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Original Research Article

Treatment Outcomes and Risk Factors in Infantile Hypertrophic Pyloric Stenosis: A Prospective Study at Mardan Medical Complex

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Abstract: ***Background:*** Infantile Hypertrophic Pyloric Stenosis (IHPS) is a common cause of gastric outlet obstruction in early infancy requiring timely surgical intervention to prevent morbidity and mortality. ***Objective:*** To evaluate treatment outcomes and associated factors of IHPS in infants managed at Mardan Medical Complex (MMC), Mardan. ***Methodology***: This prospective, hospital-based observational study included 80 infants diagnosed with IHPS and surgically managed at MMC from January 2022 to December 2023. Data on demographics, clinical presentation, preoperative hydration and electrolyte status, surgical approach, intraoperative findings, postoperative complications, and length of hospital stay were collected using a structured proforma. Open and laparoscopic pyloromyotomy were performed, and patients were followed for 30 days postoperatively. Descriptive statistics summarized patient characteristics and outcomes, while chi-square and independent t-tests assessed associations between preoperative factors and poor outcomes. A p-value <0.05 was considered statistically significant. ***Results:*** Among 80 infants, 62 (77.5%) were male and 18 (22.5%) female; 50% presented at 5–8 weeks of age. Preoperatively, 25 (31.3%) had severe dehydration and 53 (66.3%) had electrolyte imbalance. Open pyloromyotomy was performed in 66 infants (82.5%), and laparoscopic surgery in 14 (17.5%). Intraoperative complications occurred in 7 infants (8.8%). Postoperatively, vomiting within 24 hours occurred in 22 infants (27.5%), wound infection in 6 (7.5%), mucosal perforation in 2 (2.5%), reoperation in 1 (1.3%), and mortality in 2 (2.5%), resulting in 9 infants (11.3%) with poor outcomes. Severe dehydration, electrolyte imbalance, and age >8 weeks were significantly associated with poor outcomes ($p<0.01$). Mean hospital stay was 4.2 ± 1.6 days, prolonged in those with poor outcomes. ***Conclusion***: IHPS can be effectively managed surgically, with early diagnosis and preoperative stabilization critical in improving outcomes.

Keywords: Infantile hypertrophic pyloric stenosis, pyloromyotomy, dehydration, electrolyte imbalance, surgical outcomes, pediatric surgery

INTRODUCTION

Infantile Hypertrophic Pyloric Stenosis (IHPS) is a common surgical condition of early infancy, characterized by hypertrophy and hyperplasia of the pyloric muscle leading to progressive gastric outlet obstruction [1]. It typically presents between the second and eighth week of life with non-bilious projectile vomiting, visible gastric peristalsis, and a palpable pyloric olive [2]. If left untreated, IHPS may result in severe dehydration, hypochloremic metabolic alkalosis, electrolyte imbalance, and failure to thrive, which can rapidly compromise infant health

[3]. The condition carries significant clinical importance due to its potential for morbidity, despite being curable with timely diagnosis and surgical intervention [4].

The etiology of IHPS remains multifactorial, involving genetic predisposition, environmental influences, and possible neurohormonal factors [5]. Epidemiological studies indicate a higher prevalence in males compared to females, with a reported male-to-female ratio of approximately 4:1 [6]. Family history, feeding patterns, maternal smoking, and certain perinatal factors have also been implicated in its development [7]. Global incidence varies widely, with rates ranging from 1 to 4 per 1,000 live births, influenced by geographic and demographic factors [8].

Management of IHPS has evolved over time, with Ramstedt's pyloromyotomy remaining the gold standard surgical procedure, demonstrating excellent long-term outcomes [9]. Laparoscopic approaches have also been increasingly adopted worldwide, though open pyloromyotomy remains the predominant technique in resource-limited healthcare systems [10]. Treatment success, however, is not solely determined by the surgical method. Preoperative status, including the degree of dehydration, electrolyte imbalance, and nutritional condition, as well as postoperative complications such as vomiting, infection, or mucosal perforation, all influence recovery and hospital stay. Identifying factors associated with favorable or adverse outcomes is critical for optimizing perioperative care and improving overall prognosis [11, 12].

Despite advancements in pediatric surgery, there remains a lack of region-specific evidence on how treatment outcomes are shaped by clinical and perioperative factors in developing healthcare systems. Late presentation, limited diagnostic resources, and variability in perioperative care may further complicate recovery. Given this context, it is essential to evaluate treatment outcomes and identify associated factors within local healthcare setups. This pediatric surgery study therefore focuses on infants with IHPS managed at Mardan Medical Complex (MMC), Mardan.

Research Objective

To evaluate the treatment outcomes and associated factors of IHPS at Mardan Medical Complex (MMC), Mardan

Methodology

Study Design and Setting

This was a prospective, hospital-based observational study conducted in the Department of Pediatric Surgery, Mardan Medical Complex (MMC), Mardan, over a period of two years from January 2022 to December 2023. The study focused on infants diagnosed with IHPS who underwent surgical management at MMC.

Inclusion and Exclusion Criteria

All infants diagnosed with IHPS and managed surgically at MMC during the study period were included. Patients with incomplete medical records, those managed conservatively without surgery, and infants with associated major congenital anomalies were excluded.

Sample Size

The sample size was determined using the single population proportion formula, assuming a 95% confidence level ($\alpha = 0.05$), $Z = 1.96$, a margin of error (d) of 5%, and a treatment outcome proportion (p) of 4.9%, which was reported in a previous study on IHPS [13]. The calculated sample size was 71, and after adjusting for a 10% non-response rate, the final required sample size was 80 participants. Given the average annual case load of IHPS at MMC, which ranges between 35–45 cases per year, the two-year study duration was expected to provide a sufficient pool of patients to feasibly achieve this sample size.

Data Collection

Data were collected prospectively using a structured proforma developed for this study. Information included demographic characteristics (age, sex, weight), clinical presentation, preoperative laboratory findings, perioperative management, surgical approach, postoperative complications, and length of hospital stay. Follow-up was conducted in-hospital and up to 30 days postoperatively, with additional outpatient review when feasible. As the primary focus was on early postoperative outcomes, longer-term complications beyond this period were not included within the study scope.

Statistical Analysis

Data were entered and analyzed using SPSS version 25. Descriptive statistics were used to summarize patient demographics, clinical features, and treatment outcomes. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution. Chi-square test was applied to assess associations between categorical variables. Independent t-test was used for continuous variables. A p-value of <0.05 was considered statistically significant.

Ethical Approval

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Mardan Medical

Complex (MMC), Mardan. Patient confidentiality was strictly maintained by anonymizing data, and all collected information was used solely for research purposes.

RESULTS

Among the 80 infants with IHPS, 62 (77.5%) were male and 18 (22.5%) were female (Table 1). The majority presented between 5–8 weeks of age (n = 40, 50.0%), followed by 2–4 weeks (n = 28, 35.0%) and >8 weeks (n = 12, 15.0%). The mean weight at presentation was 3.25 ± 0.65 kg. Clinically, all infants (100%) had projectile vomiting, 55 (68.8%) exhibited visible gastric peristalsis, and 61 (76.3%) had a palpable pyloric "olive".

Table 1. Demographic and Clinical Characteristics of Infants with IHPS (n = 80)

Category	Variable	Frequency (n)	Percentage (%)
Sex	Male	62	77.50
	Female	18	22.50
Age at Presentation (weeks)	2–4 weeks	28	35.00
	5–8 weeks	40	50.00
	>8 weeks	12	15.00
Weight at Presentation	Mean ± SD (kg)	3.25 ± 0.65	
Clinical Presentation	Projectile vomiting	80	100.00
	Visible peristalsis	55	68.75
	Palpable "olive"	61	76.25

Preoperatively, 21 infants (26.25%) were well hydrated, 34 (42.50%) had mild dehydration, and 25 (31.25%) presented with severe dehydration (table 2). Electrolyte assessment showed 27 (33.75%) had normal values, 38 (47.50%) had hypochloremic metabolic alkalosis, and 15 (18.75%) had other imbalances, indicating that most infants had some degree of metabolic disturbance prior to surgery.

Table 2. Preoperative Clinical and Laboratory Findings of Infants with IHPS

Category	Variable	Frequency (n)	Percentage (%)
Hydration Status	Normal	21	26.25
	Mild dehydration	34	42.50
	Severe dehydration	25	31.25
Electrolyte Imbalance	Normal	27	33.75
	Hypochloremic metabolic alkalosis	38	47.50
	Other imbalances	15	18.75

The majority of infants underwent open pyloromyotomy (n = 66, 82.50%), while 14 (17.50%) had laparoscopic procedures (table 3). The mean duration of surgery was 42.3 ± 8.7 minutes. Intraoperatively, 73 patients (91.25%) experienced no complications, while 4 (5.00%) had mucosal perforation and 3 (3.75%) experienced bleeding, reflecting a generally safe surgical course.

Table 3. Perioperative and Surgical Management of Infants with IHPS

Category	Variable	Frequency (n)	Percentage (%)
Surgical Approach	Open pyloromyotomy	66	82.50
	Laparoscopic pyloromyotomy	14	17.50
Duration of Surgery	Mean ± SD (minutes)	42.3 ± 8.7	
Intraoperative Complications	None	73	91.25
	Mucosal perforation	4	5.00
	Bleeding	3	3.75

Postoperatively, 22 infants (27.50%) had vomiting within 24 hours, 6 (7.50%) developed wound infection, 2 (2.50%) had mucosal perforation, 1 (1.25%) required reoperation, and 2 (2.50%) died within 30 days (table 4). Overall, 9 patients (11.25%) experienced at least one major complication, defining the cohort with a poor outcome. The mean length of hospital stay was 4.2 ± 1.6 days.

Table 4. Early Postoperative Outcomes of Infants with IHPS (n = 80)

Category	Outcome	Frequency (n)	Percentage (%)
Minor Complications	Vomiting within 24 hrs	22	27.50
	Wound infection	6	7.50
Major Complications	Mucosal perforation (recognized postop)	2	2.50

	Reoperation required	1	1.25
	Mortality (within 30 days)	2	2.50
Overall Poor Outcome*	Total with ≥1 major complication	9	11.25
Recovery Parameter	Mean length of hospital stay (days)	4.2 ± 1.6	
*Poor outcome defined as major complications (wound infection, mucosal perforation, reoperation, or mortality). Patients with overlapping complications were counted once.			

Severe dehydration was significantly associated with poor outcome, occurring in 8 of 9 affected infants (88.89%, $\chi^2 = 14.82$, $p = 0.001$), shown in table 5. Electrolyte imbalance was present in all infants with poor outcome (n = 9, 100.00%, $\chi^2 = 8.47$, $p = 0.004$). Age >8 weeks was also linked to adverse outcomes in 5 patients (55.56%, $\chi^2 = 9.58$, $p = 0.002$). Surgical approach did not significantly influence outcome ($\chi^2 = 0.26$, $p = 0.61$). Mean hospital stay was longer in the poor outcome group (6.1 ± 2.3 vs 3.9 ± 1.2 days, $t = -3.42$, $p = 0.001$).

Table 5. Association Between Selected Preoperative Factors and Poor Outcome*

Factor	Good Outcome (n=71)	Poor Outcome (n=9)	Test Statistic	p-value
Severe dehydration	17 (23.94%)	8 (88.89%)	$\chi^2 = 14.82$	0.001
Electrolyte imbalance present	42 (59.15%)	9 (100.00%)	$\chi^2 = 8.47$	0.004
Age > 8 weeks	7 (9.86%)	5 (55.56%)	$\chi^2 = 9.58$	0.002
Surgical approach (open vs laparoscopic)	59 (83.10%) vs. 12 (16.90%)	7 (77.78%) vs. 2 (22.22%)	$\chi^2 = 0.26$	0.61
Mean hospital stay (days)	3.9 ± 1.2	6.1 ± 2.3	$t = -3.42$	0.001
*Poor outcome = postoperative complications, reoperation, or mortality within 30 days.				

DISCUSSION

The present study on IHPS at Mardan Medical Complex provides valuable insights into the clinical outcomes and associated factors in a resource-limited setting. Our findings regarding the male-to-female ratio (77.50% vs. 22.50%) are consistent with previous reports, which reported 80% male patients (male-to-female ratio 4:1), reflecting the global predominance of IHPS in male infants [14]. This male predominance may be linked to genetic predisposition and hormonal influences during early infancy, as suggested in previous epidemiological studies. Understanding this demographic trend is important for clinicians, as it highlights the population most at risk and may guide early screening efforts.

In our cohort, 50% of infants presented between 5–8 weeks of age, which is consistent with the typical age of onset for IHPS. However, a previous study from Eastern Ethiopia reported a higher proportion (17.1%) of unfavorable outcomes, with severe dehydration (AOR = 30.9) and delayed presentation (AOR = 7.37) as significant predictors [13]. In contrast, our study observed that 31.25% of infants had severe dehydration preoperatively, and 100% of those with poor outcomes had electrolyte imbalances, suggesting a need for timely intervention and electrolyte correction.

Regarding surgical approaches, 82.50% of our patients underwent open pyloromyotomy, which is the standard procedure in many settings due to its effectiveness and lower cost. This is in line with practices in resource-limited environments, where open surgery remains prevalent [15]. Notably, our study found no significant difference in outcomes between open and laparoscopic approaches, indicating that both methods can be effective when appropriately managed.

Postoperative complications in our study included vomiting within 24 hours (27.50%), wound infection (7.50%), mucosal perforation (2.50%), reoperation (1.25%), and mortality (2.50%), resulting in an overall poor outcome rate of 11.25%. These figures are comparable to those reported in other studies; for example, in this study from a developing country, the postoperative mortality rate was 11.5%, with complications observed in 15.4% of patients, reflecting the challenges of delayed presentation and associated electrolyte disturbances [16].

Our analysis identified severe dehydration, electrolyte imbalance, and age over 8 weeks as significant predictors of poor outcomes, with p-values of 0.001, 0.004, and 0.002, respectively. These findings are consistent with previous study, which also highlighted these factors as independent predictors of unfavorable outcomes [17]. These results emphasize the importance of early diagnosis, timely referral, and aggressive preoperative correction of dehydration and electrolyte disturbances. Moreover, our findings highlight the potential benefit of community education to reduce delays in presentation, which could further improve outcomes. Finally, the short hospital stay in patients with good outcomes demonstrates that when preoperative optimization is adequate, IHPS can be managed efficiently, even in settings with limited resources.

Study Strengths and Limitations

This study benefits from a prospective design and a

well-defined, consecutive cohort of 80 infants, allowing for accurate collection of preoperative, perioperative, and postoperative data. The structured proforma and 30-day follow-up enabled detailed assessment of treatment outcomes and associated risk factors such as severe dehydration, electrolyte imbalance, and delayed presentation. Additionally, the use of both descriptive and inferential statistics strengthens the reliability of the findings. However, limitations include the single-center design, which may limit generalizability, and the short follow-up period, which precludes assessment of long-term complications or growth outcomes. Furthermore, the relatively small sample size limits the statistical power to detect associations with less common predictors or rare complications.

Conclusion

The study demonstrates that IHPS can be effectively managed surgically, with the majority of infants achieving favorable outcomes. Severe dehydration, electrolyte imbalance, and age over 8 weeks were identified as significant predictors of poor outcomes, emphasizing the importance of early diagnosis, optimal preoperative stabilization, and timely surgical intervention. Open and laparoscopic pyloromyotomy were both safe and effective, highlighting that appropriate perioperative care can mitigate risks even in resource-limited settings.

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