Outcomes of Laparoscopic Pyloromyotomy with Microscope and Stab Incision vs. Open Pyloromyotomy in Infantile Hypertrophic Pyloric Stenosis; Single Institution Experience

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Purpose: We attempted to evaluate the outcomes of a newly inaugurated surgical technique of laparoscopic pyloromyotomy with microscope and stab incision (MS–LP) with right upper quadrant transverse open pyloromyotomy (RT-OP), which were performed in a single institution.

Methods: The outcome variables in terms of total anesthesia time, operative time, postoperative emesis, time to full-enteral feeding, postoperative hospital stay, cosmetic result score, medical cost, and postoperative wound complications were compared between the MS–LP and RT-OP groups.

Results: Fifty-one consecutive pyloromyotomy cases were enrolled; MS–LP (n=33) and RT-OP (n=18). There was no difference in age, pyloric thickness, and preoperative electrolyte levels between the two groups. The total anesthesia time and operative time of MS–LP were not significantly longer than that of RT-OP. Time to full-enteral feeding and postoperative hospital stay were shorter in MS–LP (20.0±18.3 vs. 35.3±14.8 hrs. and 2.4±1.3 vs. 3.4±1.2 days; p=0.047 and 0.050, respectively). The cosmetic result score and medical cost were significantly higher in MS–LP (9.1±1.0 vs. 7.3±1.2 in terms of scores and 3,501,950±1,093,147 vs. 2,522,474±68,605 in terms of KRW; p=0.001 and 0.021, respectively). No difference in postoperative wound complications was observed between the two groups.

Conclusion: Laparoscopic pyloromyotomy with microscope and stab incision may suggest recovery benefits with a shorter time to full-enteral feeding and postoperative hospital stay, as well as better cosmetic results than RT-OP. However, MS–LP may induce higher costs.

Keywords: Laparoscopic, Pyloromyotomy, Microscope, Infantile hypertrophic pyloric stenosis

INTRODUCTION

Infantile hypertrophic pyloric stenosis (IHPS) is a common cause of nonbilious emesis that requires surgical management in newborns. The incidence in Asian population is one–third to one–fifth of that in Caucasians. Since 1991, laparoscopic pyloromyotomy has been undergoing development and has also received recognition as a feasible and safe alternative to open extramucosal longitudinal myotomy. A number of Western studies have shown that the laparoscopic approach yields better cosmetic satisfaction, but there were mixed results in terms of complication rates, operative time, and hospital stay. Previous studies in Korea and Japan have shown improved recovery benefits, but were equivocal with regard to
the operative time and the costs. Moreover, these studies have not provided the objective measures of the cosmetic results.7,8 Heretofore, data regarding laparoscopic pyloromyotomy (MS-LP) using a telescope with a smaller diameter, a microscope, and a trocarless direct instrumentation through a reduced stab wound size is limited. In this study, we compared the results of surgically managed IHPS with the newly implemented laparoscopic pyloromyotomy using a microscope and stab incision with that of right upper quadrant transverse open pyloromyotomy (RT-OP).

**MATERIALS AND METHODS**

Consecutive patients, who presented to Hallym University Sacred Heart Hospital between January 2009 and December 2014 and were diagnosed with IHPS through standardized ultrasound criteria, were enrolled in this study. All surgeries were performed by a single pediatric surgeon. Data was retrospectively collected from the patients' medical records and the following results were compared between the MS-LP and the RT-OP groups. The patients' characteristics were analyzed, including the gestational age, birth weight, age at diagnosis, weight at diagnosis, pyloric thickness, as well as preoperative serum sodium, potassium, chloride, and bicarbonate levels. Total anesthesia time, operative time, postoperative hospital stay (HS), time to full-enteral feeding (EF, >60 mL full milk at once, more than three consecutive times without vomiting), cosmetic result score, medical cost, and postoperative wound complications were compared between the two groups. The postoperative cosmetic result score of the incision scar was assessed using the subjective satisfaction-scaling system that ranged from 0 (dissatisfied) to 10 (satisfied), 3 months postoperatively at an outpatient clinic by the patients' parents.

A laparoscopic pyloromyotomy with a microscope and stab incision was performed using a 2.7-millimeter laparoscopic pyloric spreader (Karl Storz, Tuttingen, Germany) and a 2.7-millimeter miniaturized Babcock grasper (Karl Storz, Tuttingen, Germany) without trocar insertion under the direct vision of a 2.4-millimeter and 30-degree umbilical telescope (Microscope, Stryker, Calamajué, MI, USA) (Fig. 1). An open pyloromyotomy was performed through a 3~4-centimeter long right upper-quadrant transverse skin incision.

### Laparoscopic pyloromyotomy with microscope and stab incision procedure

With the patient in a supine position, the surgeon shall stand on the patient's left side. A 2.7-millimeter umbilical trocar (Ethicon Endo, Puerto Rico, USA) was inserted using the Hasson technique and introducing a 2.4-millimeter 30-degree telescope. A carbon dioxide pneumoperitoneum was established with an infusion flow of 0.7 L/min. Two additional working instruments were inserted through a less than 3.0-millimeter skin incision using a muscle splitting technique; a 2.7-millimeter miniaturized Babcock grasper was inserted 5 cm lateral to the umbilicus on the right side. The duodenum was grasped just distal to the pylorus olive with the Babcock grasper from the right side and slightly rotated to the front of the scope for a better visualization of the avascular pyloric plane. For pyloromyotomy, the monopolar electrocautery knife (Dufner Instrumente, Tuttingen, Germany) was introduced through a skin incision on the left side hypochondrium, and a serosal incision was made along the pylorus olive in the avascular plane. Then, a 2.7-millimeter laparoscopic pyloric spreader was used for spreading the seromuscular layer. A thorough inspection of the mucosa was performed to look for any perforation sign and it was done by insufflating the stomach with 40 cc of air through the nasogastric tube.

**Statistical analysis**

The categorical variables were compared using a chi-square ($\chi^2$) test or a Fisher's exact test, when appropriate. The continuous variables were analyzed using the Student's t-test or the Mann–Whitney U test. Then, the data was analyzed using an SPSS 17.0 software package (Statistical Package for the Social Science, Chicago, IL, USA). A $p$ value of <0.05 was considered as statistically significant.

**RESULTS**

A total of 51 consecutive cases of surgically managed IHPS
were enrolled; MS-LP (n=33) and RT-OP (n=18). The patients’ characteristics are shown in Table 1. There was no difference in age at diagnosis, gestational age and birth weight, and preoperative serum electrolyte levels. Pylorus was slightly thicker in the MS-LP group without statistical significance.

There was no significant difference in the total anesthesia time and operative time between the groups (Table 2). Time to full-enteral feeding was significantly shorter, while the postoperative hospital stay tended to be reduced in the MS-LP group compared to the RT-OP group (20.0±18.3 vs. 35.3±14.8 hrs. and 2.4±1.3 vs. 3.4±1.2 days; p=0.047 and 0.050, respectively). The cosmetic result (Fig. 2) score of the MS-LP group was significantly higher than that of RT-OP group (9.1±1.0 vs. 7.3±1.2; p=0.001). The medical cost of MS-LP was significantly higher than RT-OP at 3,501,950±1,093,147 vs. 2,522,474±68,605 in terms of KRW; p=0.001). There was no intraoperative adverse event associated with surgical conversion from MS-LP to RT-OP. In addition, there was no incomplete pyloromyotomy that needed reoperation. Also, each group had two postoperative wound complications such as seroma.

**DISCUSSION**

Laparoscopic pyloromyotomy was first introduced in 1991 and since then, the prevalence of laparoscopic pyloromyotomy has been increased. Also, it has been frequently compared to RT-OP. This study showed that MS-LP was associated with a shorter duration to full-enteral feeding and shorter postoperative hospital stay compared to RT-OP. Such minimally
invasive techniques for the treatment of IHPS seem to have less association with the intraoperative inflammatory markers and postoperative analgesia requirements.\(^\text{8,9}\) In addition, well-designed miniaturized instruments have been noted to improve the procedural technique of conventional laparoscopic pyloromyotomy, as well as reduce trauma during abdominal access.\(^\text{10}\) Similar to previous reports and as expected, parents expressed higher satisfaction with the cosmetic results after the laparoscopic pyloromyotomy with microscope and stab incision than after the open procedures. Also, we showed that there were no differences in the total anesthesia time, operative time, and surgical complications between MS–LP and RT–OP. Given the data, it is suggested that MS–LP could be strongly encouraged as a procedure to be performed in infants with IHPS for better recovery benefits.

A previous study reported that with similar operative time and surgical complications, the use of MS–LP could translate to savings on costs compared to RT–OP.\(^\text{3,8,12}\) In another study, the use of trocarless techniques in LP was associated with the decrease in medical costs as it minimized the use of disposable instruments.\(^\text{13}\) Even though we only used one miniaturized transumbilical disposable trocar, MS–LP was associated with higher medical costs compared to RT–OP. However, parents might be willing to pay a higher price when it is related to improved cosmetic results.\(^\text{14}\) In terms of overall final expenses, a further study that prospectively examines the exact differences between costs using each technique is needed.

There are limitations in this study. First, in this study, even the initial experiences on both procedures were included. Furthermore, the data analyzed was comprised of a very small number of surgeries that were performed during a period that had relatively longer term (up to five years). It might not be adequate for a surgeon to go through an appropriate learning curve with just a small number of operations during period with a longer term. As a result, contrary to the well-designed, prospective, randomized, and controlled studies that were performed by experts in a large volume center, the operation times of both procedures in our study tended to be longer than the previous reports.\(^\text{3,6}\) Over time, fortunately, the operation time for MS–LP and RT–OP performed during the latter half of the period in this study were simultaneously reduced compared to the initial half period (from 72.0±40.8 to 47.0±17.1 in MS–LP and from 74.1±28.0 to 47.5±3.5 in RT–OP). Second, we sought to evaluate and compare the outcomes of laparoscopic pyloromyotomy with open pyloromyotomy. However, we used right upper quadrant transverse incision for open pyloromyotomy instead of circumumbilical incision. In addition, we used a stab incision for instrumentation instead of using a conventional trocar. Therefore, a follow–up study might be prioritized in order to compare the outcomes of laparoscopic pyloromyotomy with instrumentation through direct stab incision versus conventional trocar versus open pyloromyotomy through circumumbilical incision.

Given our small sample size, this retrospective comparison study may not have sufficient statistical power to make definite conclusions with regard to the substantial benefits of laparoscopic pyloromyotomy using microscope and direct instrumentation through stab incision compared to the right upper quadrant transverse open approach. Thus, we suggest that laparoscopic pyloromyotomy with microscope and stab incision could be associated with improved postoperative recovery benefits—in terms of shortened time to full-enteral feeding, shorter postoperative hospital stay and better cosmetic results—but may generate higher costs.

**REFERENCES**

1) Klein A, Cremin BJ. Racial significance in pyloric stenosis. S Afr Med J 1970;44:1131.
2) Alain JL, Grousseau D, Terrier G. Extramucosal pyloromyotomy by laparoscopy. Surg Endosc 1991;5:174–175.
3) St Peter SD, Holcomb GW, 3rd, Calkins CM, et al. Open versus laparoscopic pyloromyotomy for pyloric stenosis: a prospective, randomized trial. Ann Surg 2006;244:363–370.
4) Oomen MW, Hoekstra LT, Bakx R, Ubbink DT, Heij HA. Open versus laparoscopic pyloromyotomy for hypertrophic pyloric stenosis: a systematic review and meta–analysis focusing on major complications. Surg Endosc 2012;26:2104–2110.
5) Adibe OO, Nichol PF, Flake AW, Mattei P. Comparison of outcomes after laparoscopic and open pyloromyotomy at a high–volume pediatric teaching hospital. J Pediatr Surg 2006;41:1676–
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6) Siddiqui S, Heidel RE, Angel CA, Kennedy AP, Jr. Pyloromyotomy: randomized control trial of laparoscopic vs open technique. J Pediatr Surg 2012;47:93–98.

7) Kim SM, Jung SM, Seo JM, Lee SK. Comparison of Outcomes between Open and Laparoscopic Pyloromyotomy. J Korean Assoc Pediatr Surg DE – 2011–12–31 2011;17:139–144.

8) Fujimoto T, Lane GJ, Segawa O, Esaki S, Miyano T. Laparoscopic extramucosal pyloromyotomy versus open pyloromyotomy for infantile hypertrophic pyloric stenosis: which is better? J Pediatr Surg 1999;34:370–372.

9) Lemoine C, Paris C, Morris M, Vali K, Beaunoyer M, Aspirot A. Open transumbilical pyloromyotomy: is it more painful than the laparoscopic approach? J Pediatr Surg 2011;46:870–873.

10) Turial S, Enders J, Schier F. Microlaparoscopic pyloromyotomy in children: initial experiences with a new technique. Surg Endosc 2011;25:266–270.

11) Leclair MD, Plattner V, Mirallie E, et al. Laparoscopic pyloromyotomy for hypertrophic pyloric stenosis: a prospective, randomized controlled trial. J Pediatr Surg 2007;42:692–698.

12) Carrington EV, Hall NJ, Pacilli M, et al. Cost–effectiveness of laparoscopic versus open pyloromyotomy. J Surg Res 2012;178:315–320.

13) Ostlie DJ, Holcomb GW, 3rd. The use of stab incisions for instrument access in laparoscopic operations. J Pediatr Surg 2003;38:1837–1840.

14) Turial S, Enders J, Schier F, Santos M. Comparison of a novel technique of the microlaparoscopic pyloromyotomy to circumbilical and Weber–Ramstedt approaches, J Gastrointest Surg 2011;15:1136–1142.