

# Laparoscopic Pyloromyotomy: Learning Curve

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## ABSTRACT

**Introduction:** Infantile hypertrophic pyloric stenosis (IHPS) is one of the many causes of recurrent gastric vomiting in infants, the incidence of which is approximately 1 to 3 per 1,000 live births. Laparoscopic pyloromyotomy (LP) is becoming increasingly popular as the standard treatment for hypertrophic pyloric stenosis.

**Materials and methods:** We describe our experience with LP in 50 infants over a period of 7 years divided into two groups, with the first being first 3 years and the second being next 4 years. The LP was performed through 5-mm umbilical port with 5-mm 30 endoscope. Two 3-mm working instruments were inserted directly into the abdomen via separate lateral incisions.

**Results:** All patients were retrospectively evaluated. The procedure was performed in 50 infants with a mean age of 38 days and mean weight of 3.1 kg. All procedures, except two, were completed laparoscopically. Average operating time was 28 minutes in group I, while it was 21.44 min in group II ( $p$ -value  $<0.001$ ). There were no major intraoperative and postoperative complications.

**Conclusion:** The LP has already been shown to be feasible, safe, effective, and with reduction in incision size. We further find that LP has a definite learning curve and as experience is gained, operative time decreases. In our study, we also found time to feed also decreased significantly.

**Keywords:** Infantile hypertrophic pyloric stenosis, Laparoscopic pyloromyotomy, Learning curve.

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## INTRODUCTION

Infantile hypertrophic pyloric stenosis is one of the common causes of recurrent gastric vomiting in infants. Historically, it was treated with a gastrojejunostomy.<sup>1</sup>

Fredet introduced a pyloric muscle-splitting technique followed by transverse suturing of the muscle in 1908.<sup>1</sup> Ramstedt<sup>2</sup> described pyloromyotomy, which has remained the gold standard treatment with excellent results. Alain et al<sup>3</sup> described a laparoscopic approach for performing a pyloromyotomy. Since then, several studies have shown comparative safety and efficacy of the laparoscopic approach compared with the open technique.<sup>3-6</sup> Herein, we are studying all cases of LP and the learning curve associated with it in our institute.

## MATERIALS AND METHODS

Fifty infants with diagnosis of IHPS were treated over a period of 7 years from June 2010 to July 2016. They were divided into two groups, group I being operated between 2010 and 2012 while group II was being operated from 2013 to 2016. All patients were evaluated with ultrasonography and erect X-ray abdomen. Diagnostic criteria used were clinical history of gastric vomiting, palpable olive, and ultrasound evidence of pyloric length of more than 18 mm and thickness of  $\geq 4$  mm.<sup>7</sup> After admission and stabilization of electrolyte and acid and base balance, the infants were posted for LP.

## Ergonomics

The infant was placed in the supine position. The surgeon, the assistant, and the scrub nurse stood on the left side of the patient, with the monitor at the head end toward the right side. In some cases, the child was placed across the table with operating surgeon at foot end and monitor at head end.

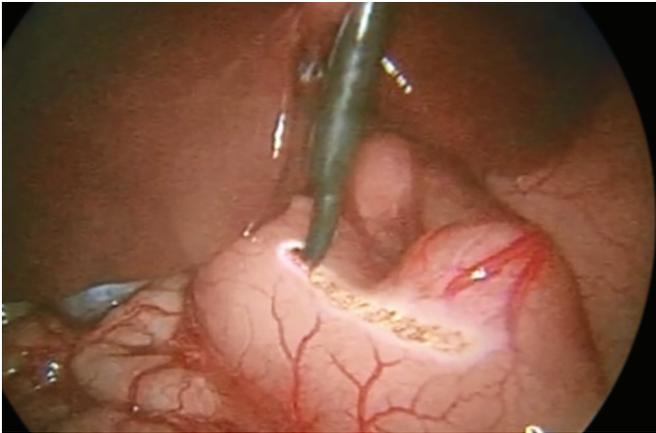
## Surgical Technique

Patients received one dose of perioperative antibiotic at the time of induction of anesthesia. All the operating surgeons in the study had more than 5 years of laparoscopy experience. A 5-mm port was inserted through a subumbilical incision by open Hasson's technique. Pneumoperitoneum was created. Insufflation of carbon dioxide (CO<sub>2</sub>) started at 0.1 L/min was increased until 1 L/min, if required. Pressure was kept at around 6 mm Hg and was increased to a maximum of 8 mm Hg, with constant monitoring of maximal concentration of CO<sub>2</sub>. Two 3-mm instruments were used directly by stab technique, one in the right anterior axillary line slightly above the level of the umbilicus,

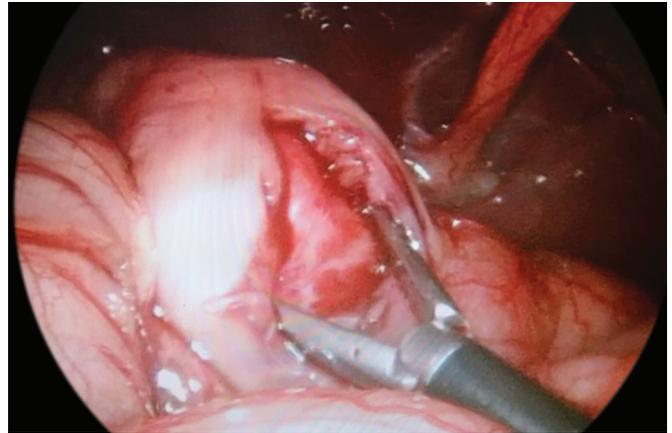
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**Fig. 1:** Pyloric olive being cut with hook



**Fig. 2:** Pylorus being spread out until mucosa bulges

to grasp the stomach and the other in the epigastric region directly over the pylorus, used for incising and splitting of the pylorus. In some cases, instrument was inserted directly in the left anterior axillary line slightly above the level of umbilicus, instead of right axillary line, to grasp stomach. In select cases, where the pylorus was visualized well and the liver was not overhanging, only one working port was used in epigastrium (2-port technique). An incision was made along the thickened pylorus with a 3-mm hook with low coagulating current (Fig. 1). In some cases, arthrotomy knife was used to make incision. The incision was deepened. The 3-mm Maryland forceps or Mixer forceps was used to further split the hypertrophied muscle fibers until mucosa was visualized bulging through the incision (Fig. 2). A satisfactory pyloromyotomy was confirmed by observing the intact bulging mucosa and confirming two separate independently moving pyloric edges, wherever possible. Mucosal perforation was excluded by insufflating the stomach with air via the nasogastric tube. The 5-mm umbilical port site was closed with an absorbable suture and the skin of all wounds was approximated with adhesive glue.

### Postoperative

Feeds were gradually introduced after 12 to 18 hours after clinical assessment. The infants were normally discharged the day after tolerating full feeds. Factors studied are duration of surgery, complications if any, time to reach full feeds, and postoperative hospital stay (Fig. 3).

Hospital Ethics Committee approval was taken. Patient data and operative procedures were taken from the department archives.

### RESULTS

Of the 50 cases, 44 were males and 6 were females (male:female ratio 7.3:1) aged 18 to 75 days (average 38.01



**Fig. 3:** Postoperative clinical view

days). Weight at admission ranged from 2.3 to 3.5 kg (average 3.036 kg). Duration of illness ranged from 3 to 16 days (average 8 days). Metabolic disturbances that needed correction were reported in almost half of the patients. Forty-eight procedures were completed laparoscopically and two required conversion, one for suspected inadequate pyloromyotomy and another for intraoperative mucosal perforation (conversion rate 4%). For inadequate pyloromyotomy, a complete pyloromyotomy was done by open technique. A mucosal perforation at the gastric end of the pyloromyotomy was sutured by open technique. Both conversions occurred early in the series (case no. 5 and 10). No conversions occurred in the last 40 cases. For analysis of data of postoperative stay and time to tolerate full feeds, the infant with mucosal perforation was excluded. Average operating time in group I was 28 minutes, while in group II, it was 21.44 minutes ( $p$ -value  $< 0.001$ ). Average postoperative length of stay was 2.8 days in group I, while in group II, it was 2.7 days ( $p$ -value 0.96). A mean of 27 hours was reported for the time to reach full feeds in group I, while in group II it was 18.8 hours ( $p$ -value  $< 0.001$ ). Apart from one patient with

**Table 1:** Demographic characteristics of two groups

	Group I (2010–2012)	Group II (2013–2016)	Total
No. of cases	16	34	50
Male:female ratio	14:2 (7:1)	30:4 (15:2)	44:6 (7.3:1)
Age at presentation (mean)	31.6 days	44.42 days	38.01 days
Weight on admission (mean)	2.9 kg	3.1 kg	3.036 kg
Duration of illness (mean)	7.2 days	8.5 days	8.084 days

prolonged emesis, no postoperative complications were noted in any of the infants. On follow-up, all infants had gained weight and were thriving well. All infants were examined 3 months after the surgery (Tables 1 and 2).

## DISCUSSION

Historically, IHPS was treated with a gastrojejunostomy.<sup>1</sup> Fredet introduced a pyloric muscle-splitting technique followed by transverse suturing of the muscle in 1908.<sup>1</sup> Ramstedt<sup>2</sup> described pyloromyotomy, which has remained the gold standard treatment for this condition with excellent results. The LP was first described by Alain et al.<sup>3</sup> Video-assisted, minimally invasive surgery is increasingly accepted in the pediatric population as more experience is gained and instruments became more refined. Various case series have been reported in the literature depicting improved parameters over a period of time as experience is gained, showing learning curve.

We reported in 2013 our initial experience with trocarless LP with conventional instruments.<sup>8</sup> The present study is a continuation of the process showing the learning curve associated with the technique of LP. In our study, we found that, initially, operating time was longer, while as experience was gained, it was decreased. Even conversion rates and complications reduced as more cases got operated. In addition, the number of ports also reduced from 4 to 3 or 2 in some cases.

Handu et al<sup>9</sup> demonstrated a fall in operative time and conversion rate with experience. Hendrickson et al<sup>10</sup> in their study, concluded that, initially, the laparoscopic approach is challenging to learn and has a significant learning curve as evident by the longer operative times. However, the operative times quickly decreased as this technique was more frequently performed. Oomen et al<sup>11</sup> in their study showed a significant decrease in the number and severity of complications between the first and second groups of LP patients, indicating that the learning curve in our series for LP involved 35 procedures. Kim et al<sup>12</sup> showed LP has a steep learning curve, especially for the first 15 patients. Operative

**Table 2:** Statistical analysis

Parameter	Group I (2010–2012)	Group II (2013–2016)	Total	p-value
Conversions	2*	Nil	2*	0.16
Operating time	28 min	21.44 min	23.53 min	<0.001
Time to full feeds	27 hrs	18.8 hrs	21.42 hrs	<0.001
Hospital stay	2.8 days	2.7 days	2.73 days	0.96

\*1 conversion because of inadequate myotomy (case no. 5),  
1 conversion due to mucosal perforation (case no. 10)

**Table 3:** Various case series pertaining to LP learning curve

Series	No of patients	Conversions	Complications
Handu et al <sup>9</sup>	101	4	10
Hendrickson et al <sup>10</sup>	25	2	1
Oomen et al <sup>11</sup>	71	3	17
Kim et al <sup>12</sup>	51	2	2
Bilt et al <sup>13</sup>	182	7	–
Ballouhey et al <sup>14</sup>	92	10	–
Present series	50	2	1

time decreases and becomes more consistent after about 30 cases. Despite the learning curve, LP can be performed safely and effectively without an increase in complications. van der Bilt et al<sup>13</sup> in their initial small series reported a relatively high complication rate. On subsequent follow-up, the operative time per surgeon dropped with experience though. There was no significant difference in the mean operative times between the two series. Ballouhey et al,<sup>14</sup> in their 2016 study, reported that risk of laparoscopy decreases in line with the surgeon's level of experience. Adibe et al<sup>15</sup> stated LP is a safe and effective alternative to open pyloromyotomy (Table 3).

## CONCLUSION

The LP has already been shown to be feasible, safe, effective, and with reduction in incision size. We further find that LP has a definite learning curve and as experience is gained, operative time decreases. In our study, we also found time to feed also decreased significantly.

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