

## Review Article

# Development of Laparoscopic Closure for Inguinal Hernia in Pediatric Surgery

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**Abstract**

Pediatric Inguinal Hernia (PIH) is a common problem in children, and high ligation of the patent processus has been its standard of care for years. Laparoscopy, which can be used for precise detection of contra lateral patencies and manage all forms of inguinal hernia with Obvious cosmetic outcome, has been widely adopted by pediatric surgeons globally. In the past two decades, new techniques expanded and continue to evolve. Although various devices are used and there are a lot of differences in details of the procedures, a trend towards diminishing the use of working ports and working instruments have been noticed. In addition, researches claimed that completely enclosing the hernia defect without peritoneal gaps to avoid simultaneous ligation of innocent tissues between the skin and hernia defect is crucial in pursuing a near-zero recurrence rate. This article provides a brief description of laparoscopic techniques for addressing PIH and discusses the process of the development of laparoscopic closure for inguinal hernia in pediatric surgery.

**Keywords:** Children; Laparoscopic surgery; Minimally invasive surgery; Inguinal hernia

## Introduction

PIH, which caused by Patent Processus Vaginalis (PPV), is a common problem in children. High ligation of the patent processus at the internal ring through an inguinal incision is a proven procedure with low recurrence. For most trained surgeons, dissection of the vas and vessels are not likely to cause injury (e.g., infertility, testicular atrophy), however, assessment of the contra lateral side could not be achieved in the same operation and some patients may require another operation for contra lateral side inguinal hernia several years later. In order to meet the quest for limiting pain and better cosmesis laparoscopic management has been widely used, which, as expected, reduced hospital stay and operation time, allowed an earlier return to normal activities, and enhanced cosmetic results. In recent years, new techniques expanded and continue to evolve. We can briefly classify all the techniques based on the number of trocar required (range from one to three trocars). We can also divide the techniques into intra peritoneal or extraperitoneal repair of PIH. Among the numerous techniques, some may require complex laparoscopic skills; some may need more trocars and working instruments, which means more visible abdominal scars. Nowadays, with the development of surgical devices, surgeons can close hernia defect within a 2mm abdominal incision, and no working instruments are needed. The recurrence rate has been comparable to open surgery. This article will provide a brief describe on the development of laparoscopic closure for PIH.

## Three-port Techniques

### High ligation without dissection of the internal ring in girls

In this technique, a grasper was used to grasp the farthestmost portion of the sac and anendoloop was applied to ligate the inverted sac, high ligation was achieved without needles or knotting. However, this technique cannot avoid injuring the vas deferens and spermatic

vessels; therefore, it cannot be used in boys [1,2].

### Suturing of the internal ring

In traditional laparoscopic high ligation of PPV, suturing of the internal ring is commonly performed. Regular instruments were applied and a Z or purse-string suture was placed intracorporeally. Only peritoneum or, at times, underlying muscular tissue were included. Both vas deferens and spermatic vessels have low risk to be injured. Therefore, this procedure can be used in male patients. The disadvantages of this procedure are that the operator needs to master intracorporeal suture skills and its relatively higher recurrence rate [3-15].

### Flip-flap technique

This technique involves making a peritoneal flap by dissection and the anterior and lateral hemi circumference of the peritoneum at the level of hernia sac, then flip it over to cover the hernia defect and fix it with intracorporeal suture. Theoretically, this prevents abdominal contents from entering the hernia sac while allowing fluid entering the abdominal cavity, thereby preventing postoperative hydrocele formation. This technique does not have a risk of injuring the vital structures. Although this technique appears elegant both technically and physiologically, there have been conflicting reports of its success rate and the operation time is significantly longer than other techniques [16,17].

## Two-port Techniques

### High ligation without dissection of the internal ring

In order to simplify the operation process, extracorporeal suturing was used and the maxillary steel awl was introduced percutaneously through the groin region to act as a needle. Under the guidance of laparoscope the surgeon can manipulate the maxillary steel awl and place a suture around the medial or lateral hemi circumference of

the internal ring extraperitoneally in order to place a purse-suture around the hernia defect. A grasper was applied to manipulate the thread in and out of the hollow of the needle. The two ends of the thread then were pulled out from the operating port and the knot is tied extracorporeally and pushed inside of abdominal cavity. This technique reduces the need for a working port. However, as a peritoneal gap was left, the recurrence rate is higher when comparing to techniques with total extraperitoneal closure of internal ring [18,19].

### High ligation with dissection of the internal ring

This technique also requires ligation of the internal ring by a purse-string suture, with the help of a grasper, a needle with suture was placed percutaneously using an external needle holder under the guidance of laparoscope. In order to lower the recurrence rate, disruption of the hernia sac is performed before placement of the purse-string suture. However, the necessity to disrupt the sac to prevent recurrences is questioned by several techniques for PIH, which does not need disrupt the sac and with low recurrence rate. In this technique, the knot was left in the subcutaneous plane instead of the preperitoneal space, which may subsequently lead to loosening of the suture when the innocent tissues are cut through [20,21].

## Single-port Techniques with Extracorporeal Knotting

### Subcutaneous endoscopically assisted ligation (SEAL)

This technique is similar to that described earlier. The port was for laparoscope only, all manipulate was done with traditional operation tools. The internal ring is closed using an absorbable suture swaged on a large needle, which is introduced percutaneously using a strong conventional needle holder. A Touhy needle, which is suitable in the curve with the needle, is used both to receive and guide the needle to across vas deferens and spermatic vessels by receiving the tip of the needle in its hollow, this may prevent unexpected damage. Although elegant in theory, this technique has some disadvantages. First, guidance by the Tuohy needle is needed, which is rendered cumbersome by two-dimensional vision [21]. Second, without aid of work instruments, the needle failed to separate vital structures from peritoneum, which leads to omission of part of the ring circumference by left a peritoneum gap while jumping over vas/vessels and an increase in the potential risk of postoperative recurrence [21-23]. Third, the curve of the needle and the Tuohy needle are matched only at a specified distance and angle.

### Percutaneous internal ring suturing (PIRS)

This technique is similar to SEAL, has been used to close the internal ring extraperitoneally using an 18-gauge hypodermic needle with a non absorbable suture in its barrel replacing the swaged needle. However, vascular injuries, although with lower incidence than SEAL, have been noted [24].

### One-trocar laparoscopic transperitoneal closure of inguinal hernia

An 18-gauge vascular access was introduced and moved until the tip of the needle reached the preperitoneal space on the roof of the hernia defect. Then, hydro dissection with isotonic saline solution was given to obtain the preperitoneal dissection to prevent trauma to the vas deferens and spermatic vessels. Under direct vision, the

catheter was advanced along the preperitoneal space on one side of the hernia defect and passed into the intra-abdominal space. The indwelling needle was removed and a non absorbable suture was threaded through the sheath of the catheter, with the other end of the suture remaining above the skin. It is important to maintain the sheath of the vascular access within abdominal wall all time until the suture is passed into the abdomen. The sheath was then withdrawn. Through the previous needle puncture wound, a homemade hook-needle, was introduced along the opposite side of the hernia defect into the intraperitoneal space to pick up the silk, and the suture was then pulled through the abdominal wall. The hernia defect was closed and the circuit suturing was tied extra corporeally [25].

### Single-port laparoscopic percutaneous extraperitoneal closure (SPLPEC) with a two-hooked core hernia apparatus

The apparatus consist of a sheath and a core, two hooks were made on the greater curve of the core for suture fix and pick up. No hydrodissection is needed, the tip of the sheath is spoon-shaped and the tip can prevent trauma to the vas deferens and spermatic vessels. All action can be completed within one apparatus, and in this technique, it's also important to keep the sheath in the abdominal wall until the suture is finished. Both this technique and the one with hydrodissection we mentioned above show great cosmetic result and low recurrence rate [26].

Compared with open surgery, detection and repair of contra lateral patencies without additional access are found to be the main advantage of three-port techniques [27]. Technically, the three-port techniques with intracorporeal suturing seem to be superior because it is easier to smooth the peritoneal folds during operation and lower the risk of vital structures injury. However, some reports have argued that the recurrence rate is higher when using these techniques [10,28]. Some risk factors for recurrence include: 1. Partial omission of the ring circumference. 2. The operator need to handle laparoscopic suturing skills, which is not easy for the beginners. 3. Strength and appropriateness of the knot. 3. Inclusion of tissues other than peritoneum in the ligature with a propensity for subsequent loosening [21]. 4. Use of absorbable sutures [23,29]. In addition, in open surgery, the scar can be as small as 1cm, and three-port techniques may need three 0.5cm incisions, which makes three-port techniques do not have a cosmetic benefit to the patients.

To decrease the recurrence rate, total extracorporeal suturing was used. Besides, no laparoscopic suturing skill is needed and the simplified process can be handled by surgeons with less laparoscopic experience. A working instrument is used to smooth the peritoneum at the neck of the hernia sac. In all techniques for PIH (either in open surgery or laparoscopic procedures), scar formation is the key element in preventing postoperative recurrence. In open surgery, disrupt of the sac neck and total extraperitoneal closure are achieved to promote scar formation. In most three-port and two-port laparoscopic techniques, operators cannot separate vas deferens and spermatic vessels from hernia sac. Therefore, a peritoneal gas is left and the internal ring is closed partially. Moreover, as both ends of the suture do not keep in the same path through abdominal wall, innocent tissue is included in the suture, when the tissue is cut through, and the ligation tend to loosen. All these risk factors can lead to postoperative recurrence.

In single-port techniques like SEAL, a peritoneal gap is still left and total extraperitoneal closure of hernia sac was first achieved by hydrodissection. With hydrodissection, the operator does not need to be afraid of vital structure injure. The needle can pass the enlarged space between vital structures and hernia sac created by hydrodissection. Except hydrodissection technique, a modified apparatus with spoon-shaped tip, as we mentioned in SPLPEC, is also applied in clinical practice, both technique can achieve a total extraperitoneal closure of internal ring without aid of working instrument. As the diameter of the device used is about 2mm, the abdominal scar is almost invisible. Another improvement for single techniques is ligation of peritoneum without unwanted tissues. In one-trocar techniques, the thread is lead into preperitoneal space from one side of hernia defect and picked up to finish the suture on the other side. If a technique cannot guarantee both ends of the thread keep in the same pathway, which means, another puncture for thread pick up is need during operation, extra tissue besides peritoneum would be involved. An ideal device of one-trocar technique for PIH should be able to accomplish thread send and thread pick up within one puncture.

## Conclusion

The techniques of laparoscopic management for PIH are numerous and they continue to evolve with a trend toward increasing use of extracorporeal knotting and decreasing use of working ports and working instruments. With the adoption of total extraperitoneal closure no innocent tissues are included in the suture. The recurrence rate is comparable to open surgery. Moreover, the patients may receive satisfactory comestic result. With growing experience, wider adoption and diminishing complications, laparoscopic techniques may act as the gold standard in the treatment of PIH in the coming future.

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