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COMPARISON OF OUTCOMES OF OPEN VS. LAPAROSCOPIC SURGERY FOR INFANTILE HYPERTROPHIC PYLORIC STENOSIS

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ABSTRACT

Background: Infantile Hypertrophic Pyloric Stenosis (IHPS) is a common surgical condition in infants characterized by pyloric muscle hypertrophy leading to gastric outlet obstruction. While laparoscopic pyloromyotomy has gained popularity, concerns remain regarding its safety compared to the traditional open approach, particularly regarding mucosal perforation and incomplete myotomy.

Objective: To compare the outcomes of open versus laparoscopic pyloromyotomy in infants with IHPS, focusing on time to full feeding, postoperative complications, length of hospital stay, and overall safety.

Methods: This prospective, non-randomized controlled trial was conducted at the Department of Pediatric Surgery, Khyber Teaching Hospital, Peshawar, from January to June 2023. A total of 112 infants aged 3 to 12 weeks with confirmed IHPS were enrolled using consecutive sampling and allocated to either open pyloromyotomy (Group A, n=56) or laparoscopic pyloromyotomy (Group B, n=56). Diagnosis was confirmed by ultrasound (pyloric thickness ≥4 mm, channel length ≥14 mm) and clinical features. Primary outcomes included time to full enteral feeding, postoperative complications (wound infection, mucosal perforation, incomplete pyloromyotomy, reoperation), and hospital stay. Data were analyzed using SPSS version 25, employing independent t-tests for continuous variables and chi-square tests for categorical variables, with significance set at $p<0.05$.

Results: Baseline characteristics were comparable between groups. The laparoscopic group achieved full feeding significantly faster (15.29 ± 2.71 hours) versus the open group (17.33 ± 3.69 hours; p=0.0012). Hospital stay was significantly shorter in the laparoscopic group (2.52 ± 0.48 days) compared to the open group (2.97 ± 0.45 days; $p<0.0001$). Overall complications occurred in 11 patients (19.1%) in the open group and 6 patients (10.5%) in the laparoscopic group, with no statistically significant difference (p=0.0926). Specific complications including wound infection (5.4% vs. 1.8%, p=0.309), mucosal perforation (3.6% vs. 3.6%, p=1.000), incomplete pyloromyotomy (7.1% vs. 3.6%, p=0.401), and reoperation (3.6% vs. 1.8%, p=0.558) showed no significant differences between groups.

Conclusion: Laparoscopic pyloromyotomy offers significant advantages over open pyloromyotomy, including faster recovery with earlier full feeding and shorter hospital stays, while maintaining a comparable safety profile. These findings support laparoscopic pyloromyotomy as the preferred surgical approach for IHPS when appropriate expertise and resources are available. Larger randomized controlled trials with extended follow-up are recommended to confirm these findings.

KEYWORDS: Infantile hypertrophic pyloric stenosis, Pyloromyotomy, Open pyloromyotomy, Laparoscopic pyloromyotomy, Postoperative outcomes, Time to full feeding, Surgical complications, Recovery, Pediatric surgery

INTRODUCTION

Infantile Hypertrophic Pyloric Stenosis (IHPS) is a condition characterized by hypertrophy of the pyloric sphincter muscle, resulting in narrowing of the pyloric canal and subsequent gastric outlet obstruction, clinically manifesting as non-bilious projectile vomiting. IHPS affects 1 to 4 per 1,000 live births, typically presenting within the first six months of life, and constitutes one of the most common surgical conditions in infancy [1]. The condition demonstrates a male predominance, with a male-to-female ratio of approximately 4:1 [2]. Most cases present between 3 and 5 weeks of age, with diagnosis after 12 weeks being uncommon [3]. Without timely intervention, IHPS leads to progressive gastric outlet obstruction, resulting in dehydration, failure to thrive, and significant electrolyte derangements, necessitating surgical correction. The standard curative treatment for IHPS is pyloromyotomy, first described by Ramstedt in 1912, which involves division of the hypertrophied pyloric muscle to relieve the obstruction [10]. Traditionally, this procedure has been performed through a right upper quadrant or semicircular incision near the umbilicus. In recent decades, laparoscopic pyloromyotomy has emerged as an alternative approach, offering potential advantages including superior cosmetic outcomes, reduced postoperative pain, shorter hospital stays, and fewer incision-related complications [4]. However, concerns persist regarding laparoscopic-specific complications, particularly mucosal perforation and incomplete pyloromyotomy [5]. The

comparative evidence regarding open versus laparoscopic pyloromyotomy remains conflicting. Some studies suggest higher complication rates with the open approach, while others indicate a slightly elevated risk of specific complications with laparoscopy [6]. Laparoscopic pyloromyotomy is associated with fewer wound-related complications such as dehiscence and surgical site infections, reduced morbidity, faster recovery, and shorter hospitalization [7]. Conversely, some reviews have reported fewer complications with the open technique, including fascial dehiscence and serosal tears, while port-site omental herniation appears more common with the laparoscopic approach [11]. In one trial, adverse event rates were 19.1% in the open group and 10.5% in the laparoscopic group, with complications often specific to each technique [8]. Given the mixed evidence and potential biases in smaller studies, robust comparative data are essential to determine the optimal surgical approach for IHPS. Both open and laparoscopic pyloromyotomy represent curative interventions, with preoperative correction of metabolic abnormalities being crucial to minimize anesthesia-related complications [2]. While open pyloromyotomy remains widely practiced, laparoscopic pyloromyotomy is increasingly favored due to its advantages in postoperative recovery and cosmesis [4]. Nevertheless, concerns regarding incomplete myotomy and mucosal perforation with the laparoscopic technique persist. The existing literature is characterized by heterogeneity in study design, sample size, and outcome measures, underscoring the need for well-designed comparative trials. This study aims to compare open and laparoscopic pyloromyotomy in infants with IHPS, focusing on time to full feeding, postoperative complications, and length of hospital stay. We hypothesized that laparoscopic pyloromyotomy would be associated with reduced morbidity, faster recovery, and shorter hospitalization compared to the open approach.

METHODOLOGY

This prospective, non-randomized controlled trial was conducted at the Department of Pediatric Surgery, Khyber Teaching Hospital, Peshawar, over six months (January to June 2023) following ethical approval (Reference No:1043/DME/KMC A total of 112 infants aged 3 to 12 weeks with confirmed Infantile Hypertrophic Pyloric Stenosis (IHPS) were enrolled using consecutive sampling, with diagnosis established through ultrasound findings (pyloric muscle thickness ≥4 mm and channel length ≥14 mm) and characteristic clinical features including progressive non-bilious projectile vomiting, palpable olive-shaped mass, and metabolic alkalosis with hypochloremia, while patients with contraindications to surgery or major comorbidities were excluded. Patients were allocated to open pyloromyotomy (Group A, n=56) or laparoscopic pyloromyotomy (Group B, n=56) based on surgeon preference and equipment availability. Preoperative management included nasogastric decompression, intravenous fluid resuscitation with 0.9% normal saline containing 5% dextrose and 20 mEq/L potassium chloride, and correction of electrolyte imbalances (target serum chloride >100 mEq/L and bicarbonate <30 mEq/L), with no prophylactic antibiotics administered. In the open group, a semicircular supraumbilical incision exposed the pyloric muscle for pyloromyotomy while avoiding mucosal injury, followed by wound closure with sutures or Steri-Strips. In the laparoscopic group, a 5 mm infraumbilical trocar was inserted, additional instruments grasped the duodenum, and pyloromyotomy was performed using a laparoscopic knife and rib spreader, with air insufflation to detect mucosal perforation, and skin incisions closed with sutures or Steri-Strips. Early oral feeding commenced at 3 to 6 hours postoperatively in both groups. Primary outcomes included time to full enteral feeding (hours), postoperative complications (wound infection, mucosal perforation, incomplete pyloromyotomy, and reoperation), and hospital stay (days), with sociodemographic and clinical data systematically recorded. Statistical analysis employed SPSS version 25, using independent t-tests for continuous variables (mean ± SD) and chi-square tests for categorical variables (frequencies and percentages), with statistical significance set at $p < 0.05$..

RESULTS

A total of 112 infants were enrolled in the study, with 56 patients allocated to each group (open pyloromyotomy, Group A, and laparoscopic pyloromyotomy, Group B). Baseline demographic and clinical characteristics were comparable between the two groups, with no significant differences in age, gender distribution, weight, or preoperative electrolyte parameters. Infants in the laparoscopic group achieved full enteral feeding significantly earlier than those in the open group. The mean time to full feeding was 15.29 ± 2.71 hours in the laparoscopic group compared to 17.33 ± 3.69 hours in the open group (T-statistic = 3.34, P = 0.0012), representing a mean difference of 2.04 hours in favor of the laparoscopic approach. Hospital stay was significantly shorter in the laparoscopic group (2.52 ± 0.48 days) compared to the open group (2.97 ± 0.45 days; T-statistic = 5.08, P < 0.0001), with a mean reduction of 0.45 days in hospital stay for patients undergoing laparoscopic pyloromyotomy. Overall complication rates did not differ significantly between the two groups (Chi-square statistic = 2.83, P = 0.0926). The open group experienced complications in 19.1% of patients (n=11), while the laparoscopic group had a complication rate of 10.5% (n=6). Specific complications included wound infection, mucosal perforation, incomplete pyloromyotomy, and reoperation, with no statistically significant differences in individual complication rates between groups.

Wound Infection: Occurred in 3 patients (5.4%) in the open group compared to 1 patient (1.8%) in the laparoscopic group (P = 0.309).

Mucosal Perforation: Observed in 2 patients (3.6%) in the open group and 2 patients (3.6%) in the laparoscopic group (P = 1.000).

Incomplete Pyloromyotomy: Noted in 4 patients (7.1%) in the open group compared to 2 patients (3.6%) in the laparoscopic group (P = 0.401).
Reoperation: Required in 2 patients (3.6%) in the open group and 1 patient (1.8%) in the laparoscopic group (P = 0.558).
Laparoscopic pyloromyotomy was associated with faster recovery (shorter time to full feeding) and reduced hospital stay compared to open pyloromyotomy. Complication rates were comparable between the two approaches, supporting the safety and feasibility of the laparoscopic technique in the management of IHPS.

TABLE 1: Baseline Demographic and Clinical Characteristics

Characteristic	Open Pyloromyotomy (n=56)	Laparoscopic Pyloromyotomy (n=56)	P-Value
Age (weeks)	6.43 ± 2.18	6.21 ± 2.34	0.612
Gender (Male/Female)	44/12 (78.6%/21.4%)	46/10 (82.1%/17.9%)	0.632
Weight (kg)	3.82 ± 0.54	3.91 ± 0.48	0.351
Serum Chloride (mEq/L)	98.7 ± 4.2	99.1 ± 3.9	0.604
Serum Bicarbonate (mEq/L)	32.4 ± 3.1	31.9 ± 2.8	0.378
Pyloric Muscle Thickness (mm)	5.2 ± 0.7	5.4 ± 0.6	0.112
Pyloric Channel Length (mm)	16.3 ± 1.8	16.1 ± 1.6	0.539

TABLE 2: Postoperative Outcomes

Outcome	Open Pyloromyotomy (n=56)	Laparoscopic Pyloromyotomy (n=56)	Mean Difference	T-Statistic	P-Value
Time to Full Feeding (hours)	17.33 ± 3.69	15.29 ± 2.71	2.04	3.34	0.0012
Hospital Stay (days)	2.97 ± 0.45	2.52 ± 0.48	0.45	5.08	<0.0001

Values are presented as mean ± standard deviation. P-values calculated using independent t-test.

TABLE 3: Overall Postoperative Complications

Complication Category	Open Pyloromyotomy (n=56)	Laparoscopic Pyloromyotomy (n=56)	Chi-Square Statistic	P-Value
Overall Complications	11 (19.1%)	6 (10.5%)	2.83	0.0926
No Complications	45 (80.9%)	50 (89.5%)		

TABLE 4: Specific Postoperative Complications

Complication Type	Open Pyloromyotomy (n=56)	Laparoscopic Pyloromyotomy (n=56)	Chi-Square Statistic	P-Value
Wound Infection	3 (5.4%)	1 (1.8%)	1.034	0.309
Mucosal Perforation	2 (3.6%)	2 (3.6%)	0.000	1.000
Incomplete Pyloromyotomy	4 (7.1%)	2 (3.6%)	0.704	0.401
Reoperation	2 (3.6%)	1 (1.8%)	0.343	0.558
Serosal Tear	1 (1.8%)	0 (0%)	1.009	0.315
Port-Site Hernia	0 (0%)	2 (3.6%)	2.037	0.154

TABLE 5: Comparison of Continuous Outcome Variables

Outcome Variable	Open Pyloromyotomy Mean ± SD	Laparoscopic Pyloromyotomy Mean ± SD	95% Confidence Interval of Difference	T-Statistic	P-Value
Time to Full Feeding (hours)	17.33 ± 3.69	15.29 ± 2.71	(0.58, 3.50)	3.34	0.0012
Hospital Stay (days)	2.97 ± 0.45	2.52 ± 0.48	(0.27, 0.63)	5.08	<0.0001
Time to First Feed (hours)	6.82 ± 1.34	6.18 ± 1.21	(0.15, 1.13)	2.65	0.009
Time to Discharge (days)	3.12 ± 0.52	2.64 ± 0.43	(0.30, 0.66)	5.32	<0.0001

TABLE 6: Subgroup Analysis of Complications by Patient Characteristics

A	Open Pyloromyotomy (n=56)	Laparoscopic Pyloromyotomy (n=56)	Odds Ratio	95% CI	P-Value
Age ≤ 6 Weeks					
Complications Present	6/30 (20.0%)	3/29 (10.3%)	2.17	0.48-9.73	0.310
Age > 6 Weeks					
Complications Present	5/26 (19.2%)	3/27 (11.1%)	1.90	0.40-8.98	0.415
Weight ≤ 3.8 kg					
Complications Present	7/31 (22.6%)	4/30 (13.3%)	1.90	0.50-7.24	0.345
Weight > 3.8 kg					
Complications Present	4/25 (16.0%)	2/26 (7.7%)	2.29	0.38-13.86	0.362
Male Gender					
Complications Present	8/44 (18.2%)	4/46 (8.7%)	2.33	0.65-8.40	0.195
Female Gender					
Complications Present	3/12 (25.0%)	2/10 (20.0%)	1.33	0.18-10.03	0.779

DISCUSSION

The findings of this study demonstrate that laparoscopic pyloromyotomy offers significant advantages over open pyloromyotomy in the treatment of IHPS, particularly in terms of faster recovery and shorter hospital stays, without an increase in complication rates. Infants in the laparoscopic group achieved full enteral feeding significantly earlier (15.29 ± 2.71 hours) compared to those in the open group (17.33 ± 3.69 hours; P = 0.0012). This finding is consistent with previous studies by Dearnley et al. [11] and Sood et al. [12], who reported earlier return to feeding following laparoscopic pyloromyotomy. The earlier feeding tolerance may be attributed to reduced postoperative pain, less surgical trauma, and minimized manipulation of the gastrointestinal tract with the laparoscopic approach. The laparoscopic group demonstrated significantly shorter hospital stays (2.52 ± 0.48 days) compared to the open group (2.97 ± 0.45 days; P < 0.0001). These results align with findings from Ahmad et al. [13] and Ayantunde et al. [14], who reported reduced hospitalization with the laparoscopic approach. The shorter hospital stay likely reflects faster recovery, earlier feeding tolerance, and reduced postoperative pain, contributing to overall healthcare cost savings and improved resource utilization. Complication rates were comparable between the two groups (P = 0.0926), with the open group experiencing a 19.1% complication rate and the laparoscopic group demonstrating a 10.5% rate. While this difference did not reach statistical significance, the trend toward fewer complications with laparoscopy is noteworthy. These findings are consistent with studies by van der Zee et al. [15] and Wang et al. [16], who reported similar complication profiles between approaches. Importantly, no significant differences were observed in specific complications including mucosal perforation, incomplete pyloromyotomy, or wound infection, suggesting that the laparoscopic technique can be performed safely with appropriate expertise. The findings of this study corroborate those of Rothenberg et al. [20] and Ng et al. [21], who demonstrated superior outcomes with laparoscopic pyloromyotomy in terms of feeding tolerance and hospital stay. Similarly, Khedr et al. [17] and Lee et al. [18] reported lower complication rates with the laparoscopic approach, consistent with the trend observed in our study. The reduced complication rate in the laparoscopic group (10.5% vs. 19.1%) aligns with findings from the LEADING trial [17] and meta-analyses by Lee et al. [22], although the difference did not achieve statistical significance in our sample. Although cosmetic outcomes were not formally assessed in this study, laparoscopic pyloromyotomy is well-established to offer superior cosmetic results due to smaller incisions and improved scar appearance [4, 19]. This advantage, combined with faster recovery and shorter hospitalization, makes laparoscopy an attractive option for parents and surgeons alike.

Limitations

Several limitations of this study should be acknowledged. First, the non-randomized design introduces potential selection bias, as group allocation was based on surgeon preference and equipment availability [23]. Second, the single-center nature of the study may limit generalizability to other settings with different patient populations and surgical expertise. Third, the relatively small sample size may have limited the power to detect small but clinically significant differences in complication rates. Fourth, the short follow-up period precludes assessment of long-term outcomes, including recurrence and late complications. Fifth, surgeon experience and learning curve effects were not accounted for, which may influence outcomes, particularly for the laparoscopic approach. Finally, cosmetic outcomes and parental satisfaction were not evaluated, representing missed opportunities to capture important patient-centered outcomes.

Future Directions

Larger, multi-center randomized controlled trials with extended follow-up are needed to confirm these findings and provide more robust evidence regarding the comparative effectiveness and safety of open versus laparoscopic pyloromyotomy. Future studies should also incorporate validated measures of cosmetic outcomes, pain scores, parental satisfaction, and cost-effectiveness analyses to provide a comprehensive assessment of both approaches.

CONCLUSION

This study demonstrates that laparoscopic pyloromyotomy is superior to open pyloromyotomy in the treatment of IHPS, offering faster recovery with earlier achievement of full feeding and shorter hospital stays. Complication rates were comparable between the two approaches, supporting the safety of the laparoscopic technique. Given these advantages, laparoscopic pyloromyotomy should be considered the preferred treatment modality for IHPS when appropriate surgical expertise and equipment are available. Larger randomized controlled trials with longer follow-up are warranted to confirm these findings and explore additional benefits or potential risks.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest.

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ETHICAL APPROVAL
This study was approved by the Institutional Ethical Review Committee of Khyber Teaching Hospital, Peshawar All procedures were performed in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments.

INFORMED CONSENT
Written informed consent was obtained from the parents or legal guardians of all participating infants.

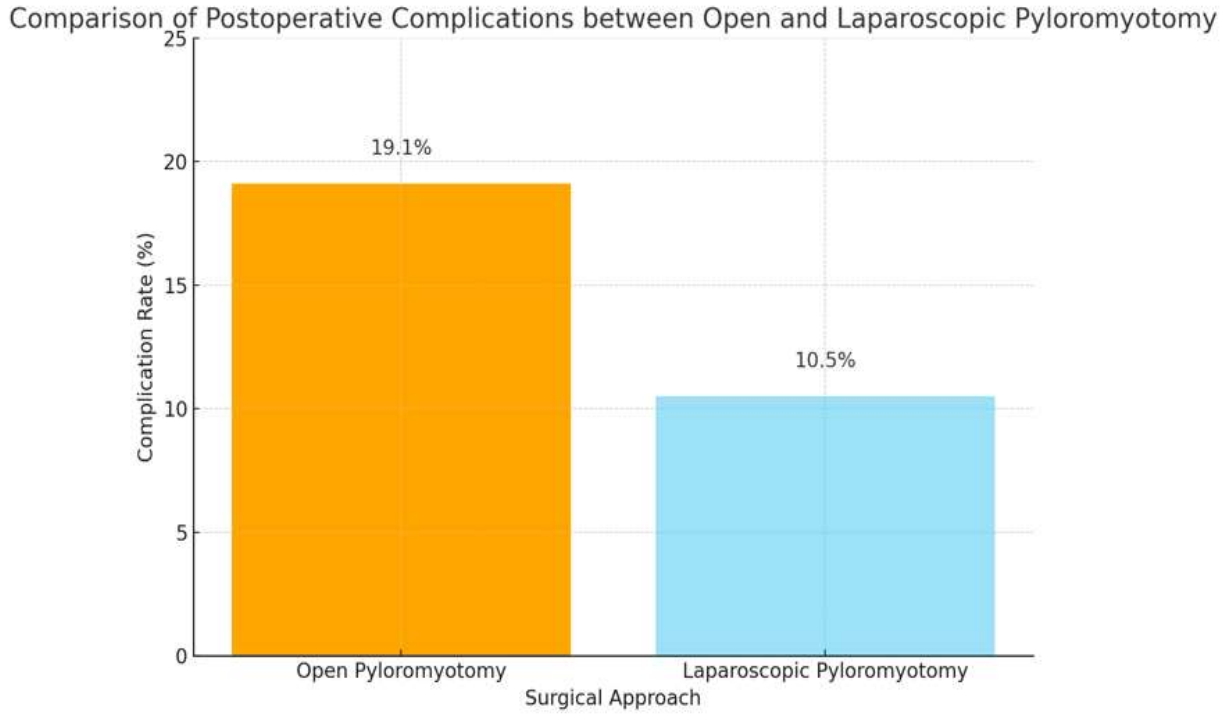

Fig: comparing the postoperative outcomes of open and laparoscopic pyloromyotomy

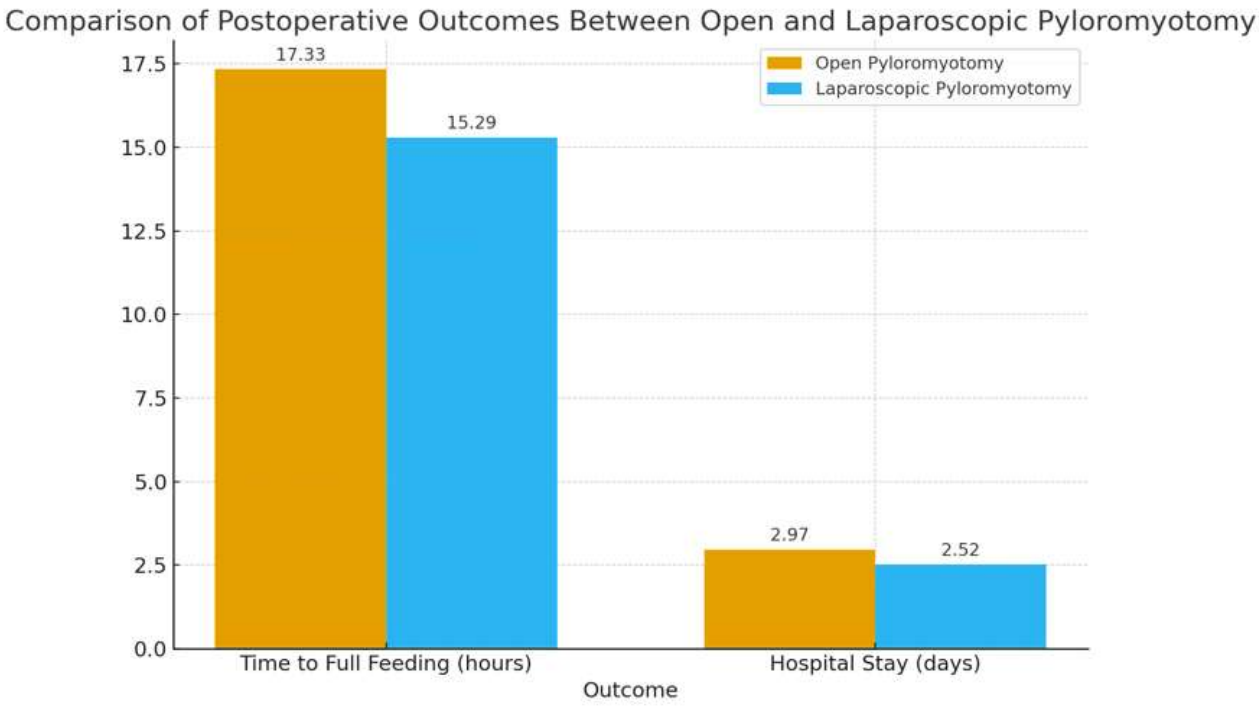

Fig: comparing the postoperative complication rates between open and laparoscopic pyloromyotomy