**Incidence and Concurrent Laparoscopic Repair of Hypertrophic Pyloric Stenosis and Patent Processus Vaginalis**

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**INTRODUCTION**

Although laparoscopic herniorrhaphy is the most common procedure performed by pediatric surgeons at present, herniorrhaphy with an asymptomatic patent processus vaginalis (PPV) remains controversial. The incidence of contralateral PPV on laparoscopy in previous studies was reported as 20%–50%, but it is believed to approach 100% in premature infants. It has been reported that 4%–34% patients have the risk of developing subsequent metachronous contralateral hernia after a repair of an ipsilateral hernia.¹ If this is true, then the identification and closure of a PPV at the time of ipsilateral hernia repair will obviate the need for a second operation in thousands of children every year. With recent advances in minimally invasive surgery, transinguinal diagnostic laparoscopy has emerged as a safe and effective method for evaluating a pediatric patient with PPV. Meanwhile, the laparoscopy has been widely used to manage the infantile hypertrophic pyloric stenosis (IHPS), due to equally high success rate, minimal complications, and a shorter hospital stay.

What should the operating surgeon do when a PPV is identified during laparoscopic herniorrhaphy? Limited reports are available regarding the incidence and concurrent laparoscopic repair of an open internal inguinal ring identified during laparoscopic evaluation for the IHPS. This study aimed to investigate the incidence of PPV and the efficacy of concurrent laparoscopic repair of the PPV and IHPS.

**METHODS**

Study approval was obtained from the Institutional Review Board and Ethics Committee of Wuhan Medical and Health Center for Women and Children, and the informed consents were obtained from all patients’ parents or guardians. We retrospectively reviewed the records of 103 consecutive patients who had received laparoscopic pyloromyotomy (LP) for IHPS, from January 2012 to December 2012 in Wuhan Medical and Health Center for Women and Children. IHPS was diagnosed by ultrasonography with pyloric muscle thickness >4 mm and length >14 mm. Patients were excluded if they had received unilateral or bilateral herniorrhaphy or had recent respiratory infections, major developmental anomalies, or had a history of prior abdominal surgery. All children received general anesthesia in surgery. None of the patients had received medical therapy before their operation. If they had a concurrent open internal inguinal ring, the laparoscopic approach was used to repair the open internal ring and to perform the pyloromyotomy. Follow-up consisted of physical examinations for ≥12 months postoperatively.

Once the patient was properly anesthetized, he/she should be positioned supine on the table, and the bladder and stomach were emptied by the pressure on the bladder and placement of an orogastric (OG) tube in the stomach. The OG tube will be useful later for a leak test to ensure that the submucosa has not been perforated during the myotomy. Surgery was performed by two senior pediatric surgical attending physicians with advanced laparoscopic training. The patient was in the supine position. LP was performed with three periumbilical trocars, which were arranged an equilateral triangle type. The first 3-mm trocar through a transverse incision at the higher part of umbilicus (12 O’clock), the others at 4 O’clock, 8 O’clock direction for 5 mm trocar [Figure 1]. An intra-abdominal pressure of 8–12 mmHg and flow rate of 2–3 L/min was usually sufficient. The pylorus was stabilized with an atraumatic grasper and a longitudinal seromuscular incision made from the prepyloric vein into the gastric antrum. A myotomy length of 2 cm was the...
goal to avoid an incomplete myotomy and postoperative vomiting. The leak and patency tests can be done under direct laparoscopic visualization of the submucosa. The stomach was insufflated with 100 ml of air to confirm an intact mucosa. Then the patient should be changed to steep Trendelenburg’s position. After exploring bilateral PPVs by laparoscopy, if unclosed PPV was observed, we punctured on the surface of inner ring with sled needle belt line, and then ligated the hernia sac in the high bit with the help of clamps. The fascia and umbilical wound were closed with absorbable sutures, and the stab incisions were closed with adhesive. After 3-month follow-up, navel incision scar was small and hidden with satisfactory appearance [Figure 2].

RESULTS
During the study period, 103 patients underwent LP for the IHPS. The patients aged from 8 to 100 days (median 37 days) and the male-to-female ratio was 6:1 (89/14). There were 88 full-term infants and 15 premature infants. Sixty-six patients (64%) had the IHPS and concurrent PPV (visually, along with palpation for carbon dioxide). Of these 66 IHPS patients, 55 PPV patients (83.3%, including 32 bilateral, 21 right, 2 left) were found during the surgery, the others had been diagnosed as inguinal hernias preoperatively (4 bilateral, 4 left, 3 right), and were confirmed as PPV by laparoscopy. The internal ring was closed laparoscopically concurrent with the LP in all 66 patients. The extra average operative time for closing the internal ring was 5 min in each side. No postoperative complications had developed after a minimal follow-up of 12 months. All procedures were performed on an inpatient basis, mean postoperative hospital periods were 5.5 days (3–8 days).

DISCUSSION
IHPS is the most common surgical cause for vomiting in infants. It has an incidence of 3 per 1000 live births per year, although wide variations have been documented with geographic location, season and ethnic origin. This disease usually presents between the 2nd and 6th weeks of life, more commonly in the white population, in males and typically in first-born children. Our study showed IHPS was more common in males too, but the ratio of male-to-female was 6:1, which was higher than the ratio reported in the previous literatures. It may be that male is more than female in China. Under normal circumstances, sex ratio at birth is determined by the laws of biology, maintaining between 103 and 107 (with women of 100, the proportion of men to women). However, the data from National Bureau of Statistics showed that the sex ratio of Chinese birth population was 117.7 in 2012 (www.news.cn January 21, 2013). The treatment of IHPS has evolved markedly during the last century. Gastrojejunostomy was advocated in 1908 when Fredet introduced the technique of longitudinal splitting of the pyloric muscle along with transverse suturing of the split muscle. In 1912, Ramstedt described longitudinal splitting of the pyloric muscle with sparing of the mucosa, which has withstood the test of time. LP for IHPS has been reported as a feasible and safe manner since 1991. A systematic review and meta-analysis of 502 patients (LP 247, open pyloromyotomy [OP] 255) showed an absolute incidence of major postoperative complications was 4.9% in the LP group. Meta-analysis showed that the incidence of major postoperative complications in LP group was not significantly higher than that in OP group. Both time to full feeding and postoperative hospital stay tended to be shorter in LP group.[2] Similar results had been reported in a previous randomized control trial study of 98 IHPS patients, there was no significantly difference in operating time, hospital stay, or refeeding patterns between OP and LP groups. The complication rates were similar in these two methods. However, long-term cosmetic results were significantly superior in the laparoscopic group.[3] Almost 20 years after the first introduction of LP by Alain, the laparoscopic approach is becoming common and seems to have some advantages over the open method. In the present study, all 103 IHPS underwent LP without a conversion to OP and without complications.

Figure 1: Laparoscopic pyloromyotomy was performed with three periumbilical trocars, which were arranged an equilateral triangle type, at 4 O’clock, 8 O’clock for 5 mm trocar, and 12 O’clock direction for 3 mm trocar.

Figure 2: Navel incision scar showed satisfactory appearance with small and hidden.
To our knowledge, the incidence and concurrent laparoscopic repair of an open internal ring have not been previously reported. The incidence of 64% was higher than that of an open ring in other conditions of the groin. In children, this is nearly related to a PPV, which fails to close after birth. There was significantly difference between the rate of contralateral PPV (19.4%) and the rate of bilateralism (9.7%) or the rate of subsequent development of a symptomatic metachronous contralateral hernia (4.2%). This illustrated that a PPV is not equivalent to a clinical hernia.

The pivotal question was that whether the open internal ring found in these children reflected a problem of sufficient evidence for surgical correction. In order to find out whether a patient with PPV needs an operation, one must take into account any possible complications that may be sustained after a procedure. The incidences of postoperative reduction in testicular size or frank atrophy in boys were as high as 3% and 2%, respectively. Other complications, including damage to the vas deferens and a postoperative high-riding testis, have been reported even after a negative exploration. In our study, when a PPV was noted, it was closed through a crease incision, and a 2-0 suture was placed in the lower half of the internal inguinal ring using a specially devised needle. The suture was advanced extraperitoneally across the cord and vessels and was retrieved through the upper half of the ring by the specially devised needle and then tied up extracorporeally, achieving complete extraperitoneal ligation of the ring. This totally extraperitoneal operation can greatly reduce the damage to vas deferens and spermatic vessels. The internal ring was closed laparoscopically concurrent with the LP in all 66 patients. No postoperative complications had developed after a minimal follow-up of 12 months. The other single institution study evaluated 1164 patients who underwent a unilateral inguinal hernia repair during the 10 years period, and laparoscopy was used in 1010 patients. No intraoperative complications were found in laparoscopy group, and 10 patients (1.0%) developed a surgical site infection after operation. All patients with surgical site infections were treated initially with oral antibiotics. No patient required hospitalization or reoperation. In the control group including 154 patients unreceiving laparoscopy, one wound infection was identified (0.6%). There was no difference in rate of recurrence. There was minimal risk of infection or recurrence following unilateral inguinal hernia repair, and this risk did not increase with the use of the laparoscopic contralateral exploration.

With the advent of laparoscopy, the criteria for the use of transinguinal laparoscopy in contralateral groin exploration have been expanded, and published reports have demonstrated that transinguinal laparoscopic exploration is simple, safe, and effective. During laparoscopic surgery, clinicians can simultaneously detect and repair PPV (without additional access, time, or anesthesia), otherwise, one-sixth of these patients with PPV were in the risk of developing into hernias. In other hand, the detection of processus vaginalis could avoid a second anesthesia and the risk and mental trauma of a second operation for children, the anxiety associated with a second operation for parents, and the embarrassment associated with the appearance of a second hernia at a later time for the physician. In our study, the average time for closing the internal ring was 7 min, and no intracorporeal laparoscopic knot-tying was required. In addition, the advantage of laparoscopic exploration is that no addition incisions are required. And it is easy to grasp this skill. No postoperative complications had developed after a minimal follow-up of 12 months. We felt that the laparoscopic closure of the internal ring is not technically challenging and can be performed safely and expeditiously, thus potentially avoiding additional surgery under general anesthesia and its attendant risks. The entirety of these laparoscopical procedures in pediatric general surgery should be encouraged.

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