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Laparoscopic pyloromyotomy decreases postoperative length of stay in children with hypertrophic pyloric stenosis☆,☆☆

Justin B. Mahida [a,b], Lindsey Asti [b], Katherine J. Deans [a,b], Peter C. Minneci [a,b], Jonathan I. Groner [a,*]

[a] Department of Pediatric Surgery, Nationwide Children's Hospital, Columbus, OH
[b] Center for Surgical Outcomes Research, The Research Institute at Nationwide Children's Hospital, Columbus, OH

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ABSTRACT

Objective: To determine the impact of laparoscopic versus open pyloromyotomy on postoperative length of stay (LOS).
Materials and methods: The 2013 National Surgical Quality Improvement Project Pediatric database was queried for all cases of pyloromyotomy performed on children <1 year old with congenital hypertrophic pyloric stenosis. Demographics, clinical, and perioperative characteristics for patients with and without a prolonged postoperative LOS, defined as >1 day, were compared. Logistic regression modeling was performed to identify factors associated with a prolonged postoperative LOS.
Results: Out of 1143 pyloromyotomy patients, 674 (59%) underwent a laparoscopic procedure. Patients undergoing open pyloromyotomy had a longer operative time (median 28 vs. 25 min, $p < 0.001$) but shorter duration of general anesthesia (median 72 vs. 78 min, $p < 0.001$). Patients undergoing open pyloromyotomy more frequently had a prolonged postoperative LOS (32% vs. 26%, $p = 0.019$). Factors independently associated with postoperative LOS >1 day included open pyloromyotomy (odds ratio, 95% confidence interval, p-value) (1.38, 1.03–1.84, $p = 0.030$), cardiac comorbidity (3.64, 1.45–9.14, $p = 0.006$), pulmonary comorbidity (3.47, 1.15–10.46, $p = 0.027$), lower weight (1.005 per 100 g decrease, 1.002–1.007, $p < 0.001$), longer preoperative LOS (1.35 per additional day, 1.13–1.62, $p = 0.001$), longer operative time (1.11 per additional 5 min, 1.05–1.17, $p < 0.001$), higher preoperative blood urea nitrogen (1.04 per additional mg/dl, 1.01–1.07, $p = 0.012$), and higher serum sodium (1.08 per additional mg/dl, 1.03–1.14, $p = 0.004$).
Conclusions: Compared to laparoscopic pyloromyotomy, open pyloromyotomy is independently associated with a higher likelihood of a prolonged postoperative LOS.

Hypertrophic pyloric stenosis affects 1.9 of every 1000 live births and pyloromyotomy is the standard of care for this condition [1,2]. The traditional approach for this procedure is a right upper quadrant transverse incision, although other “open” approaches, such as a periumbilical incision, have been described [3]. Although open pyloromyotomy is associated with a low complication risk, it results in scarring that has been associated with reports of worse body image and less satisfaction with scar cosmesis [4]. Laparoscopic pyloromyotomy has several potential advantages, including a shorter hospital stay, shorter postoperative recovery, less postoperative pain, lower complication rates, and improved cosmesis. However, these benefits as reported in published studies have been inconsistent [4–11]. Disadvantages, including higher likelihood of incomplete pyloromyotomy and perforation requiring reoperation, have been suggested by some studies [6,8] but have not been confirmed in randomized controlled trials [10,12].

The current study utilized prospectively collected, validated, and standardized data in the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) Pediatric to perform a multi-institutional analysis to identify factors associated with a prolonged postoperative length of stay (LOS) in patients undergoing pyloromyotomy. Specifically, we wanted to assess if a laparoscopic

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* Corresponding author at: Department of Pediatric Surgery, Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205. Tel.: +1 614 722 3919.
E-mail address: Jonathan.Groner@nationwidechildrens.org (J.I. Groner).

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approach was associated with a decreased LOS or fewer postoperative complications.

1. Materials and methods

The ACS NSQIP Pediatric is a multispecialty program that reports peer-reviewed, risk-adjusted 30-day postoperative outcomes for surgical cases performed on patients <18 years of age from participating institutions for the purpose of benchmarking and quality improvement. Dedicated surgical clinical reviewers at participating institutions collect more than 124 data elements (including information on demographics, preoperative and intraoperative variables, and postoperative occurrence and discharge variables) on patients selected by the ACS NSQIP 8-day cycle-based systematic sampling of 35 procedures per cycle [13–15].

All instances of pyloromyotomy performed on patients diagnosed with hypertrophic congenital pyloric stenosis based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 750.5 with a primary Current Procedural Terminology (CPT) code of 43,520 in the 2013 ACS NSQIP Pediatric were included. For purposes of defining the minimally invasive nature of a case, the ACS NSQIP Pediatric categorizes all included cases into one of three options: minimally invasive technique only, minimally invasive and open technique, and open or not applicable [16]. Cases in which the surgical approach was coded as an open or not applicable procedure were included in the open pyloromyotomy cohort, and those for whom the surgical approach was coded as a minimally invasive procedure only were included in the laparoscopic pyloromyotomy cohort. Patients who were coded as having a minimally invasive and open procedure were defined as having undergone a laparoscopic procedure that was converted to an open approach. They were included in the laparoscopic pyloromyotomy cohort and included in all analyses comparing laparoscopic to open pyloromyotomy populations.

Demographic, clinical, and 30-day outcome characteristics between patients who underwent an open versus a laparoscopic pyloromyotomy were compared and definitions for all NSQIP variables can be found elsewhere [16]. Patients with pulmonary risk factors were defined as any patient with a diagnosis of asthma, chronic lung disease, structural pulmonary disorder, cystic fibrosis, preoperative ventilator dependence, preoperative oxygen requirement, or a preoperative tracheostomy. Neurologic risk factors were defined as history of a cerebrovascular accident (CVA), tumor involving the central nervous system (CNS), seizure disorder, cerebral palsy, structural CNS abnormality, neuromuscular disorder, or intraventricular hemorrhage. Operation time was defined as the length of time between the initial surgical incision and closure of all surgical incisions. Total anesthesia time was defined as the length of time between initiation of induction of general anesthesia and handoff of the patient's care from the anesthesia provider to the postoperative care provider, inclusive of operation time. To separate operation time from total anesthesia time, *postoperative anesthesia time*, defined as the time between the end of surgery and handoff of the patient's care from the anesthesia provider to the postoperative care provider, was also compared. All complications were identified within 30 days of the operation, unless otherwise specified. *Wound complications* were defined as superficial surgical site infections (SSI), deep SSIs, organ or organ space SSIs, and wound disruption. *Respiratory complications* were defined as pneumonia, unplanned intubation, pulmonary embolism, and ventilator dependence >48 h. Urinary tract complications included acute renal failure, progressive renal insufficiency, and urinary tract infection. Central nervous system complications included coma >24 h, seizure, and nerve injury. Cardiovascular complications included cardiac arrest requiring cardiopulmonary resuscitation, CVA, and venous thromboembolism. Other complications included graft or prosthesis failure, postoperative systemic sepsis, unplanned reoperation, or death. Other outcomes included postoperative LOS, unplanned readmission, and transfusion performed intraoperatively or within 72 h of surgery.

Continuous variables were compared using Wilcoxon rank-sum tests and categorical variables were compared using Pearson chi-square tests or Fisher exact tests where appropriate for open versus laparoscopic pyloromyotomy. *P*-values <0.05 were considered statistically significant. A multivariable logistic regression model was fit to identify adjusted odds ratios (aOR) and 95% confidence intervals (CI) of preoperative factors predictive of a prolonged postoperative LOS, defined as a postoperative LOS > 1 day, which is consistent with prior studies [17,18]. Factors with *p*-value <0.20 in the univariable analysis were considered for inclusion in the backwards stepwise regression model. A *p*-value <0.20 was chosen because less-stringent *p*-values used for univariable analysis may identify more important variables to include in the multivariable model [19,20]. The Hosmer–Lemeshow goodness of fit test was used to assess the adequacy of model fit to explain variation in the dataset with a *p*-value of <0.05 required to accept our final model [19]. All analyses were performed using SAS 9.3 (Cary, NC).

2. Results

Of 1143 patients with hypertrophic congenital pyloric stenosis who underwent pyloromyotomy, 674 (59%) were performed laparoscopically and 469 (41%) were open procedures. Thirty of the laparoscopic pyloromyotomies (4%) were converted to an open procedure. Table 1 shows demographics and preoperative characteristics for the two procedure type groups. Patients undergoing a laparoscopic procedure were more likely to identify as white, to weigh less, and to have a congenital malformation other than pyloric stenosis. Patients undergoing open surgery had longer operative times, but patients undergoing laparoscopic surgery had longer total anesthesia duration.

Table 2 presents outcomes following surgery. Patients undergoing laparoscopic pyloromyotomy were less likely to have a postoperative LOS >1 day. There were no differences in the number of patients experiencing a complication of any type between the two groups including the number of patients undergoing an unplanned related reoperation. On multivariable analysis (Table 3), the following factors were significantly associated with a postoperative LOS >1 day (aOR, 95% CI): an open procedure (1.38, 1.03–1.84, $p = 0.030$), cardiac comorbidity (3.64, 1.45–9.14, $p = 0.006$), pulmonary comorbidity (3.47, 1.15–10.46, $p = 0.027$), lower weight (1.005 per 100 g decrease, 1.002–1.007, $p < 0.001$), longer preoperative LOS (1.35 per additional day, 1.13–1.62, $p = 0.001$), longer operative time (1.11 per additional 5 min, 1.05–1.17, $p < 0.001$), higher preoperative blood urea nitrogen (1.04 per additional mg/dl, 1.01–1.07, $p = 0.012$), and higher serum sodium (1.08 per additional mg/dl, 1.03–1.14, $p = 0.004$).

3. Discussion

Compared to laparoscopic pyloromyotomy, open pyloromyotomy was independently associated with a higher likelihood of a postoperative LOS >1 day. Laparoscopic pyloromyotomy was not associated with an increased proportion of readmissions, need for initiation of supplemental nutrition, or other unintended consequences from the decreased postoperative LOS. These findings are consistent with previous studies comparing open and laparoscopic pyloromyotomy [6,10].

Patients undergoing laparoscopic pyloromyotomy were less likely in the current study to have a postoperative LOS >1 day. This finding is consistent with previous studies noting a shorter postoperative LOS in patients undergoing laparoscopic pyloromyotomy [5,6]. One study notes that the reduced LOS is the main driver for a cost savings of 14% when comparing patients undergoing laparoscopic pyloromyotomy to patients undergoing open pyloromyotomy [5]. Tolerance of oral intake and postoperative pain control are the two main barriers to postoperative discharge for these patients. Previous studies demonstrate no difference in time to full feeding but reduced postoperative analgesic