Review Article

Technical Refinements in Single-Port Laparoscopic Surgery of Inguinal Hernia in Infants and Children

Yu-Tang Chang¹,²,³

¹ Division of Pediatric Surgery, Department of Surgery, Kaohsiung Medical University Hospital, Kaohsiung Medical University, 100 Tzyou 1st Road, Kaohsiung 80708, Taiwan
² Graduate Institute of Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung 80708, Taiwan
³ Department of Surgery, Faculty of Medical School, College of Medicine, Kaohsiung Medical University, Kaohsiung 80708, Taiwan

Correspondence should be addressed to Yu-Tang Chang, 890300@ms.kmuh.org.tw

Received 1 November 2009; Revised 19 February 2010; Accepted 23 March 2010

Academic Editor: Matthew Kroh

Copyright © 2010 Yu-Tang Chang. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

The techniques of minimal access surgery for pediatric inguinal hernia are numerous and they continue to evolve, with a trend toward increasing use of extracorporeal knotting and decreasing use of working ports and endoscopic instruments. Single-port endoscopic-assisted percutaneous extraperitoneal closure seems to be the ultimate attainment, and numerous techniques have mushroomed in the past decade. This article comprehensively reviews and compares the various single-port techniques. These techniques mainly vary in their approaches to the hernia defect with different devices, which are designed to pass a suture to enclose the orifice of the defect. However, most of these emerging techniques fail to entirely enclose the hernia defect and have the potential to lead to higher incidence of hernia recurrence. Accompanying preperitoneal hydrodissection and keeping identical subcutaneous path for introducing and withdrawing the suture, the suture could tautly enclose the hernia defect without upper subcutaneous tissues and a lower peritoneal gap, and a trend towards achieving a near-zero recurrence rate.

1. Introduction

Traditional inguinal herniotomy is a well-developed surgical technique for uncomplicated inguinal hernia in infants and children. It usually necessitates one small 1.5 to 2 cm skin incision, and the possible postoperative complications, such as recurrence or injury to the vas deferens, are not high [1]. Laparoscopic surgery has recently emerged as an alternative in its management. Although not as widely used as conventional open herniotomy, laparoscopic herniorrhaphy has clear advantages, especially those related to the evaluation of possible contralateral opening and a safe high ligation of the hernia sac at the internal ring without injury to the vas deferens and spermatic vessels [2]. In 1997, El-Gohary first described laparoscopic ligation of inguinal hernia in girls [3]. Subsequently, numerous technical reports for the laparoscopic hernia repair in children have evolved [2].

Although modifications on laparoscopic surgery continue to be refined, there are some technical limitations, which influence a pediatric surgeon’s willingness to perform the procedure [2]. The universally known limitations of the laparoscopic surgery are (1) most of these methods employ a laparoscope inserted via an umbilical incision and two lateral ports for instruments to ligate the hernia defect [4]. The necessity for intraabdominal skills, such as intracorporeal suturing, knot-tying, and manipulation of the suture on a needle may be time-consuming and cumbersome [5]. (2) Recurrence rate after laparoscopic surgery is generally known to be higher than after open surgery [1, 4]. Partial omission of the defect circumference, strength and appropriateness of the knot, inclusion of tissue other than peritoneum in the suture with a propensity for subsequent loosening, use of absorbable sutures, and failure to detect a rare or direct hernia are some reported factors contributing to recurrence in laparoscopic surgery [2]. (3) Compared to open herniotomy with an almost disappeared wound in the skin crease, laparoscopic approach did not take any superiority in cosmesis [6]. Conversely, the procedure was thought not to be minimally invasive because of the necessity of multiple skin incisions and pneumoperitoneum
during operation. In a single-blinded, randomized study, recovery and outcome were similar after open and three-port laparoscopic hernia repair in children. Moreover, three-port laparoscopic approach was associated with increased operative time and postoperative pain [6].

To enhance a pediatric surgeon’s willingness, further development is intended to decrease the number and size of skin incisions, lower the recurrence rate, and simplify or avoid intracorporeal technique [2]. From above conception, single-port endoscopic-assisted percutaneous extraperitoneal closure seems to be the ultimate attainment and numerous techniques have mushroomed in the past decade [5, 7–11]. Herein, the author reviews the literature in an attempt to compare the various approaches of the latest advancement in pediatric hernia surgery.

2. Surgical Technique

Of single-port laparoscopic surgery for pediatric inguinal hernia, the suture was always introduced and withdrawn percutaneously at the corresponding skin of the orifice.
Table 1: Reported single-port technique with extracorporeal knotting.

<table>
<thead>
<tr>
<th>Studies (1st author)</th>
<th>Technique</th>
<th>Port size (mm)</th>
<th>Number of associated stabbing incisions</th>
<th>Complete ring</th>
<th>Subcutaneous tissue inclusion</th>
<th>Tensionless knot tying</th>
<th>Protection of vas and vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harrison et al. 2005 [7]</td>
<td>SEAL</td>
<td>2.7</td>
<td>2 (unilateral) 4 (bilateral)</td>
<td>-, small gap +</td>
<td>−</td>
<td>+, jump over them</td>
<td></td>
</tr>
<tr>
<td>Ozgediz et al. 2007 [8]</td>
<td>SEAL</td>
<td>2.7</td>
<td>2 (unilateral) 4 (bilateral)</td>
<td>-, small gap +</td>
<td>−</td>
<td>+, jump over them</td>
<td></td>
</tr>
<tr>
<td>Patkowski et al. 2006 [9]</td>
<td>PIRS</td>
<td>2.5 or 5</td>
<td>1 (unilateral) 2 (bilateral)</td>
<td>-, small gap +</td>
<td>−</td>
<td>+, jump over them</td>
<td></td>
</tr>
<tr>
<td>Bharathi et al. 2008 [5]</td>
<td>Modified SEAL and dual encirclage</td>
<td>5</td>
<td>At least 3 (unilateral) At least 6 (bilateral)</td>
<td>+ + +, hydrodissection</td>
<td>+ + +, hydrodissection</td>
<td>+ + +, hydrodissection</td>
<td></td>
</tr>
<tr>
<td>Chang et al. 2008 [10]</td>
<td>Hooked pin method</td>
<td>5</td>
<td>1 (unilateral) 2 (bilateral)</td>
<td>+</td>
<td>+, hydrodissection</td>
<td>+, hydrodissection</td>
<td></td>
</tr>
</tbody>
</table>

SEAL: subcutaneous endoscopically assisted ligation; PIRS: percutaneous internal ring suturing.

Figure 2: The final wound appearance of the inguinal hernia repair (arrows) and the hernia defect after the suture was tied (upper inset).

of the hernia defect by variable devices, and was tied extracorporeally to obliterate the hernia sac. The knot was then placed in the subcutaneous space. Reported single-port techniques with extracorporeal knotting are shown in Table 1 [5, 7–11].

2.1. Technique of Subcutaneous Endoscopically Assisted Ligation (SEAL). The first described is Harrison et al. in 2005 with subcutaneous endoscopically-assisted ligation (SEAL) of the hernia defect [7]. The SEAL technique has been performed since 2001 [8]. Using only the camera port and passing a suture on a large swaged-on needle percutaneously to enclose the defect, knot-tying was performed extracorporeally. In 2007, the same group described the early result of 300 inguinal hernias [8]. Overall complications occurred in 15.7% of patients and a recurrence rate of 4.3% was comparable to prior series of laparoscopic repairs. However, the known limitations of the SEAL technique are (1) for successful mating and guidance, the entry point of both the needle and the track should exactly match the curve of the needle. If the curve of the needle could not conform to the configuration of the ring, it would be difficult to pass the needle through the posterior hemicircumference of the ring. The needle may jump over the vas and vessels and a peritoneal gap may be left untouched. (2) Two stab incisions are necessary for the swaged-on needle and the receiving Tuohy needle, and a depression or fold of the corresponding skin might sometimes occur if the knot-tying is not placed in the correct deeper plane [5]. (3) If the size of the defect is extraordinarily large, an additional instrument to assist guidance of the needle or conversion to open herniotomy is necessary [8, 12, 13].

In 2008, Bharathi et al. modified the technique of SEAL [5]. A small amount of saline was injected using a hypodermic or spinal needle in the retroperitoneal space (preperitoneal hydrodissection) to lift up the peritoneum of the vas and the vessels. The suture could be then advanced to encircle the posterior hemicircumference of the defect completely. If the saline injection should fail, the authors would take as much as the circumference of the defect as was possible without collateral damage by the first suture. Then, this allowed a second, separate loop to encircle the defect. However, multiple stab incisions at the corresponding skin were always necessary.

2.2. Technique of Percutaneous Internal Ring Suturing (PIRS). In 2006, Patkowski et al. described the technique of percutaneous internal ring suturing (PIRS) for inguinal hernia in children [9]. An 18-gauge injection needle with
2.3. Technique with a Vascular Catheter, a Hooked Pin, and Preperitoneal Hydrodissection. In 2008, the author developed a modified technique of SEAL and PIRS [10]. Under the laparoscopic guidance, the hernia defect was enclosed by a nonabsorbable suture, which was introduced into the abdomen by an 18 Fr vascular catheter (Surflash I.V. catheter, I.D. 0.95 × 64 mm, Terumo Corporation, Tokyo, Japan) on one side of the hernia defect and withdrawn on the opposite side by a hooked pin, which was made by an orthopedic pin (I.D. 1.8 mm, MES-CF01-063-21, Mizuho, Tokyo, Japan), through one needle puncture point (Figure 1). During the procedure, 5 to 8 mL of isotonic saline solution were infused via the needle into the preperitoneal space to obtain the preperitoneal dissection of the hernia defect. The author started to perform the surgical technique in March 2007. From March 2007 to January 2010, a total of 288 procedures were performed among 201 consecutive infants and children. Of the technique, only one umbilical trocar wound and another stab incision were made (Figure 2). Besides, the hernia defect could be enclosed completely without a lower peritoneal gap since preperitoneal hydrodissection could safely separate the peritoneum from the vas and the vessels. Since the used vascular catheter and hooked pin were long enough (64 mm and 300 mm, resp.), failure to lift up the peritoneum entirely was rare. However, some upper subcutaneous tissues, including nerves and muscles, may cause injury by their inclusion in the upper portion of the circuit suturing. The inclusion of unnecessary subcutaneous tissues in the ligature may lead to a propensity for subsequent loosening of the knot, causing later recurrence [2].

2.4. Technique with a Hooked Injection Needle and Preperitoneal Hydrodissection. Later, the author described the modification of the hooked pin method with a homemade hooked injection needle (Optiva I.V. Catheter Radiopaque, I.D. 1.8 × 50 mm, Ethicon Endo-surgery, Johnson-Johnson Company), which is designed to traverse the suture and cause hydrodissection to the preperitoneal space [11]. During the procedure, the tip of the hooked injection needle was kept beneath the fascia at the period after introducing and before
pulling the suture. Thus, the suture could tautly enclose the hernia defect without upper subcutaneous tissues and a lower peritoneal gap.

3. Discussion

Postoperative peritoneal adhesions are a consequence of injured peritoneal surface (including incision, cauterization, suturing, or other means of trauma) fusing together to form scar tissue [14]. Of the inguinal hernia sac, the endothelium suturing, or other means of trauma (fusing together) may leave multiple peritoneal gaps. The resultant peritoneal injury may cause more tissue trauma, further promote the formation of peritoneal adhesions and fibrosis [16]. Therefore, during passing of the suture, preperitoneal normal saline injection may cause more tissue trauma, further promote the formation of peritoneal adhesions and minimize later recurrence (Figure 4).

However, being a technique of percutaneous closure of inguinal hernia, simultaneous ligation of subcutaneous tissues between the skin and hernia defect was inevitable [5, 7–10]. This might possibly increase the recurrence rate when subsequent loosening of the knot takes place. Accompanying peritoneal hydrodissection and keeping identical subcutaneous path for introducing and withdrawing the suture, the latest reported single-port technique could overcome the limitations and tautly enclose the hernia defect without upper subcutaneous tissues and a lower peritoneal gap [11].

4. Conclusions

Preperitoneal hydrodissection could completely enclose the hernia defect without peritoneal gaps, whereas keeping identical subcutaneous path during traversing the suture could avoid simultaneous ligation of subcutaneous tissues between the skin and hernia defect. Furthermore, the smaller and fewer skin incisions of the single-port technique could reach the state of minimally invasive surgery. However, single-port laparoscopic surgery for pediatric inguinal hernia is a technique in evolution. More long-term follow-up concerning the recurrence rate is necessary.

References


