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Laparoscopic inguinal hernia repair by modified peritoneal leaflet closure: description and initial results in children

Jason P. Van Batavia^{a,*}, Carmen Tong^b, David I. Chu^a, Trudy Kawal^a, and Arun K. Srinivasan^a

^aDivision of Urology, Children's Hospital of Philadelphia, Perelman School of Medicine at University of Pennsylvania, Philadelphia, PA, USA

^bDepartment of Urology, Einstein Healthcare Network, Philadelphia, PA, USA

Summary

Introduction—Inguinal hernias are common in infants and children. While the gold standard for hernia repair in the pediatric period has been via an open inguinal incision with dissection and high ligation of the hernia sac, over the past two decades laparoscopic herniorrhaphy has increased in popularity. The advantages of laparoscopy include decreased post-operative pain, improved cosmetic results, ability to easily assess the contralateral side for an open internal inguinal ring, and decreased risk of metachronous hernias. Herein, we describe a modified laparoscopic herniorrhaphy using a peritoneal leaflet closure and report our operative experience with intermediate-term results.

Methods—We retrospectively reviewed our IRB-approved registry for all children who underwent initial laparoscopic herniorrhaphy at our tertiary care center over a 2.5-year period. All surgeries were performed by a single surgeon using a technique we have termed the peritoneal leaflet closure. This technique involves incising the peritoneum circumferentially around the open internal ring and developing peritoneal leaflets which are then closed together over the ring with a running non-absorbable barbed stitch (Figure). Intraoperative findings and complications, operative times, and post-operative complications were reviewed for all children.

Results—A total of 50 initial laparoscopic hernia repairs (4 bilateral, 42 unilateral) were performed in 46 children (43 boys, 3 girls) at a median age of 5.9 years (range 0.5–16.7). Median operative time was 73 minutes (range 48–138) for unilateral and 106 minutes (range 104–135) for bilateral herniorrhaphy. No patient had an intraoperative complication. Two children (4%) had contralateral open rings discovered at time of surgery and underwent unplanned bilateral laparoscopic hernia repair. All patients went home on the same day as the procedure and three children (6%) had minor post-operative complaints (umbilical bulge, thigh pain, and urine

*Corresponding author. Pediatric Urology, The Children's Hospital of Philadelphia Division of Urology, 3rd Floor Wood Building, 34th and Civic Center Blvd, Philadelphia, PA 19104, USA. vanbatavij@email.chop.edu.

Conflict of interest

None.

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holding) that all self-resolved. Thirty-nine children had follow-up data available. Intermediate-term complications occurred in two children (5%): one boy developed a contralateral hydrocele (despite a closed ring at surgery) and one boy had a hernia recurrence that required open repair. Overall, operative success with the modified peritoneal leaflet closure technique was therefore 97% (38 of 39 children with follow-up). All 37 boys who followed up had bilateral descended testes of normal size and consistency.

Conclusions—Laparoscopic herniorrhaphy using a peritoneal leaflet closure technique is safe and effective when used in infants and children to close an indirect hernia (i.e. patent processus vaginalis). No intraoperative complications occurred in this cohort and success rate was 97%.

Keywords

Laparoscopy; Inguinal hernia repair; Herniorrhaphy; Surgical technique

Introduction

Inguinal hernia is one of the most common surgical conditions in infants and children, with an overall incidence of between 1% and 4% in full-term neonates to as high as 30% in premature neonates [1]. Nearly one-third of all inguinal hernias present prior to 6 months of age and the incidence rate is almost 5–10 times larger in boys than girls [2,3]. Interestingly, right sided inguinal hernias are more common than left sided ones, although 15–20% of children present with bilateral hernias [1,2]. Given the high prevalence, inguinal hernia repair is one of the most common surgical procedures performed by pediatric general surgeons and pediatric urologists.

As with most surgeries, there are a variety of approaches and techniques for hernia repair in infants and children. Unlike in adults, where direct inguinal hernias are predominant and repair is most commonly performed with a mesh or plug, pediatric inguinal hernias are almost all indirect hernias caused by a patent processus vaginalis [2,4]. Traditionally, because of this anatomical difference, the gold standard treatment for pediatric inguinal hernia repair has been via an open inguinal incision with dissection and high ligation of the hernia sac. In the past two decades, however, laparoscopy has come to the forefront as both a diagnostic tool and a conceivable approach to many pediatric surgeries, including herniorrhaphy [5–7].

Laparoscopic herniorrhaphy was first described by Montupet in 1993 using a purse-string suture closure technique of the internal inguinal ring with nonabsorbable suture [8]. Since then, several variations or modifications of the procedure have been proposed [9,10]. Although all laparoscopic herniorrhaphy techniques have the same goal – to obliterate the patent processus vaginalis – some use an entirely intracorporeal approach while others take advantage of extracorporeal or percutaneous techniques [6,11–15]. Proponents of the laparoscopic approach for hernia repair cite a similar success rate to that using the open approach, with several additional advantages including decreased post-operative pain, improved cosmetic results, ability to easily visualize and assess the contralateral internal inguinal ring for synchronous hernia, and lower post-operative complication rate [16,17]. Here, we describe a modified laparoscopic herniorrhaphy using a peritoneal leaflet closure

and report our operative experience. We hypothesized that our peritoneal leaflet modification would be reproducible without compromising outcomes.

Patients and methods

We retrospectively reviewed our IRB-approved registry for children who underwent initial laparoscopic herniorrhaphy at our tertiary care center between 4/2013 and 1/2016. All surgeries were performed by a single surgeon (AKS) using a technique we have termed the peritoneal leaflet closure.

We initially used a traditional three-port setup for laparoscopic cases, but gradually transitioned to a single site system towards the end of this series. Currently almost all cases are performed with the single site system if feasible (Fig. 1). For traditional three-port laparoscopy, intraperitoneal access was obtained via the modified Veress needle technique. After confirmation of position, the abdomen was insufflated with CO₂ to a pressure of between 10 and 12 mmHg. Next, we inserted a 5-mm umbilical trocar for the laparoscopic lens and two lateral 3-mm ports for instruments. For single site laparoscopy, we used the GelPOINT Advanced Access Platform (Applied Medical, Rancho Santa Margarita, CA, USA). Access for single site laparoscopy was obtained using a modified open Hassan technique. After access was obtained, the surgical procedure was performed identically regardless of traditional three-port or single site laparoscopy. First, both internal rings were visualized and inspected to determine ring status – open vs. closed (summary figure, panel A). Each open internal inguinal ring (i.e. patent processus vaginalis) was marked with a small circumferential incision around the open ring in the peritoneum (summary figure, panel B). Peritoneal leaflets were developed bluntly by peeling the peritoneum away from the anterior abdominal wall circumferentially and from the testicular vessels and vas deferens in the inferior aspect of the internal ring. This enables a tension-free closure and also protects the vessels and vas during suturing from inadvertent injury. Next, the leaflets were sutured together over the ring using a non-absorbable barbed stitch (V-loc with manufacturer information) in a running fashion – thus closing the ring and ligating the hernia sac (summary figure, panel C). In boys with large communicating hydroceles, if the scrotal fluid component could not be completely drained laparoscopically, an open scrotal hydrocelectomy or scrotal aspiration was also performed at the time of laparoscopic herniorrhaphy. For all patients, intraoperative findings, operative times (from skin incision to application of dressing), postoperative complications (measured using Clavien-Dindo classification system) and surgical outcomes were reviewed. Surgical success was based on number of children with follow-up and was defined as no hernia recurrence or ipsilateral hydrocele per child at any follow-up and no need for additional ipsilateral inguinal surgery.

Results

In total, 50 consecutive laparoscopic hernia repairs were performed in 46 children (43 males, 3 females) at a median age at surgery of 5.9 years (interquartile range (IQR) 3.1–8.4 years). Patient baseline characteristics, operative findings, and outcomes are shown in Table 1. Four children underwent bilateral laparoscopic herniorrhaphy while the remaining 42 underwent unilateral repair. Median operative times were 73 minutes (IQR 69–94 minutes) for

unilateral and 106 minutes (IQR 101–114 minutes) for bilateral herniorrhaphy. There were no intraoperative complications. Four males (8%) required open scrotal hydrocelectomy at the time of laparoscopic herniorrhaphy to drain excess fluid. One male required conversion to open secondary to inguinal floor laxity and need for surgical reinforcement of the inguinal canal floor via suturing of the conjoint tendon to the inguinal ligament (i.e. Bassini repair). Two children (4%) had contralateral open rings discovered at time of surgery and underwent unplanned bilateral laparoscopic hernia repair.

All patients were discharged to home on the same day as the procedure. Three children (7%) had minor acute post-operative complaints (i.e. umbilical bulge, thigh pain, and urine holding) that all self-resolved. There were no post-operative complications based on the Clavien-Dindo classification system. Thirty-nine children (37 males, 2 females; 85% of all children) had follow-up data available at a median of 8 months after surgery (IQR 3–20 months). Intermediate-term complications occurred in two children (5%): one male developed a contralateral hydrocele (despite a closed ring at surgery); one male had a hernia recurrence that required open repair. Operative success with the modified peritoneal leaflet closure technique was therefore 97% (38 of 39 children with follow-up). All 37 males who had follow-up had bilateral descended testes of normal symmetrical size and consistency.

Discussion

The open technique for inguinal hernia repair in children with high ligation of the patent processus vaginalis has been the gold standard, with a high success rate and low risk of complications [1,2]. However, this approach has several limitations and risks. First, open herniorrhaphy carries small but significant risks of iatrogenic cryptorchidism, testicular hypotrophy, complete atrophy (which may be as high as 0.3–3%), and damage to the vas deferens or spermatic vessels [2,16,18]. One histologic study of specimens from open inguinal hernia repairs noted vas deferens or epididymis along with the hernia sac in 0.5% of cases [19]. These risks are not unique to the open approach, although one recent systematic review noted significantly higher rates of iatrogenic cryptorchidism and testicular atrophy after open (2.7%) vs. laparoscopic (0.9%) hernia repair [16]. Second, open herniorrhaphy does not allow examination of the contralateral internal inguinal ring for a hernia or patent processus vaginalis, which may be present in up to 56% of infants <2 years of age and 40% of children >2 years of age at time of surgery [20,21]. To overcome this, some surgeons perform contralateral inguinal exploration at the time of repair, especially in children <1–2 years of age, while others perform diagnostic laparoscopy either through an umbilical incision or through the open ipsilateral hernia sac [21–23]. In a meta-analysis of open herniorrhaphies, Miltenburg and associates found that laparoscopic evaluation of the contralateral inguinal ring only added a mean 6 minutes to the operative time and was highly sensitive (99.4%) and specific (99.5%) for detecting a patent processus vaginalis [23]. When a contralateral patent processus vaginalis is diagnosed via laparoscopy trans-hernia sac, the contralateral side is repaired through a separate inguinal incision. Even when diagnosis is made by laparoscopy via an umbilical port site, many surgeons opt to perform the hernia repair via an open inguinal approach rather than laparoscopically despite the increase in laparoscopic skills of pediatric general surgeons and urologists in recent years.

Today, minimally invasive surgery has been demonstrated to be safe and effective in the pediatric population for a myriad of diagnoses and procedures. In general, laparoscopy is reported to offer numerous advantages over open surgery, including magnified visualization, faster recovery, shorter length of stay, reduced analgesic requirement, fewer complications, and improved cosmesis [16,24–26]. For hernia repair, laparoscopy repair offers an additional benefit of being able to easily visualize and assess the contralateral inguinal ring and, if present, to surgically repair the contralateral patent processus vaginalis without additional incisions. Given these advantages, numerous novel laparoscopic techniques have emerged to treat pediatric inguinal hernias.

Laparoscopic herniorrhaphy techniques all have the same goal of obliterating the patent processus vaginalis and can be broadly divided into intracorporeal and extracorporeal procedures. The first intracorporeal technique was described by Montupet and associates and involved closure of the peri-orificial peritoneum at the internal inguinal ring with a nonabsorbable purse-string suture [12]. In 1998, Schier described a similar technique which used a series of “N” or “Z”-shaped nonabsorbable sutures across the internal inguinal ring instead of a purse-string [8]. In 1999, Montupet and Esposito described a modification in which the peri-orificial peritoneum lateral to the internal inguinal ring was cut prior to placement of the purse-string suture [27]. Later, Becmeur and colleagues proposed an intracorporeal technique that “reproduced every step in the conventional open procedure,” including excising a portion of the patent processus vaginalis [11]. Most recently, in 2011, Wheeler and associates described creating a circumferential peritoneal incision around the internal inguinal ring followed by closure with a purse-string suture [11,14]. Various extracorporeal techniques have been published, including percutaneous placement of a special awl or needles to pass sutures across the hernia sac and avoid need for intracorporeal suturing, preperitoneal hydrodissection, and micro-incisions to ligate the sac [28,29]. Success rates with each of these techniques may vary based on laparoscopic skills and surgeon experience but are similar to success rates with the open approach (95–100%) [16,17].

Despite its reported benefits, similar outcomes to the open approach, and increasing use among pediatric general surgeons, laparoscopic herniorrhaphy has been slow to be integrated into the pediatric urologist’s armamentarium. One recent retrospective study of surgeons at academic centers in the United States noted that while 14% of all hernia repairs performed by pediatric surgeons were done laparoscopically, only 5% of hernia repairs done by pediatric urologists were laparoscopic [30]. Furthermore, 42% of all pediatric surgeons attempted at least one laparoscopic inguinal herniorrhaphy compared with 14% of pediatric urologists. Interestingly, the opposite was true for trends in orchiopexy technique, with over 70% of pediatric urologists performing at least one laparoscopic orchiopexy compared with 37% of pediatric surgeons [30]. These findings by Chan and colleagues suggest that the reason for the lower numbers of laparoscopic herniorrhaphies performed by pediatric urologists in the US is not a lack of familiarity or comfort with laparoscopic skills itself, but rather some other unknown cause. Perhaps this discrepancy results from differences in training, specifically a lack of exposure to the techniques for laparoscopic herniorrhaphy during urologic residency training compared with general surgery training. Regardless of cause, by further reporting on the laparoscopic approach to the hernia repair in infants and

children and by describing our modification, our hope is to increase awareness and use of this technique among pediatric urologists.

Our modification of the intracorporeal technique proposed by Wheeler and colleagues involves complete dissection and development of peritoneal leaflets after circumferential incision around the internal inguinal ring in the peri-orificial peritoneum followed by closure of the leaflets to each other using a running barbed nonabsorbable suture [14]. Creation of the peritoneal leaflets or flaps allows approximation of raw peritoneal edges and tissue during ring closure, which we propose encourages water-tight closure and fibrosis/scarring of the internal ring to prevent hernia recurrence. Furthermore, use of the barbed self-locking suture allows the defect to be closed in a running fashion without the need for tying a knot, which is faster and easier than performing a purse-string closure. While our initial results and success rate (38 of 39, 97%) are similar at a median follow-up of 8 months to other laparoscopic and open techniques, additional longer-term follow-up is required to ensure the durability of this technique.

There are several limitations of this study including its retrospective nature. As all surgeries were performed by a single surgeon who elected to perform this laparoscopic procedure in all inguinal hernia cases, there is no adequate control group for comparison, although our results here are similar to other reported series. Likewise, we were unable to assess the learning curve for this procedure or costs compared with the conventional open approach, both of which are important clinically but are beyond the scope of this study. Finally, our numbers were not large enough to compare traditional laparoscopic three-port with the single site system, although no difference was noted. While the focus of this study was to describe our modified technique and preliminary results, we plan on exploring any differences between three-port and single site in a subsequent study with larger numbers.

Conclusion

Laparoscopic herniorrhaphy using a peritoneal leaflet closure technique is safe and effective when used in infants and children to close an indirect hernia (i.e. patent processus vaginalis). No intraoperative complications occurred and success rate was 97% overall. Despite low usage rate among pediatric urologists to date, laparoscopic hernia repair is a well established alternative to the open approach, especially when bilateral inguinal hernias are present or there is concern for a possible contralateral patent processus vaginalis.

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Figure 1.

Intraoperative image showing setup for single site laparoscopy. The GelPOINT Advanced Access Platform (Applied Medical, Rancho Santa Margarita, CA, USA) is placed via an infraumbilical incision after gaining access to the peritoneum using a modified open Hassan technique. In this image, the patient's head is to the left and the ports are aimed in a caudal direction to gain access to the internal inguinal ring.

Figure 2.

Intraoperative images of modified peritoneal leaflet closure technique in a right-sided inguinal hernia. (A) An incision is made circumferentially in the peri-orificial peritoneum just proximal to the internal inguinal ring (dashed white line). Care must be taken to identify and preserve the vas deferens (yellow arrow) and testicular vessels (red arrow) during this step. (B) Image immediately after dissection and development of the peritoneal leaflets. (C) The peritoneal leaflets are then closed together over the internal inguinal ring with a running, non-absorbable barbed suture.

Figure.

Intraoperative images of modified peritoneal leaflet closure technique in a right-sided inguinal hernia. (A) An incision is made circumferentially in the peri-orificial peritoneum just proximal to the internal inguinal ring (dashed white line). Care must be taken to identify and preserve the vas deferens (yellow arrow) and testicular vessels (red arrow) during this step. (B) Image immediately after dissection and development of the peritoneal leaflets. (C) The peritoneal leaflets are then closed together over the internal inguinal ring with a running, non-absorbable barbed suture.

Table 1

Patient baseline characteristics, operative findings, and results

Total number of patients	46
Male	43
Female	3
Median age, years [IQR]	5.9 [3.1–8.4]
Total number of hernia repairs	50
Hernias	
Single, n (%)	42 (84)
Bilateral, n (%)	4 (16)
Laparoscopic technique	
Traditional three port	22 (48)
Single site system	24 (52)
Median duration of surgery, mins [IQR]	
Unilateral repair	73 [68.5–94.5]
Bilateral repair	106 [101–114]
Conversion to open, n (%)	1 (2)
Immediate postop complaints, n (%)	3 (6.7)
Follow-up:	
# patients with postop follow-up, n (%)	39 (85%)
Males	37
Females	2
Median follow-up, months [IQR]	8 [3–20]
Adverse outcomes	
Hernia recurrence, n (%)	1 of 39 (2.6)
Contralateral hydrocele, n (%)	1 of 37 (2.7)
Presence of bilateral descended testes at follow-up visit, n (%)	37 of 37 (100)
Success, n (%)	38 of 39 (97)