Outcomes Of Open Versus Laparoscopic Pyloromyotomy: A Single Centre Experience

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Background: Infantile hypertrophic pyloric stenosis (IHPS) remains the most often cause of projectile vomiting in infants during first month of life that required surgical correction. During many years open pyloromyotomy remains a gold standard of treatment in newborns with IHPS. Today, laparoscopic pyloromyotomy gradually accepted by pediatric surgeons. However, there are still contradictory results in the literature regarding the benefits and disadvantages of laparoscopic compared to the open procedure to treat infants with IHPS. The purpose of the study was to analyze cases of IHPS treated at L'viv regional children's clinical hospital «OXMATDYT» using the open and laparoscopic technique.

Material and Methods: A retrospective study was conducted 98 cases of IHPS treated from January 2009 to December 2020. The patients were divided into two study groups, depending on surgical approach. The patients from the first group were operated by open pyloromyotomy (OP) and patients from the second group underwent laparoscopic pyloromyotomy (LP).

Results: OP was performed in 76 patients and 22 patients were operated laparoscopically. The operation time was slightly shorter in open group, but this difference was insignificant (p=0.124). Despite a slightly shorter operative time in OP group, these patients more often had postoperative vomiting (15.8%) and significantly longer time to start oral intake (7.9±1.7 hours, p0.001) compared with patients of LP group. The perforation of mucosa was noted in one child of LP group. The frequency of wound infection was almost the same in both groups of patients (p=0.906). Incisional hernia (2.63%) and adhesive bowel obstruction (2.63%) were noted in case of OP.

Conclusion: Both technics are the safe and effective for the treatment of patients with IHPS. Laparoscopy has several advantages over open pyloromyotomy, without additional complications.

Key words: infants, hypertrophic pyloric stenosis, pyloromyotomy, open surgery

Introduction

Infantile hypertrophic pyloric stenosis (IHPS) remains the most often cause of projectile non-bilious vomiting in infants during first month of life. IHPS typically manifests between 2 and 6 weeks of age where the pyloric channel became narrowing, resulting in gastric outlet obstruction [1, 2].

The exact etiology of IHPS remains unknown. The failure of pyloric muscle relaxation has been attributed to inadequate innervation, defect of nitric oxide metabolism [3], hyperacidity in the stomach [4], and various environmental and genetics factors [5, 6] have been implicated as risk factors for IHPS occurrence. Despite the identification of these factors, conservative therapies to reverse the muscle hypertrophy have still not been established in most European clinics and if implemented have shown poor outcomes, leaving surgical management as the only option to alleviate this pathology. The medical management is usually reserved for patients who are deemed unfit to undergo general anesthesia due to severe medical co-morbidities [1].

Extramucosal pyloromyotomy for the treatment of pyloric stenosis was first described by Ramstedt in 1912 and during many years this method remains the «gold standard» of the treatment [7]. The open approach is effective at providing excellent exposure of the pylorus but results in an abdominal scar that grows with the patient and may becomes quite significant with time. In 1991, Alain et al. described the laparoscopic approach [8] and this surgical modality gradually accepted by pediatric surgeons [2, 9].

There are still contradictory results in the literature with regard to the benefits and disadvantages of laparoscopic compared to the open procedure to treat infants with IHPS. Some authors claimed that laparoscopic pyloromyotomy associated by a shorter hospital stay, shorter postoperative recovery, and less postoperative pain [10-12], however these advantages were not confirmed [9, 13, 14]. Besides that, some authors have questioned the safety of laparoscopy because of increased frequency of surgical complications compared with open pyloromyotomy [15, 16].

The purpose of the study was to analyze cases of IHPS treated at L'viv regional children's clinical hospital «OXMATDYT» using the open and laparoscopic technique and compare them in terms of the duration of surgery, intra- and post-operative complications, and duration of hospital stay.

Material and Methods

A retrospective study was conducted 98 cases of IHPS treated at our department from January 2009 to December 2020. Ethical approval was obtained from the local research ethics committee in L'viv regional children's clinical hospital «OXMATDYT». Informed voluntary consent for the treatment was signed by parents in all patients.

Diagnosis of IHPS was confirmed by ultrasonography according to the length of the pyloric canal and thickness of the pyloric muscles.

For the purpose of this study the patients were divided into two study groups, depending on surgical approach. The patients from the first group were operated by the traditional open pyloromyotomy (OP) while the patients from the second group underwent laparoscopic pyloromyotomy (LP). The technique used for pyloromyotomy was chosen by the operating surgeon.

OP performed through the right upper quadrant transverse skin incision. Pyloromyotomy is performed from the antrum of the stomach to the prepyloric vein of Mayo. The muscle edges of hypertrophied pylorus are dissected using a blunt instrument. The procedure is terminated when the mucosa protrudes through the incision.

Laparoscopic pyloromyotomy. After draping, a 5 mm incision was created to introduce a trocar through an infra-umbilical skinfold. Pneumoperitoneum was produced by the classic open Hasson technique. A level of pneumoperitoneum is set at 6 mm Hg. A 5-mm laparoscope is used to inspect the abdominal cavity. Two 3-mm instruments are then introduced through the stab incisions, first at the level of the right anterior axillary region above the umbilicus to grasp the pyloric olive, the second in the epigastric region, above the pylorus, to incise it and separate the muscle fibers. Pyloromyotomy is performed by arthrotomy knife #11 from the antrum of the stomach to the prepyloric vein of Mayo. The muscle edges of hypertrophied pylorus are dissected using an endo-dissector. Completion of pyloromyotomy was confirmed by ballooning of the intact mucosa and two independently moving pyloric edges. At the end of the procedure an air insufflation through nasogastric tube into stomach for testing seromucosal integrity was performed.

With the aim to reduce potential bias between treatment groups, standardized postoperative management protocols were used. Feeding was started from 4 to 6 h after surgery and increased to full enteral feed (150 mL/kg per day in eight divided feeds or full breastfeeding), as tolerated.

The SPSS 15.0 software package was used for the statistical analysis of the results. The data were represented as mean ± standard deviation; the two groups were compared using the mean rank sum test, with $p < 0.05$ being used for significant differences.

Results

Of the 98 cases 84 were males and 14 were females (Male:Female ratio 6:1) aged 2-11 weeks (average 4.9 weeks). Duration of illness before the surgery ranged from 2 to 42 days (average 11.4 days).

By ultrasonography, measurements of pyloric channel length (22.8±3.8 mm) and wall thickness (5.9±1.3 mm) were abnormal and consistent with the diagnosis of IHPS.

OP was performed in 76 patients and 22 patients were operated laparoscopically. The two groups were homogeneous (Table 1).

Table 1. Comparison of preoperative data in open (n=76) and laparoscopic (n=22) group

	Open group	Laparoscopic group	p-Value
Age (weeks)	5.2±2.1	4.6±2.3	0.293
Gender:			
Boys; n (%)	66 (86.8)	18 (81.8)	0.589
Girls; n (%)	10 (13.2)	4 (18.2)	0.589
Duration of illness (days)	11.2±9.5	10.6±4.2	0.793
Electrolyte disturbance; n (%)	31 (40.8)	9 (40.9)	0.992
Pyloric channel length (mm)	22.7±3.6	23.2±4.6	0.681
Wall thickness (mm)	5.9±1.3	6.1±1.6	0.518

There were no differences between both groups in age (p=0.293), gender (p=0.589), duration of illness (p=0.793), and presence of electrolytes' disturbance (p=0.992). Besides that, the investigated groups had no difference in length of pyloric channel (p=0.681) and wall thickness (p=0.518).

The operation time was slightly shorter in open group, but this difference was insignificant (p=0.124). Table 2 presents peri- and postoperative results in both groups of patients.

Table 2. Comparison of perioperative and postoperative data

	Open group	Laparoscopic group	p-Value
Operative time (min)	34.2±6.8	37.8±10.7	0.124
Time to start oral intake (hours)	7.9±1.7	5.6±1.5	<0.001
Postoperative vomiting; n (%)	12 (15.79)	3 (13.63)	0.727
Length of hospital stay (days)	7.3±3.1	5.1±4.2	0.031
Perforation of mucosa; n (%)	0	1 (4.55)	0.398
Wound infection; n (%)	3 (3.95)	1 (4.55)	0.906
Incisional hernia; n (%)	2 (2.63)	0	0.156
Respiratory complications; n (%)	1 (1.32)	0	0.316
Adhesive bowel obstruction; n (%)	2 (2.63)	0	0.156

Despite a slightly shorter operative time in OP group, these patients more often had postoperative vomiting and significantly longer time to start oral intake compared with patients of LP group (Table 2).

The perforation of mucosa was noted in one child of LP group and this damage was sutured laparoscopically without conversion. There were no cases of incomplete myotomy in both groups. The frequency of wound infection was almost the same in both groups of patients (p=0.906). Incisional hernia (2.63%) and development of adhesive bowel obstruction (2.63%) were noted in case of OP.

Discussion

Pyloromyotomy is the most common method of treatment in infants with IHPS, despite the attempts of medical treatment with atropine in patient with this pathology [17]. The OP characterized by the simplicity of approach, low incidence of complications, and short duration of surgery [18, 19]. However, this operation results, in some patients, in a quite visible scar that may be destressing to patient later in life [20, 21].

After applying in 1991 the laparoscopic approach for pyloromyotomy, this technic gradually has gained popularity among pediatric surgeons around the world [9, 13, 22-24]. The outcome of both surgical modalities was compared by several studies and meta-analyses with contradictory results regarding the advantages and disadvantages of each technique [10, 11, 21, 25]. Currently, there are no clear evidence-based recommendations, and the selection between open and mini-invasive approaches is still directed by the surgeons' preference.

The duration of surgery, especially in newborns, one of the important landmarks in pediatric surgery. In the present study, the OP was slightly faster than LP, but this difference was insignificant (p=0.124). Such result is consistent with the data of some authors [26, 27], but contradicts the results of other literature data [2, 28, 29]. The longer operative time in the laparoscopic group can be assumed to the earlier cases and with increased skills this time decreased. In the initial stages, we used introduction of trocars for the operating instruments, which prolonged operative time, but applying of stab incision technique also led to decrease of operative time that is consistent with the literature data [30]. Mahida et al.

[31] noted the longest duration of time in operating room for laparoscopic group, but the clear time of surgery was the shorter in this group.

The operative time influenced on time of onset of enteral feeding [32]. Despite the longer operative time of LP, the onset of enteral feeding was earlier in this group of patients compared with patients after OP (p<0.001). The faster starting of oral intake is the one of advantages of laparoscopic approach [27-29]. However, some authors did not find difference in time of onset of enteral feeding between open and laparoscopic groups [16, 30]. It is important to note that every hospital has different standardized protocols for a feeding regimen, which makes an objective comparison difficult.

Length of hospital stay was significantly shorter in laparoscopic vs. open group of patients (p=0.031), which coincides with the literature data [2, 10, 11, 31], while other data shown similar length of hospital stay in both groups of patients [26, 33].

Like any surgery, pyloromyotomy, independently of approach (open or laparoscopic), can associated with various perioperative complications. Mucosa perforation and incomplete myotomy are the most often intraoperative complications during pyloromyotomy [14, 21, 34, 35].

Overzealous myotomy may lead to full-thickness division of the pylorus with perforation and on the other hand, overly careful myotomy can lead to incomplete dissection of pyloric muscle. An adequate myotomy, especially in cases of LP, must balance between the risk of perforation and the risk of incomplete myotomy, although an inability to palpate the divided pylorus makes the evaluation of these risks particularly challenging [16]. Due to that, the preoperative ultrasonography measurement of the length of pyloric channel and thickness of pyloric muscle is an important for the LP. According to the ultrasonography data, the average length of pyloric was 28 mm, due to that the incision length was 20-25 mm in case of LP, that permitted to avoid the incomplete myotomy in either group that concordance with the literature data [30, 36]. Herewith, according to the literature data frequency of incomplete pyloromyotomy ranged from 0.1% to 3.4% in case of LP and from 0.3% to 1.1% – of OP [10, 21, 22, 35, 37]. The present study does not support evidence that laparoscopic approach may be associated with increased rates of incomplete pyloromyotomy requiring re-operation.

In our study, it was one (4.55%) case of mucosal perforation during LP and no cases at OP. Some literature data pointed on the higher incidences of mucosal perforation in case of laparoscopic approach (0.83%-3.3%) [21, 26, 35] and others showed the opposite results with higher frequency in case of open approach (3.6%-5.9%) [2, 22, 27]. A meta-analysis of results of three randomized controlled trial did not found significant difference in mucosal perforations between laparoscopic and open groups (odds ratio 0.96, 95% confidence interval: 0.22-4.26) [38].

Analysis of intra-operative complications may have different interpretations by different groups of surgeons. Thus, surgeons who are in favor of mini-invasive interventions may consider the difference in the frequency of incomplete myotomy and mucosal perforation in laparoscopic and open access so small that it has questionable clinical significance. In contrast, surgeons who are proponents of traditional interventions may focus on a statistically higher incidence of these complications during laparoscopic approach. That is confirmed by literature data [35].

Development of surgical site infection is a quite often postoperative complication after pyloromyotomy, independently of the type of approach [2, 10, 30]. The incidence of wound infection ranged from 2.4% to 4.9% after OP and nearly 2% after LP [2, 10, 11, 26, 33]. In this study, rate of wound infection was insignificantly higher in the laparoscopic group compared with the open group (4.55% vs. 3.95%, p=0.906). This result can be explained by the relatively small group of patients operated with laparoscopic approach.

Applying of the stab incision technique allowed to avoid occurrence the incisional hernia in laparoscopic group. By that, the rate of incisional hernia in open group was 2.63% (p=0.156). According to the literature data rate of incisional hernia after OP ranged from 2.4% to 5.4% and after LP – from 0.9% to 4.6% [10, 22, 38]. Mullassery et al. [39] noted that over a 6-year period at a single center, incisional hernia repair was performed in 6 of a total of 255 children who had initially undergone open (4) or laparoscopic (2) pyloromyotomy, reflecting an incisional hernia rate of 2.52%.

Evidence also suggests that adhesion-related complications occur less frequently after laparoscopic versus open procedures that confirmed by our study, where were two cases of adhesive bowel obstruction after OP and no cases after LP [40].

There are several limitations in this study: first, the sample size was small, and second, it was a retrospective and single-center study.

Conclusion

Both technics are the safe and effective for the treatment of patients with IHPS. Laparoscopy has several advantages over open pyloromyotomy, without additional complications.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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