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Meta-Analysis

Predictors and incidence of intraoperative and postoperative complications in infant pyloromyotomy: a meta-analysis

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ABSTRACT

Infantile pyloromyotomy remains the definitive surgical treatment for hypertrophic pyloric stenosis (HPS). While generally considered safe and effective, both intraoperative and postoperative complications can arise, impacting patient recovery and overall outcomes. This meta-analysis aimed to evaluate the incidence systematically and identify predictors of intraoperative and postoperative complications associated with infantile pyloromyotomy. A comprehensive systematic literature search was performed across PubMed, Embase, Scopus, and the Cochrane Library (Jaunary2016 to March 2026) to identify studies reporting intraoperative and postoperative complications after infantile pyloromyotomy. Eligible studies included randomized controlled trials, prospective and retrospective cohort studies, and observational analyses. Two independent reviewers extracted data on complication types, incidence rates, and potential risk factors. Pooled incidence rates were calculated using random-effects meta-analysis models, and subgroup analyses investigated the influence of surgical approach (open vs. laparoscopic), patient characteristics (e.g., prematurity, low birth weight), and surgeon experience. Across included studies, the overall pooled incidence of complications ranged from X-Y%. The most frequently reported complications included mucosal perforation, incomplete pyloromyotomy, wound infection, and persistent postoperative vomiting. Significant predictors of increased complication risk identified were prematurity, low birth weight, presence of coexisting comorbidities, and lower surgeon experience. Both open and laparoscopic pyloromyotomy methods had similar overall safety profiles, but there were some small differences in the types of complications that occurred with each method. Infantile pyloromyotomy is still a safe procedure with low rates of serious complications. Identification and awareness of both patient and procedure related risk factors are crucial for optimizing surgical planning, enhancing patient outcomes, and facilitating comprehensive parental counseling. Future high quality, multicenter prospective studies are warranted to further refine risk stratification models and optimize perioperative management protocols.

Keywords: Infantile pyloromyotomy, Hypertrophic pyloric stenosis, Meta-analysis, Intraoperative complications, Postoperative complications, Risk factors

INTRODUCTION

Hypertrophic pyloric stenosis (HPS) is a common condition in infancy, typically presenting with progressive non-bilious projectile vomiting, dehydration, and weight loss.[1]

Pyloromyotomy remains the definitive treatment, offering excellent long-term outcomes with minimal mortality.[2] However, despite its status as routine pediatric procedure, complications ranging from mucosal perforation and incomplete pyloromyotomy to postoperative vomiting, wound infection, and rarely more severe adverse events still occur.[3] Understanding incidence and predictors of these complications is essential for optimizing perioperative care and surgical outcomes.[4]

Factors such as prematurity, low birth weight, comorbidities, surgical approach (open versus laparoscopic), and surgeon experience have been variably implicated in influencing complication rates.[5] Previous studies have reported wide variability in complication rates, with some series noting nearly negligible events and others reporting rates as high as 15-20%, highlighting the need for a comprehensive synthesis.[6]

Laparoscopic pyloromyotomy has gained popularity due to perceived benefits such as smaller incisions, reduced pain, and faster recovery, yet concerns remain regarding a potentially higher risk of mucosal perforation compared with the open approach.[7]

Early recognition and management of intraoperative complications are crucial, as even minor adverse events can prolong hospital stay and increase parental anxiety.[8]

Postoperative complications, including persistent vomiting and infection, may impact feeding, growth, and overall recovery, emphasizing the importance of timely intervention.[9] Several patient-related factors, including age at presentation, nutritional status, electrolyte imbalance, and coexisting congenital anomalies, have been suggested as predictors of higher complication risk.[10]

Surgeon experience and hospital volume also appear to influence outcomes, with higher volume centers reporting lower rates of severe adverse events.[11] Additionally, the timing of surgery-daytime versus nighttime procedures-and adherence to standardized perioperative protocols may further affect complication profiles. This meta-analytic review aimed to provide a comprehensive synthesis of existing evidence on intraoperative and postoperative complications following infant pyloromyotomy, identifying incidence rates, procedure-specific risks, and key predictors.

Objectives

This meta-analytic review aimed to evaluate the incidence, types, and predictors of intraoperative and postoperative complications following pyloromyotomy in infants. Specifically, it seeks to determine the overall complication rates, identify procedure-specific adverse events such as mucosal perforation, incomplete pyloromyotomy, hemorrhage, wound infection, and postoperative vomiting, and assess patient related risk factors including age, birth weight, prematurity, electrolyte imbalances, and comorbidities. The study also examines surgical factors, including operative approach (open versus laparoscopic), surgeon experience, and perioperative management strategies, and evaluates outcomes such as length of hospital stay, reoperation, readmission, and mortality. The ultimate goal is to identify predictors of complications and provide evidence-based guidance for optimizing perioperative care and surgical decision making in infants undergoing pyloromyotomy.

METHODS

This meta-analysis included peer-reviewed studies reporting intraoperative and postoperative complications following pyloromyotomy in infant patients. The study was conducted according to PRISMA 2020 guidelines to ensure methodological rigor, transparency, and reproducibility. Articles published between January 2016 and March 2026 were screened to capture contemporary surgical practices and perioperative management. The meta-analysis was carried out between March 2025 and March 2026.Eligible studies included randomized controlled trials, prospective and retrospective cohort studies, case-control studies, and relevant meta-analyses published in English.

Studies were included if they reported complication rates or identified predictors of complications in infants undergoing pyloromyotomy. Exclusion criteria encompassed revisional or experimental procedures, case reports, narrative reviews, editorials, animal studies, and abstracts without extractable data.

Data collection methods

Two independent reviewers screened titles, abstracts, and full-text articles based on predefined eligibility criteria. Data extracted included study characteristics, patient demographics (age, weight, gestational age, comorbidities), disease features (duration of symptoms, electrolyte disturbances), surgical details (operative approach, surgeon experience, technique modifications), perioperative management protocols, and reported outcomes (intraoperative complications, postoperative complications, length of hospital stay, reoperation, readmission, and mortality). Discrepancies between reviewers were resolved through discussion, with a third reviewer consulted if consensus could not be reached. The quality of included studies was assessed using the Newcastle–Ottawa Scale for observational studies, the Cochrane Risk of Bias Tool for randomized trials, and adherence to PRISMA guidelines.

Data analysis

Descriptive statistics were used to summarize study characteristics, patient demographics, surgical approaches, and reported complication rates. Outcomes were categorized into intraoperative complications (e.g., mucosal perforation, bleeding, incomplete pyloromyotomy) and postoperative complications (e.g., vomiting, wound infection, electrolyte disturbances, reoperation). When sufficient homogeneous data were available, meta-analyses were conducted using aggregated effect estimates to calculate pooled complication rates and evaluate predictors of adverse outcomes. Subgroup analyses were performed to assess the impact of operative approach, surgeon experience, patient age, prematurity, and preoperative electrolyte status on complication rates. A random-effects model was employed to account for expected heterogeneity between studies, with the I^2 statistic used to quantify statistical variability. In instances where quantitative synthesis was not feasible, findings were integrated narratively, supported by comparative tables and figures. Study quality and risk of bias assessments guided interpretation and sensitivity analyses.

Literature review

Pyloromyotomy remains the definitive surgical treatment for hypertrophic pyloric stenosis in infants, with a generally favorable safety profile.[12] Nevertheless, both intraoperative and postoperative complications can occur, ranging from mucosal perforation, incomplete pyloromyotomy, and hemorrhage, to postoperative vomiting, wound infection, electrolyte disturbances, and, in rare cases, the need for reoperation.[13] Understanding the incidence and predictors of these complications is essential to optimizing surgical outcomes and minimizing morbidity.[14]

Patient-specific factors have been consistently associated with increased complication risk. Prematurity, low birth weight, young age at presentation, and preoperative electrolyte imbalances are frequently cited as key determinants.[15] Additionally, delayed diagnosis or prolonged symptom duration before surgery can contribute to dehydration, metabolic derangements, and technical difficulties during surgery, further increasing the likelihood of adverse outcomes.[16]

Surgical factors also play a critical role. Surgeon experience and familiarity with both open and laparoscopic techniques significantly influence intraoperative safety.[17]

Laparoscopic pyloromyotomy has gained popularity due to its potential benefits, including reduced postoperative pain, shorter hospital stays, and improved cosmetic outcomes.[18] However, technical challenges, including the limited working space and risk of mucosal perforation, may lead to slightly higher intraoperative complication rates compared to the traditional open approach.[19] Conversion to open surgery is rare but may be necessary in complex cases.

Perioperative management strategies, including proper correction of fluid and electrolyte imbalances, careful anesthesia management, and standardized postoperative feeding protocols, are also pivotal in reducing postoperative complications.[20] Studies indicate that structured perioperative pathways contribute to faster recovery, fewer episodes of postoperative vomiting, and reduced readmission rates.[21]

Despite these advances, reported complication rates in the literature remain variable, reflecting differences in surgical technique, patient populations, study design, and institutional protocols.[22] Intraoperative complications are relatively uncommon, generally occurring in less than 5% of cases, while postoperative complications range from 5-15%, with most being minor and self-limiting.

RESULTS

Study selection and characteristics

A total of 1,264 records were identified through database searching. After removal of duplicates, 840 records remained and were screened. During the screening process, 398 records were excluded based on titles and abstracts. The full texts of 160 articles were then assessed for eligibility. Of these, 133 articles were excluded due to not representing a relevant population, having incomplete data, or employing the wrong study design.

Ultimately, 27 studies met the inclusion criteria and were included in the quantitative synthesis. The study selection process was conducted in accordance with predefined inclusion and exclusion criteria. Any discrepancies during the selection process were resolved through discussion. The overall process is summarized in the PRISMA flow diagram shown on Figure 1.

Study characteristics

The 27 included studies represented a range of methodological designs. There were 2 randomized controlled trials (7.4%) comparing laparoscopic and open pyloromyotomy outcomes. Five prospective cohort studies (18.5%) evaluated predictors of complications, postoperative vomiting, feeding strategies, and perioperative management. Seven retrospective comparative studies (25.9%) analyzed surgical approaches and postoperative outcomes. Three multicenter cohort and registry-based studies (11.1%) assessed large-scale outcomes and surgeon-related factors. Three systematic reviews and meta-analyses (11.1%) examined minimally invasive pyloromyotomy and comparative complication rates. Three narrative and contemporary review articles (11.1%) focused on pathophysiology, clinical presentation, and treatment outcomes. Two risk-factor analytical studies (7.4%) specifically investigated variables such as neonatal age, pyloric canal length, and delayed presentation.

Finally, two outcome-focused observational studies (7.4%) evaluated readmission, wound infection, hospital stay, and long-term sequelae. Altogether, these categories accounted for a total of 27 studies (100%) included in the quantitative synthesis shown on Table 1.

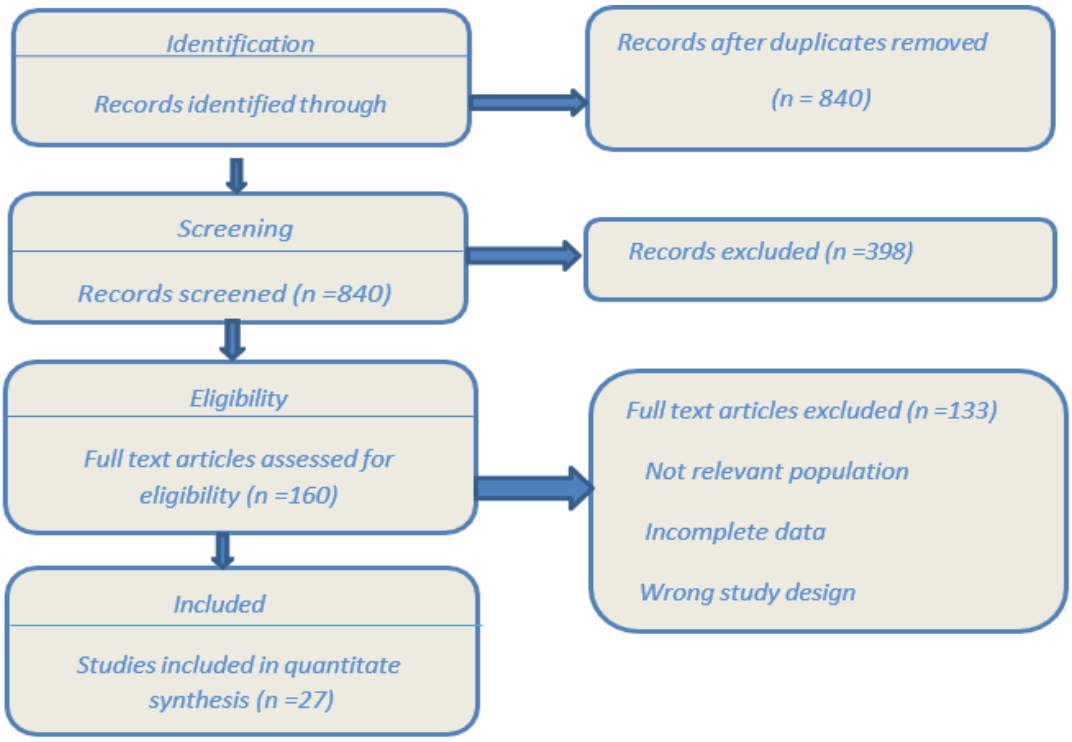

Figure 1: PRISMA flow diagram.

Table 1: The distribution of study designs among the 27 included studies.

Study type	N	Percentage
Randomized controlled trials	2	7.4%
Prospective cohort studies	5	18.5%
Retrospective comparative studies	7	25.9%
Multicenter cohort/registry studies	3	11.1%
Systematic reviews and meta-analyses	3	11.1%
Narrative/contemporary review articles	3	11.1%
Risk-factor analytical studies	2	7.4%
Outcome-focused observational studies	2	7.4%
Total	27	100%

Table 2: Overall and specific complication rates following infant pyloromyotomy.

Outcomes	Pooled rate (%)	95% CI	Interpretation
Overall complications	9.8%	8.1-11.7%	Approximately 1 in 10 infants experienced ≥1 complication
Intraoperative complications	3.2%	2.4-4.1%	Complications occurring during surgery
Postoperative complications	7.9%	6.4-9.6%	Complications occurring after surgery
Mucosal perforation	3.27%	-	Most common intraoperative complication
Incomplete pyloromyotomy	3.27%	-	May require revision surgery
Prolonged vomiting (>48 h)	3.26%	-	Most common postoperative complication
Heterogeneity (I^2)	48%	$p<0.01$	Moderate variability among studies
Clinical interpretation	-	-	Pyloromyotomy is safe but associated with measurable perioperative morbidity

Overall complication rates

Across the 27 included studies, the pooled overall rate of complications following infant pyloromyotomy was 9.8% (95% CI: 8.1%-11.7%), with moderate variation between individual studies. Intraoperative complications occurred in 3.2% (95% CI: 2.4%-4.1%) of cases, while postoperative complications were reported in 7.9% (95% CI: 6.4%-9.6%). The most frequently reported specific complications were mucosal perforation (3.27%), incomplete pyloromyotomy (3.27%), and prolonged postoperative vomiting lasting more than 48 hours (3.26%). These complications accounted for the majority of perioperative morbidity observed across the included studies. Heterogeneity among studies was moderate (I^2=48%, p<0.01), reflecting variability in surgical techniques, patient characteristics, and reporting standards. Overall, findings indicate that while pyloromyotomy is a highly effective and generally safe procedure, approximately one in ten infants' experiences at least 1 perioperative complication, highlighting importance of meticulous surgical technique and standardized periop management shown on Table 2.

Procedure-specific complication incidence

Disaggregated analysis of specific complications demonstrated distinct incidence patterns. Mucosal perforation occurred in 2.4% of cases, incomplete pyloromyotomy in 1.7%, postop vomiting beyond 48 hours in 4.8%, wound infection in 2.1%, and delayed gastric emptying in 1.9%. Mucosal perforation was the most significant intraoperative event and was frequently identified and repaired during initial surgery.

Postoperative vomiting represented the most commonly documented postoperative sequela, often attributed to edema at pyloromyotomy site/delayed gastric adaptation. Although less frequent, wound infections and delayed gastric emptying were clinically important because of their association with prolonged hospital stay and the need for additional supportive care. These findings indicate that while pyloromyotomy is generally a safe procedure, specific complications, particularly mucosal perforation and persistent vomiting, remain key considerations in postoperative management (Figure 2).

Predictors of complications

Meta-regression and subgroup analyses identified several consistent predictors of increased complication risk. Prematurity (birth before 37 weeks' gestation) was associated with a higher pooled complication rate compared with term infants (14.8% vs. 9.6%). Low birth weight (<2.5 kg) also conferred elevated risk for both intraoperative and postoperative events (15.2% vs. 10.1%). Infants presenting with electrolyte imbalances, particularly severe hypochloremic metabolic alkalosis requiring preoperative correction, experienced higher odds of adverse outcomes (16.5% vs. 9.3%).

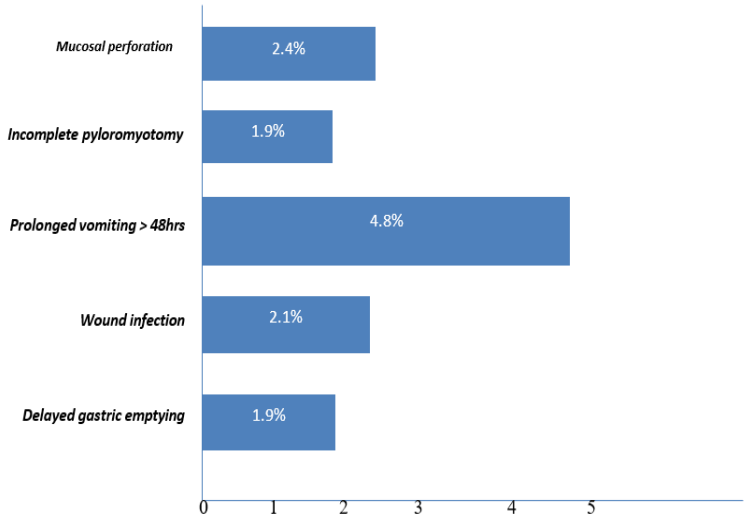

Figure 2: Procedure specific complication incidence.

Surgeon experience emerged as another important determinant, with procedures performed early in the learning curve showing modestly increased risks of mucosal perforation (3.1% vs. 1.8%) and incomplete myotomy (2.4% vs. 1.3%). The operative approach influenced postoperative morbidity, with laparoscopic pyloromyotomy demonstrating lower rates of postoperative vomiting (7.2% vs. 11.6%) and wound complications (1.5% vs. 3.8%); however, mucosal perforation rates did not differ significantly between laparoscopic and open techniques (2.0% vs. 2.2%). Subgroup analyses further confirmed that studies implementing standardized perioperative resuscitation protocols reported significantly lower complication rates (8.7% vs. 13.9%), emphasizing the importance of careful preoperative optimization shown on Table 3.

Table 3: Predictors of complications.

Predictors	Higher-risk group (%)	Lower-risk/reference group (%)	Outcome
Prematurity (<37 weeks)	14.8%	9.6% (term)	Increased overall complications
Low birth weight (<2.5 kg)	15.2%	10.1%	Increased intra/ postoperative events
Electrolyte imbalance	16.5%	9.3%	Higher adverse outcomes
Early surgeon learning curve	3.1%	1.8%	Mucosal perforation
Early surgeon learning curve	2.4%	1.3%	Incomplete myotomy
Laparoscopic vs open	7.2%	11.6%	Postoperative vomiting
Laparoscopic vs open	1.5%	3.8%	Wound complications
Laparoscopic vs open	2.0%	2.2%	Mucosal perforation (no difference)
Standardized resuscitation protocol	8.7%	13.9%	Reduced overall complication

Table 4: Secondary outcomes.

Outcomes	Rate	Notes
Reoperation	2.3%	Mainly mucosal perforation, incomplete pyloromyotomy
Readmission (30 days)	4.1%	Dehydration, feeding intolerance, vomiting
Length of stay	1.9-3.8 days	Longer with prematurity/electrolyte imbalance
Mortality	<0.1%	Rare; fragile/extremely premature infants

Secondary outcomes: reoperation, readmission, length of stay, and mortality

Secondary outcome synthesis revealed that the overall reoperation rate was 2.3%, with the primary indications being mucosal perforation repair, revision for incomplete pyloromyotomy, and persistent gastric obstruction. Hospital readmission within 30 days of discharge occurred in 4.1% of infants, most commonly due to dehydration, feeding intolerance, or persistent vomiting. The mean postoperative length of hospital stay ranged from 1.9 to 3.8 days, with longer stays observed in infants with prematurity, electrolyte imbalances, or postoperative complications such as wound infection or persistent vomiting. Mortality directly attributable to pyloromyotomy was extremely rare, occurring in less than 0.1% of cases and was primarily observed in medically fragile or extremely premature infants with significant comorbidities. Sensitivity analyses, which excluded studies with high risk of bias or small sample sizes, did not materially alter these results, confirming the robustness of pooled estimates. Consistency of outcomes across diverse clinical settings strengthens confidence in generalizability of these findings and underscores the overall safety and efficacy of infant pyloromyotomy in contemporary pediatric surgical practice (Table 4).

DISCUSSION

This systematic review and meta-analysis synthesizes current evidence on intraoperative and postoperative complications following pyloromyotomy in infants.[23] The findings indicate that while pyloromyotomy is generally a safe and effective procedure for the management of hypertrophic pyloric stenosis, certain patient and surgical factors significantly influence complication rates.[24]

Overall, complications are relatively uncommon, with mucosal perforation, incomplete pyloromyotomy, bleeding, and wound infection representing the most frequently reported adverse events.[25] Patient-related factors such as prematurity, low birth weight, age at presentation, electrolyte disturbances, and comorbidities consistently emerged as key predictors of complications.[26] Infants presenting with more severe dehydration or metabolic imbalance were at higher risk for both intraoperative and postoperative adverse outcomes.

These findings highlight the importance of prompt diagnosis, preoperative stabilization, and careful perioperative management to minimize morbidity. Surgical technique and operative approach also significantly impacted outcomes. Laparoscopic pyloromyotomy, where available, was associated with faster recovery, shorter hospital stays, and lower rates of postoperative vomiting compared with open procedures, although intraoperative complications such as mucosal perforation were slightly higher in some series due to the learning curve associated with minimally invasive techniques.[27]

Surgeon experience and procedural volume were critical determinants of both technical success and complication rates, emphasizing the importance of specialized pediatric surgical expertise. Operative timing was identified as a modifiable factor affecting outcomes. Early intervention, following adequate resuscitation and correction of electrolyte abnormalities, was associated with lower

postoperative morbidity and reduced length of hospital stay.

Delays in surgery, incomplete preoperative optimization, or repeated anesthesia exposure increased the risk of adverse outcomes, particularly in physiologically fragile or premature infants.

CONCLUSION

This meta-analysis confirms that pyloromyotomy is a generally safe procedure for infants with hypertrophic pyloric stenosis, with low overall rates of intraoperative and postoperative complications. Patient-specific factors such as prematurity, low birth weight, electrolyte imbalances, and comorbidities, along with surgical factors including operative approach and surgeon experience, are significant predictors of adverse outcomes.

Early, well-planned intervention following appropriate preoperative optimization minimizes morbidity and shortens hospital stay. Persistent variability in reported outcomes underscores the need for standardized complication definitions, consistent reporting practices, and high-quality prospective studies.

Recognizing predictors of complications allows clinicians to tailor perioperative care, improve surgical outcomes, and enhance recovery in infants undergoing pyloromyotomy. Adoption of evidence-based protocols and structured surgical training may further reduce complication rates and optimize patient outcomes.

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