# Laparoscopic Pyloromyotomy: Redefining the Advantages of a Novel Technique

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## ABSTRACT

**Objective:** With recent advances in minimally invasive techniques, many surgeons are favoring laparoscopic over traditional "open" pyloromyotomy for hypertrophic pyloric stenosis. The results of few studies, however, exist in the literature adequately comparing surgical outcome. We present a retrospective analysis of 56 consecutive patients who underwent laparoscopic or open pyloromyotomy.

**Methods:** A retrospective chart review of 56 consecutive infants (ages: 2 to 9 weeks; weights: 2.2 to 5.4 kilograms) who underwent laparoscopic (Group A-28) vs open (Group B- 28) pyloromyotomy between January 2000 and May 2001 was performed. Preoperative (age, sex, weight, HCO3, and K values) and postoperative (operating time, time to full feedings, persistence of emesis, and hospital stay) parameters were compared. Statistical analysis was performed via the Student $t$ test and chi-square/Fischer analysis where appropriate. A $P$ value <0.05 was considered significant.

**Results:** Preoperative parameters of both groups were similar ($P$ >0.05). In Group A, 26/28 (92.9%) were completed successfully with 2 open conversions. Group A versus Group B average operating times (36.1 vs 32.5 minutes), time to full feedings (24.1 vs 27.0 hours), and hospital stay (2.5 vs 2.6 days) were similar ($P$ >0.05). Persistent vomiting was observed in Group A, 25.0% (day 1)/3.5% (day 2) vs Group B, 39.3% (day 1)/10.7% (day 2). One infant in Group B required operative drainage of a wound abscess 1 week after surgery.

**Conclusions:** Laparoscopic pyloromyotomy can be performed with similar efficiency and surgical outcome as traditional open pyloromyotomy. Improved cosmesis and avoidance of wound complications are major benefits of this procedure, and a tendency towards less postoperative emesis is a potential benefit that deserves further investigation.

**Key Words:** Laparoscopic, Pyloromyotomy, Hypertrophic, Stenosis.

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## INTRODUCTION

Hypertrophic pyloric stenosis (HPS) is the most common surgical cause of vomiting in early infancy, with its clinical presentation evident in the first few weeks of life.[1] For the last century, the standard surgical treatment has been a seromuscular splitting of the pylorus or "pyloromyotomy," with preservation of an intact mucosal lining. This basic technique has been proven safe and effective, but the surgical approach to this procedure has been largely debated.

Open pyloromyotomy (OP) through different incisions has traditionally been the standard approach for this pathology. Upper midline laparotomy, oblique or transverse incisions in the right hypochondrium, and a circumbilical incision have been popular surgical approaches to pyloromyotomies and well described in the literature.[2] With recent advances in minimally invasive techniques, laparoscopic pyloromyotomy (LP) has emerged as a novel approach favored by many in the surgical community. The laparoscopic technique has been ascribed the potential benefits of shorter hospital stay, early tolerance of full feedings, less postoperative pain, and minimal postoperative complications.

The first LP was performed in France in 1990[3] and since then, few reports have compared the outcome of this technique with that of its open counterpart. This study intends to present our experience with laparoscopic pyloromyotomy and to compare surgical outcome in children who received a conventional open procedure.

## MATERIAL AND METHODS

The charts of 61 children who underwent pyloromyoto-

my for HPS at the Children's Hospital-New Orleans between January 2000 and May 2001 were retrospectively reviewed. The diagnosis of HPS in all cases was confirmed via abdominal ultrasonography, an upper gastrointestinal series, or both. To standardize the results of our study variables and make them comparable between both groups, patients with any comorbidity on admission that could prolong the hospital stay were excluded. Five children were excluded on this basis from the study because of associated comorbid conditions, such as congenital heart disease, milk jaundice, and urinary tract infection. The remaining children (n = 56) were included in the study. The cases were consecutively performed as OP during the first half of the study period or laparoscopically during the second half of the same time frame. During the first half of this time frame, 28 patients underwent a standard open pyloromyotomy via a circumbilical incision. In the second half of this time period, 28 children underwent the procedure via laparoscopy. All children received preoperative antibiotics and underwent either procedure by the same 2 staff pediatric surgeons from this institution. Postoperative pain was controlled in most patients with oral or rectal Tylenol, or both, and in a few instances 1 to 2 doses of parenteral narcotics.

A statistical analysis of the following preoperative parameters gathered at admission from all the study patients was performed: age, sex, weight, and sodium bicarbonate and potassium serum level. Postoperative variables studied in both groups were hospital stay, operating time, time to full feedings, postoperative emesis, need for reoperation, intra- and postoperative complications. Postoperative emesis was defined as the patient vomiting during postoperative day 1 or postoperative day 2. Need for conversion to laparotomy was also recorded in the laparoscopic group.

**Operative Technique**

*LP:* With the patient under general anesthesia, a Veress needle is introduced via the closed technique in the supraumbilical and $CO_2$ insufflation initiated, maintaining an intraabdominal pressure of 12 mm Hg. A 5-mm step trocar (Innerdyne, US Surgical Corporation. Norwalk, CT) and 30° laparoscope are introduced through the umbilicus for direct visualization. Two puncture sites are created in the right (A) and left (B) hypochondrium. A 2-mm pyloric grasper is introduced through A to hold the duodenum, and an arthrotomy knife through B to make a longitudinal

incision in the pylorus just proximal to the prepyloric vein and extending into the antrum. Subsequently, a pyloric spreader is introduced through B and the seromuscular layer separated. Upon completion of the pyloromyotomy, mucosal integrity is confirmed by insufflating air into the stomach through a nasogastric tube observing for air bubbles. In cases where mucosal perforation is identified, laparotomy via a circumbilical incision is performed and the mucosal defect repaired with a single layer of 4.0 Vicryl sutures buttressed by a tongue of omentum.

*OP:* The open counterpart of the above procedure involves a crescent-shaped supraumbilical fold incision and a vertical opening at the level of the linea alba. The greater curvature of the stomach is brought out through the operative incision and the pylorus exposed. Similarly, an incision is made proximal to the prepyloric vein and extended up into the antrum. After inspecting the integrity of the mucosa, the pylorus is returned to the abdomen with the fascia and skin closed in separate layers.

*Feeding protocol:* The identical feeding protocol was used in both groups. One ounce of Pedialyte was started 6 hours postoperatively and then substituted with full-strength formula 3 hours later, subsequently advancing by half an ounce every 3 hours. Tolerance of full feedings was considered the child tolerating 2 consecutive 2-ounce feedings without emesis.

*Statistical analysis:* Because the sample size in each group was less than 30 patients, the distribution of continuous variables studied was tested for normality. Histograms were used for this purpose, and if a normal distribution was suggested, a Student *t* test was used to compare the means of these variables in both groups. Similarly, if a normal distribution was not suggested, a nonparametric Wilcoxon rank-sum test was used to compare the results.

To compare the results of proportions, as with postoperative emesis or complication rate, the chi-square analysis or Fisher's exact test was used when appropriate. A *P*-value < 0.05 was considered statistically significant. Furthermore, to validate our findings of no difference in some of the variables compared, a power analysis was performed to determine whether the sample size of our study was adequate to arrive to those conclusions. A power > 80% was used to identify a difference of 1 day in the hospital stay, 8 minutes in the operating time, and 10 hours in the time needed to reach full feedings.

## RESULTS

Preoperative parameters, such as age, sex, body weight, serum potassium, and bicarbonate levels, were compared, and no statistically significant differences were found between both groups of patients **(Table 1)**. Twenty-six of 28 (92.8%) successfully completed LP, with 2 suffering mucosal perforation requiring conversion to OP. No significant differences were found between both groups in terms of hospital stay, operating time, time to reach full feeding tolerance, intra- or postoperative complications, and postoperative emesis on day 1 or 2 after surgery. Three of the postoperative parameters, hospital stay, operating time, and time to full feedings, had a study power > 80 % for the sample size used, supporting the notion that a nonsignificant $P$ value was found because of a nonexistent difference rather than a small sample size. Postoperative emesis was present in the LP group in 25% (day 1)/3.5% (day 2) versus the OP group where it was 39.3% (day1)/10.7% (day 2). The power to accurately find a difference for these variables was not sufficient for the sample size used.

Further breakdown of operating times in the LP group revealed that comparison of average operating times early vs later in the experience were 36.0 (n=14) and 35.5 minutes (n=14), which again yielded no significant difference. In the LP group, 2/28 (7.1%) intraoperative disruptions of the gastric mucosa occurred compared with 1/28 (3.6%) in OP. All these gastric lacerations were discovered during the procedure and primarily closed via laparotomy. Both children were subsequently discharged home on the second day following surgery, after an uneventful postoperative course.

No postoperative complications occurred in the LP group, compared with 1/28 (3.6%) in the OP group, where a wound abscess developed 1 week postoperatively requiring operative drainage. In the LP group, 3/28 (10.7%) patients required parenteral narcotics, compared with 9/28 (32.1%) in OP group. All children were well on follow-up clinic visits. (Data are summarized in **Table 2**).

## DISCUSSION

The surgical treatment of HPS through an extramucosal technique with a longitudinal incision was first described by Fredet and Lesne in 1908.[4] This procedure was subsequently modified by Ramstedt,[5] who in 1912 introduced longitudinal seromuscular splitting without sutur-

| Table 1. Preoperative Parameters | | | |
|---|---|---|---|
| | Laparoscopic (n=28) | Open (n=28) | $P$ Value |
| Age | 35.7±5.5 | 41.8±4.8 | 0.1 |
| Weight | 3.9±0.3 | 3.7±0.3 | 0.7 |
| HCO$_2$ | 29.1±1.6 | 29.0±1.8 | 0.9 |
| K | 4.6±0.3 | 4.6±0.3 | 0.7 |
| Sex (m/f) | 0.89 | 0.82 | 0.7 |

ing, which has remained the gold standard for managing HPS.[5] Despite this being the standard treatment for this condition, the surgical approach used to perform this surgery has been extensively debated. With recent advances in minimally invasive techniques, laparoscopic pyloromyotomy (LP) has gained increasing popularity among various surgical groups. LP was first reported by Alain et al[3] in 1991, and since then many institutions have utilized this technique. As of today, numerous articles have been published about this procedure, but only 6 have compared the surgical outcome of children undergoing the open versus the laparoscopic procedure, with 2 studies originating from institutions in the United States.[2,6-10] These comparison studies have reported discrepant results, and none have utilized power analysis to validate negative results found. **Table 3** summarizes the findings of these studies.

The current study was intended to accurately compare the surgical outcome of patients who underwent OP vs outcomes of those who underwent LP. OP was consecutively performed during the first half of the study period and LP in the second half. Furthermore, all patients followed the same postoperative care protocol, and anyone with a comorbidity that would prolong hospital stay was excluded from the study. Although this was not a prospective randomized trial, the study design was intended to produce results somewhat comparable to those of a randomized study.

As per the results of our study, the variables of hospital stay, operating time, and time to full feedings showed no statistically significant differences between groups with a power > 80% for the sample size, thus in theory reducing the chances of missing a difference that indeed exists. Interestingly, there appeared to be a tendency towards increased episodes of emesis in the OP group (42% vs 25%), although the sample size required to reach

**Table 2.**
Postoperative Parameters

| | Laparoscopic (n=28) | Open (n=28) | *P* Value |
|---|---|---|---|
| Hospital stay (days) | 2.50±0.5 | 2.64±0.4 | 0.65 |
| Operating time (minutes) | 36.0±4.3 | 32.5±3.0 | 0.18 |
| Time to full feedings (hours) | 24.1±4.3 | 27.0±5.4 | 0.41 |
| Postoperative emesis (POD 1) | 25.0% | 39.3% | 0.25 |
| Postoperative emesis (POD 2) | 3.6% | 10.71% | 0.61 |
| Intraoperative complications | 7.1% | 3.6% | 1.0 |
| Postoperative complications | 0% | 3.7% | 0.31 |
| Reoperation | 0% | 0% | N/A |
| Open conversion | 7.1% | N/A | N/A |

**Table 3.**
Laparoscopic vs Open Pyloromyotomy: Experience From the Literature

| Study | Study Design | Sample Size | Operating Time | Time to Full Feedings | Hospital Stay | Postoperative Emesis |
|---|---|---|---|---|---|---|
| Scorpio[11] | Retrospective-1995 | 26 | Same | OP>LP | Same | Same |
| Greason[9] | Retrospective-1995 | 11 | Same | Same | N/S | Same |
| Ford[5] | Retrospective-1997 | 33 | LP>OP | OP>LP | N/S | N/S |
| Sisten[4] | Retrospective-1997 | 36 | LP>OP | N/S | OP>LP | N/S |
| Bufo[3] | Retrospective-1998 | 29 | Same | Same | Same | Same |
| Fujimoto[1] | Prospective-1999 | 30 | LP=OP | OP>LP | N/S | OP>LP |

a significant power, and thus statistical significance, was insufficient. Independent of the presence or absence of postoperative vomiting episodes, the hospital stay was statistically similar in both groups, which in the face of an adequate study power for this variable suggests that even if a tendency exists towards increased postoperative emesis in the OP group, this is not significant enough to prolong hospitalization. Furthermore, the observation that a higher number of patients in the OP group received parenteral narcotics may in part explain the increased incidence of postoperative emesis in this group, in addition to a theoretically increased incidence of adynamic ileus associated with the open procedure.

Decreased time to reach full feedings has been suggested by some as a potential advantage of LP. Contrary to findings in this report, Scorpio et al,[10] Ford et al,[8] and Fujimoto et al[6] reported shorter times to reach full feedings. It is noteworthy to mention that Ford et al[8] reported his results without any statistical analysis, and the remaining 2 studies started feedings at a much later time for the OP group. Furthermore, in the prospective study by Fujimoto et al,[6] the OP group achieved tolerance to a full feeding volume comparable to the one we used, but at an average time of 64 hours postoperatively, a value more than twice that reported in our study.

OP has been reported to carry a risk of mucosal disruption and wound infections of up to 8.5% and 11.8%, respectively.[11] Our series of LP shows an absence of wound infections and a mucosal disruption rate of 7.1%, with both mucosal disruptions discovered intraoperatively. Remarkably, both children in the LP group suffering this complication were discharged on postoperative day 1.

A review of the 6 comparative studies is shown in **Table 3**. Compiling all these studies together, the overall complication rates for the LP and OP groups were 4.5% and 1.8% for intraoperative mucosal disruption, 2.41% and 0.8% for inadequate pyloromyotomy, 0.84% and 3.3% for wound infections. **Table 4** summarizes these findings and compares them with our results.

**Table 4.**
Laparoscopic vs Open Pyloromyotomy: Complication Rate From a Combined Experience

| | Combined Experience | | Our Results | |
| --- | --- | --- | --- | --- |
| | LP | OP | LP | OP |
| Intraoperative perforation | 4.5% | 1.8% | 7.1% | 3.6% |
| Insufficient myotomy | 2.4% | 0.8% | 0% | 0% |
| Wound infection | 0.8% | 3.3% | 0% | 3.7% |

In conclusion, LP can be performed with similar efficiency and surgical outcome compared with the more traditional open pyloromyotomy. Operating time, hospital stay, and time to full feedings were statistically comparable with that of the open procedure. The lack of intravenous narcotic requirement in the laparoscopic group may help explain the tendency towards less postoperative emesis.

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