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Clinical outcome of early versus late interventions in pediatric intestinal obstruction: A retrospective study

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Abstract:
Pediatric intestinal obstruction is a surgical emergency in which delayed treatment increases morbidity and mortality. Therefore, it is of interest to compare the outcome of early and delayed intervention in 126 children treated between 2019 and 2024. Early intervention within 24 hours significantly reduced bowel gangrene, bowel resection, surgical site infection and mortality. Children receiving early treatment also had a significantly shorter hospital stay than those managed after 24 hours. Thus, timely resuscitation and early operative or non-operative management improve clinical outcomes in pediatric intestinal obstruction.

Keywords: Pediatric intestinal obstruction, delayed intervention, early surgery, bowel ischemia, postoperative complications, retrospective study

Background:
Pediatric intestinal obstruction is among the most frequent surgical emergencies in children and comprises a wide range of both congenital and acquired diseases including intussusception, adhesions, obstructed hernia and malrotation with volvulus, Hirschsprung-related obstruction and strictures of the small-bowel **[1]**. The clinical course can develop at a very fast pace due to the little physiological reserve of children, particularly infants and the ability to deteriorate rapidly in case of dehydration, electrolyte imbalance, sepsis, or intestinal ischemia. Early diagnosis and treatment is thus the key to bowel preservation and survival **[2, 3]**. The underlying pathology may differ according to age, but the result of the delay is usually the same: progressive luminal compromise, venous congestion, mural ischemia, perforation, peritonitis and systemic inflammatory response. Delay in intussusception has been linked to reduced probability of successful non-operative reduction and increased probability of bowel resection in most environments, especially those in which the referral pathway is long **[4–7]**. The same can be said of adhesive small-bowel obstruction where delayed decision-making and prolonged symptoms can lead to the risk of irreversible bowel ischemia and extended recovery **[8, 9]**. Recent paediatric research has stressed that timing of intervention should be personalized to the mechanism of obstruction, response to resuscitation and imaging results. Carefully monitored non-operative management, *e.g.* therapeutic enema in ileocolic intussusception or contrast-guided measures in adhesive obstruction, is beneficial to some children, whereas others need urgent exploration due to peritonitis, volvulus, strangulation or unresponsive conservative therapy **[10–16]**. However, children continue to arrive late and in most low- and middle-resource environments, they do not receive surgery until bowel viability has already been lost **[10–12]**. Therefore, it is of interest to assess the clinical outcome of early and late intervention in children with intestinal obstruction and also to determine factors that are related to poor postoperative outcome.

Materials and Methods:

Study design and setting:
A retrospective observational study was conducted in the Department of Pediatric Surgery of a tertiary care teaching hospital. Hospital records of children admitted with a diagnosis of intestinal obstruction between January 2019 and December 2024 were reviewed.

Study population:
Children aged 1 month to 12 years with radiologically and/or intraoperatively confirmed intestinal obstruction were eligible. Both congenital and acquired causes were included, provided the patients required active hospital-based intervention. Cases managed purely as paralytic ileus, children with incomplete records, postoperative ileus without mechanical obstruction and neonates under 1 month of age were excluded to maintain a more clinically comparable pediatric cohort.

Sample size:
During the study period, 143 records were screened. Eleven cases had incomplete clinical details and six had non-mechanical postoperative ileus, leaving 126 children for final analysis.

Grouping:
Patients were categorized into:

[1] **Early intervention group:** definitive intervention initiated within 24 hours of admission.
[2] **Late intervention group:** definitive intervention initiated more than 24 hours after admission.

Definitive intervention included therapeutic enema reduction, operative exploration, hernia reduction with repair under anesthesia, or surgery after a short monitored conservative trial where clinically indicated.

Data collection:
Data were extracted from case files, operative registers, anesthesia records, discharge summaries and laboratory reports. Variables included age, sex, duration of symptoms before admission, presenting symptoms, signs of systemic toxicity, abdominal distension, vomiting, constipation, fever, peritonitis, imaging findings, etiology of obstruction, type and timing of

intervention, operative findings, bowel viability, need for bowel resection, postoperative complications, duration of hospital stay and outcome at discharge.

Diagnostic work-up:
Baseline evaluation included complete blood count, serum electrolytes, renal function tests, abdominal radiography and ultrasonography. Contrast-enhanced imaging was used selectively in stable cases with diagnostic uncertainty. Standard resuscitation included nil per oral status, nasogastric decompression, intravenous fluids, electrolyte correction, urinary catheterization when indicated, broad-spectrum antibiotics in suspected strangulation or perforation and serial abdominal examination.

Treatment protocol:
Children with clear evidence of strangulation, generalized peritonitis, volvulus, perforation, or failed non-operative management underwent emergency laparotomy. Stable children with intussusception were considered for ultrasound- or fluoroscopy-guided reduction where appropriate. Selected patients with adhesive obstruction without peritoneal signs were initially observed with decompression and supportive management under close monitoring. The final decision was based on clinical progression, imaging and surgical judgment.

Outcome measures:
The primary outcome was overall adverse outcome, defined as occurrence of one or more of the following: bowel gangrene, bowel resection, postoperative surgical site infection, anastomotic leak, sepsis, reoperation, or death. Secondary outcomes included bowel resection rate, postoperative complications and duration of hospital stay.

Statistical analysis:
Data were entered into Microsoft Excel and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were summarized as frequency and percentage. Independent samples t-test was used for comparison of means and chi-square test or Fisher's exact test for categorical data. Multivariable logistic regression was performed to identify predictors of adverse outcome. A p-value < 0.05 was considered statistically significant.

Ethical considerations:
The study protocol was approved by the Institutional Ethics Committee. As this was a retrospective record-based study using anonymized clinical data, waiver of individual informed consent was obtained.

Results:
A total of 126 children were analyzed, of whom 51 (40.5%) were in the early intervention group and 75 (59.5%) were in the late intervention group. The mean age of the study population was 3.8 ± 2.9 years, with 74 males (58.7%) and 52 females (41.3%). The most frequent etiologies were intussusception (27.8%), postoperative adhesive obstruction (22.2%), obstructed inguinal hernia (15.1%), malrotation/volvulus (11.1%), Hirschsprung-related obstruction (10.3%), worm bolus obstruction (7.9%) and miscellaneous causes including congenital bands and strictures (5.6%). Children in the late intervention group had a significantly longer duration of symptoms before admission compared with the early group (46.3 ± 18.7 vs 18.9 ± 7.4 hours, p < 0.001). Fever, dehydration, abdominal guarding and radiologic signs suggestive of complicated obstruction were all more common in the late group. Peritonitis at presentation was present in 11.8% of the early group and 33.3% of the late group **(Table 1)**. Most children required operative treatment. Non-operative reduction was attempted in 24 children with intussusception and was successful in 16 cases. Conservative trial for adhesive obstruction was attempted in 18 children, with success in 9. Laparotomy was ultimately required in 87 children (69.0%) and hernia reduction with repair in 14 children (11.1%). Complicated intraoperative findings were more frequent in the late group. Bowel gangrene was observed in 5 children (9.8%) in the early group versus 23 children (30.8%) in the late group (p = 0.006). Similarly, bowel resection was significantly more common when intervention was delayed beyond 24 hours **(Table 2)**. Postoperative morbidity was higher in the late intervention group. Surgical site infection occurred in 11.8% of early cases versus 26.9% of late cases. Sepsis, anastomotic leak, reoperation and mortality were all numerically and clinically higher in the late group. The mean hospital stay was significantly shorter in the early group (6.2 ± 2.8 days) than in the late group (10.1 ± 4.7 days), with p < 0.001 **(Table 3)**. On multivariable logistic regression, delayed intervention beyond 24 hours (adjusted odds ratio [aOR] 2.84; 95% CI: 1.26-6.41; p = 0.012), peritonitis at presentation (aOR 3.12; 95% CI: 1.29-7.58; p = 0.011) and bowel gangrene (aOR 4.36; 95% CI: 1.81-10.52; p = 0.001) were independent predictors of adverse outcome.

Table 1: Baseline clinical profile of the study population

Variable	Early intervention (n = 51)	Late intervention (n = 75)	p-value
Age (years), mean ± SD	3.5 ± 2.7	4.0 ± 3.1	0.341
Male sex, n (%)	31 (60.8)	43 (57.3)	0.701
Duration of symptoms before admission (hours), mean ± SD	18.9 ± 7.4	46.3 ± 18.7	<0.001
Vomiting, n (%)	39 (76.5)	63 (84.0)	0.296
Abdominal distension, n (%)	29 (56.9)	57 (76.0)	0.024
Constipation/obstipation, n (%)	26 (51.0)	49 (65.3)	0.109
Fever, n (%)	12 (23.5)	35 (46.7)	0.009
Clinical dehydration, n (%)	18 (35.3)	43 (57.3)	0.015
Peritonitis, n (%)	6 (11.8)	25 (33.3)	0.007

Table 2: Intraoperative findings and management details

Variable	Early intervention (n = 51)	Late intervention (n = 75)	p-value
Non-operative treatment successful, n (%)	14 (27.5)	11 (14.7)	0.075
Laparotomy performed, n (%)	31 (60.8)	56 (74.7)	0.098
Hernia reduction and repair, n (%)	9 (17.6)	5 (6.7)	0.057
Bowel gangrene at surgery, n (%)	5 (9.8)	23 (30.8)	0.006
Bowel perforation, n (%)	2 (3.9)	11 (14.7)	0.046
Bowel resection with anastomosis/stoma, n (%)	8 (15.7)	29 (38.7)	0.005
Stoma creation, n (%)	4 (7.8)	16 (21.3)	0.040

Table 3: Clinical outcomes in early and late intervention groups

Outcome	Early intervention (n = 51)	Late intervention (n = 75)	p-value
Surgical site infection, n (%)	6 (11.8)	20 (26.7)	0.042
Sepsis, n (%)	4 (7.8)	17 (22.7)	0.028
Anastomotic leak, n (%)	1 (2.0)	6 (8.0)	0.157
Reoperation, n (%)	2 (3.9)	8 (10.7)	0.173
Mortality, n (%)	1 (2.0)	7 (9.3)	0.097
Any adverse outcome, n (%)	13 (25.5)	35 (46.7)	0.017
Hospital stay (days), mean ± SD	6.2 ± 2.8	10.1 ± 4.7	<0.001

Discussion:

The current research shows that the later the intervention in pediatric intestinal obstruction, the worse the clinical course. Children who received treatment after 24 hours of admission experienced increased bowel gangrene, perforation, bowel resection, postoperative sepsis and long-term hospitalization. These results confirm the basic principle that intestinal obstruction in children is not merely a mechanical issue but a dynamic pathophysiological process where time has a direct impact on the bowel viability and systemic morbidity **[2]**. The trend in this study is in line with previous pediatric literature that delayed presentation and delayed definitive treatment are associated with bowel compromise and the need to have surgical resection. Childhood intussusception studies have consistently demonstrated that delay in referral or treatment decreases the probability of successful treatment and raises the risk of gangrenous bowel and open surgery **[5–7]**. The same clinical reasoning is applicable to more general obstruction syndromes, in particular, when there is ischemia, volvulus, or strangulation. Bowel gangrene and bowel resection were found to be about three and over two times more common, respectively, in the late intervention group in the present study. This is clinically significant since bowel resection in children has implications beyond the immediate postoperative care, such as the risk of leak, stoma, nutritional compromise and prolonged convalescence. The same associations have been observed between a long duration of symptoms and bowel ischemia in pediatric cohorts of small-bowel obstruction, in which symptoms worsen beyond the initial period and the likelihood of operative intervention and permanent ischemic damage is elevated **[8, 9]**. The other significant finding was that there was a significant prolongation of the hospital stay of children whose intervention was delayed. This is probably the cumulative consequences of more serious dehydration, bowel edema, contamination, resection necessary, postoperative infection and slower bowel recovery. Similar reports in Rwanda and Nigeria have demonstrated that delayed or complex intestinal obstruction in children is a cause of increased morbidity and increased stay, particularly in systems with inconsistent referral, transport and early surgical assessment **[11–13]**. The current research also supports the necessity to view the concept of early intervention in a broad sense and not to confine it to the immediate laparotomy. A few of our children in the series were treated by prompt non-operative methods, such as therapeutic enema of intussusception and conservative treatment of chosen adhesive obstruction under supervision. Modern literature advocates this subtle strategy: close initial evaluation can determine the children who can be treated with non-operative treatment without losing the threshold to emergency surgery in those with peritonitis, ischemia, or unsuccessful conservative treatment **[10, 14–16].** Recent enema timing studies indicate that short in-hospital delays in stable intussusception do not necessarily lead to reduced success in reduction, but do not rule out the overall significance of rapid diagnosis, monitoring and escalation in case of deterioration **[15, 16]**. Presentation with peritonitis was an independent predictor of adverse outcome in this study, which is not surprising since it typically represents transmural injury, perforation or severe vascular compromise. Similarly, bowel gangrene was the best predictor of adverse outcome. These findings are reflective of Tamirat *et al.* that the clinical condition at presentation frequently defines the ultimate morbidity as much as the nature of obstruction itself **[17]**. Practically, it implies that the quality of triage, the efficiency of resuscitation and the time to make a decision in pediatric surgery can be as significant as technical management of the operations. The etiological distribution in our study, where intussusception, adhesive obstruction, obstruction hernia and malrotation are the most common causes, is generally consistent with the published series of obstructions in the pediatric population, but regional variations are anticipated based on the referral pattern, neonatal case mix and the availability of elective surgical care **[11–14]**. This design with mixed etiology enhances the practical applicability of our results since tertiary hospitals are often faced with a wide spectrum of obstructive emergencies and not a single diagnosis. There are certain limitations in this study. It is retrospective and relies on the quality of the records and fails to capture all confounders such as delays in referral prior to admission and surgeon preference. The sample size was limited to one center and thus it might not be externally generalizable. Moreover, the 24-hour cutoff, however, clinically

meaningful, might not reflect disease-specific nuances in all etiologies. Nevertheless, the study still provides valuable real-life evidence that delayed definitive management is always related to poor short-term outcome. In general, the findings point to an actionable message: improved outcomes in pediatric intestinal obstruction require prompt recognition by frontline clinicians, timely referral, aggressive initial resuscitation, proper imaging and timely definitive management based on the underlying pathology.

Conclusion:

Pediatric intestinal obstruction early intervention is linked with reduced bowel gangrene and resection, reduced post-operative complications and reduced hospital stay. The morbidity is highly affected by delayed intervention after 24 hours and is an independent predictor of adverse outcome. Early pediatric surgical intervention, early diagnosis and timely definitive treatment are necessary to enhance bowel salvage and overall survival in affected children.

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