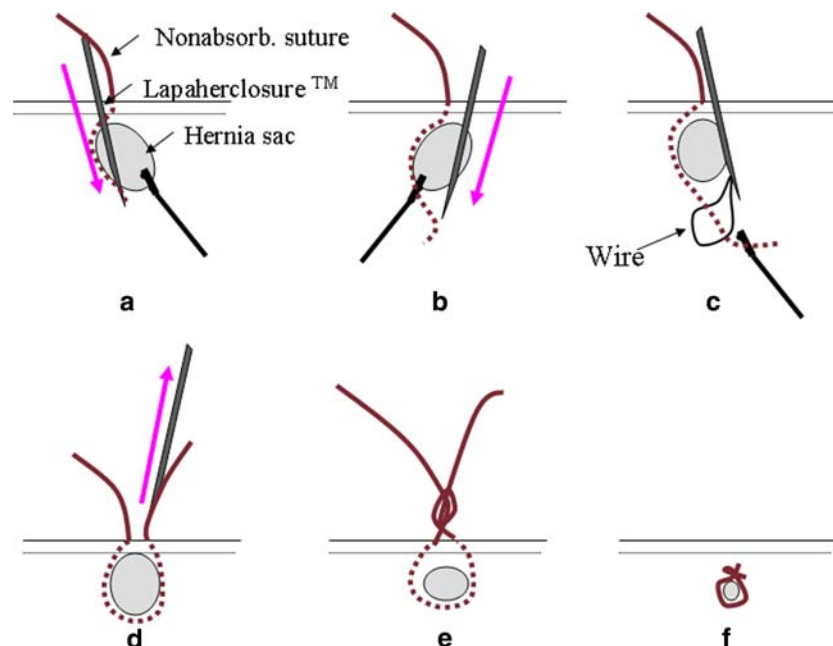


Fig. 4 Operational technique. **a** Using the grasper for traction, the needle and suture are passed around the lateral aspect of the hernia sac at the level of the inguinal ring, remaining extraperitoneal until half of the sac has been surrounded. The peritoneum was pierced with the needle, and the end of the suture was removed from the needle using the grasper. **b** The needle is withdrawn and the empty needle is then inserted and passed around the medial half of the

neck of the hernia defect. The peritoneum is reentered where the suture enters the peritoneal cavity. **c** The intraperitoneal end of the suture is passed through the wire and held. **d** The needle is again withdrawn with the suture. **e** The suture is tied extracorporeally, completing an extraperitoneal high ligation of the sac. **f** After cutting the excess suture, the knot retracts subcutaneously

observed within 5 years in 6.5% (27 of 415 cases) of girls who received conventional unilateral inguinal hernia repair. However, there was no contralateral hernia observed after laparoscopic herniorrhaphy in our series. These findings suggest that contralateral exploration and prophylaxis closure of PPV during laparoscopic herni-

orrhaphy can prevent the occurrence of contralateral inguinal hernia.

The relationship of the length of processus vaginalis to the development of hernia is still unknown. In this study, we measured the length of the hernia sac and PPV using an Endo SnakeTM. The results have shown that hernia sac was significantly longer than an asymptomatic PPV without hernia. One reason is that the hernia sac may be enlarged by the incarcerated organs. Another possibility is that a small PPV may not develop into a clinical hernia. In this study, the minimum size of a hernia sac was 27 mm. Based on this, we consider that PPV which are smaller than 20 mm are unlikely to develop into clinical hernias, making a closure procedure unnecessary.

There have been numerous reports describing various laparoscopic techniques for pediatric inguinal hernia repair [1–7]. In most of these series, an intracorporeal purse-string suture or Z sutures were placed around the neck of the hernia sac, which is then closed intracorporeally. However, we have introduced a new technique in which the neck of the hernia sac is closed with an extraperitoneal purse-string suture. The suture is applied using a special needle designed specifically for laparoscopic herniorrhaphy. This needle—LapaherclosureTM—is commercially available from Hakko Medical Co., Tokyo, Japan.

The recurrence rate of inguinal hernia has been reported to be slightly higher with laparoscopic hernior-

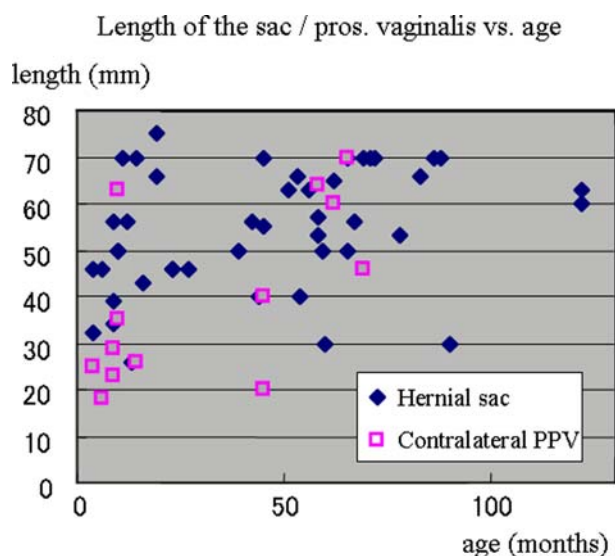


Fig. 5 Relation between the length of the sac/PPV and age. No significant correlation was observed. The minimum size of a hernia sac was 27 mm

rhaphy than with the conventional technique. Montupet and Esposito [2] reported that in two of 45 patients (4.4%) there was a recurrence on the same side. However, the results of our series show that our procedure has a high success rate and a low incidence of complications; there was no recurrence and no major complications in any patient within 2 years. Endo and Ukiyama [5] also reported on the similar technique of extraperitoneal closure of hernia sacs using the Endo-needle, with no complications and low recurrence rates (0.88%). The low incidence of recurrent hernia in our procedure may be due to extraperitoneal closure and extracorporeal ligature, which provide more accurate closure of the hernia sac.

We first performed laparoscopic herniorrhaphy only in girls to avoid the risk of injury to the vas deferens or the blood supply of the testis and iatrogenic ascent of the testis. It has been reported that damage to the vas deferens and blood supply to the testes may cause atrophy of the testis, diminished size of the testis, and iatrogenic cryptorchism [15]. Now that the procedure's techniques have been established and operators are more skilled, we are planning to extend the procedure to boys.

We believe that the technique described here is an effective and reliable therapy. Contralateral exploration and closure of asymptomatic PPV can prevent the occurrence of contralateral inguinal hernia and thereby preclude the need for additional surgery later. We conclude that the LPEC method is a safe and efficacious procedure that should be viewed as an acceptable alternative to the traditional open approach.

References

- Schier F (1998) Laparoscopic herniorrhaphy in girls. *J Pediatr Surg* 33:1495–1497
- Montupet P, Esposito C (1999) Laparoscopic treatment of congenital inguinal hernia in children. *J Pediatr Surg* 34:420–423
- Schier F (2000) Laparoscopic surgery of inguinal hernias in children—initial experience. *J Pediatr Surg* 35:1331–1335
- Takahara H, Ishibashi H, Satoh H, Fukuyama T, Iwata T, Tashiro S (2000) Laparoscopic surgery for inguinal lesions of pediatric patients. In: *Proceedings of 7th world congress of endoscopic surgery*, pp 537–542
- Endo M, Ukiyama E (2001) Laparoscopic closure of patent processus vaginalis in girls with inguinal hernia using specially devised suture needle. *Pediatr Endosurg Innov Tech* 5:187–191
- Schier F, Montupet P, Esposito C (2002) Laparoscopic inguinal herniorrhaphy in children: a three-center experience with 933 repairs. *J Pediatr Surg* 37:395–397
- Gorsler CM, Schier F (2003) Laparoscopic herniorrhaphy in children. *Surg Endosc* 17:571–573
- Grossmann PA, Wolf SA, Hopkins JW, Paradise NF (1995) The efficacy of laparoscopic examination of the internal inguinal ring in children. *J Pediatr Surg* 30:214–218
- Wulkan ML, Wiener ES, VanBalun N, Vescio P (1996) Laparoscopy through the open ipsilateral sac to evaluate presence of contralateral hernia. *J Pediatr Surg* 31:1174–1177
- Miltenburg DM, Nuchtern JG, Jaksic T, Kozinetz C, Brandt ML (1988) Laparoscopic evaluation of the pediatric inguinal hernia—a meta analysis. *J Pediatr Surg* 33:874–879
- Yerkes E, Brock JW, Holocomb GW, Morgan WM (1998) Laparoscopic evaluation for a contralateral patent processus vaginalis: part III. *Urology* 51:480–483
- Ulman I, Demircan M, Arıkan A, Avanoğlu A, Ergun O, Ozuk G, Erdener A (1995) Unilateral inguinal hernia in girls: is routine contralateral exploration justified? *J Pediatr Surg* 30:1684–1686
- Kemmotsu H, Oshima Y, Joe K, Mouri T (1998) The features of contralateral manifestations after the repair of unilateral inguinal hernia. *J Pediatr Surg* 33:1099–1103
- Tackett LD, Breuer CK, Luks FI, Caldamone AA, Breuer JG, DeLuca FG, Caesar RE, Efthemiou E, Wesselhoeft CW Jr (1999) Incidence of congenital inguinal hernia: a prospective analysis. *J Pediatr Surg* 34:684–688
- McGregor DB, Halverson K, McVay CB (1980) The unilateral pediatric inguinal hernia: should the contralateral side be explored? *J Pediatr Surg* 15:313–317