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Original Research Article

Outcomes analysis of laparotomy, ileostomy and relaparotomy for diverse abdominal pathologies in children

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ABSTRACT

Background: Acute abdomen in children, arising from diverse surgical conditions, can be treated by open laparotomy or by laparoscopic intervention. This study aimed to assess the demographics, underlying etiologies, and outcomes of different surgical procedures performed to treat pediatric patients with acute abdomen.
Methods: This retrospective, single-institution study was conducted in the Department of Pediatric Surgery at a tertiary care centre in central India. This study spanned from January 1, 2000, to December 31, 2022. This study included children from infancy to 12 years of age who underwent surgery for abdominal pathologies leading to acute intestinal obstruction or perforation peritonitis.
Results: Over a 23-year study period, 704 children aged 0 to 12 years underwent surgery for intestinal obstruction or perforation peritonitis. The primary abdominal pathologies managed *via* laparotomy included intussusception (32.38%), bowel (ileal) perforation with peritonitis (26.13%), symptomatic Meckel's diverticulum (12.21%), Koch's abdomen (5.68%), congenital bands, cysts, and malrotation of the gut (7.95%), patent vitelline duct (3.97%), and a few others. Surgical interventions included segmental resection of the ileum with ileo-ileal anastomosis (180; 25.56%), wedge resection or repair of bowel perforation (166; 23.57%), ileostomy creation, adhesiolysis, and a few other procedures. Seventeen percent of children required creation of a diverting ileostomy, and seven percent required a relaparotomy for management of their postoperative complications. Despite management, 62 (8.8%) children died during the study period.
Conclusions: Mortality was especially higher in children undergoing surgery for bowel perforation peritonitis, those requiring ileostomy, and those needing relaparotomy to manage postoperative complications.

Keywords: Ileostomy, Intestinal obstruction, Intussusception, Laparotomy, Meckel diverticulum, Mortality, Pediatrics, Peritonitis

INTRODUCTION

Acute abdomen in infants and children encompasses a broad spectrum of surgical conditions, broadly categorized as intestinal obstruction or peritonitis, with etiologies varying according to age group.[1-4] In the neonatal period, intestinal obstruction is most often due to intestinal atresia, Hirschsprung's disease, congenital anomalies (such as bands), and malrotation.[1,5-7] Neonatal peritonitis typically results from bowel perforation secondary to necrotizing enterocolitis or spontaneous gastric perforation.[2,8,9] During infancy and early childhood, intussusception is predominant cause of bowel obstruction, while Meckel's diverticulum, congenital bands, and malrotation remain significant considerations throughout childhood.[10-12] Surgical management of these above-mentioned abdominal pathologies may be achieved through either by open laparotomy or

laparoscopic techniques.[1-5,7-10] This manuscript presents a comprehensive retrospective analysis of 704 laparotomies, 120 ileostomies created, and 48 relaparotomies performed over 23 years for a wide range of surgical pathologies in children under 12 years of age.

METHODS

This retrospective, single-institution, descriptive study was conducted at the Department of Pediatric Surgery, Gandhi Medical College and Associated Hospitals, Bhopal, India, a tertiary care centre in central India. The objectives were to evaluate patients' demographics, etiologies of acute abdomen, and outcomes of various surgical interventions in children. This analysis also included indications and outcomes of ileostomy creation and relaparotomy performed. This study also compared outcomes of laparotomy, ileostomy creation, and relaparotomy in children operated on between January 1, 2000, and December 31, 2009 (Study phase I) with those operated on between January 1, 2010, and December 31, 2022 (Study phase II). This study spanned 23 years, from January 1, 2000, to December 31, 2022. This study included children aged from infancy to 12 years who were treated by doing laparotomy for the management of their abdominal pathologies causing acute intestinal obstruction or perforation peritonitis. This review includes a few previously published works by the corresponding author.[13-16]

Inclusion criteria

This study exclusively included children (0-12 years) who needed surgical therapies for intestinal obstruction or small bowel perforation peritonitis and were treated by doing open laparotomies.

Exclusion criteria

In children, during the study period, laparotomies performed for anorectal malformations (ARMs), Hirschsprung's disease, appendicitis, neonatal necrotizing enterocolitis, intestinal atresia, colonic perforation, abdominal trauma, and abdominal tumors, were excluded. Surgical procedures performed through abdominal route for the repair of congenital diaphragmatic hernia, and laparotomies carried out for exomphalos and gastroschisis were excluded. Laparotomies carried out for urological and hepatobiliary diseases were also excluded. Also excluded cases with missing or incomplete desired details.

Depending on the surgical therapy provided, the cases were grouped into three categories, as below:

Group A cases

Included children who were treated by performing various surgical procedures, but did not require the creation of the ileostomy or relaparotomy during their management for acute intestinal obstruction or perforation peritonitis.

Group B cases

Included children who were treated by performing various surgical procedures, but did require the creation of an ileostomy during their management for acute intestinal obstruction or perforation peritonitis, or postoperative complication. Children who required ileostomy creation during relaparotomy were also included in Group B.

Group C cases

Included children who were treated by performing the above-mentioned various surgical procedures but subsequently required relaparotomy for the management of their postoperative complications, following surgery for acute intestinal obstruction or perforation peritonitis. Children who required ileostomy creation during relaparotomy were excluded from Group C cases, but included in Group B cases.

This manuscript presents results as numbers, percentages, ranges, and p-values, with statistical analyses performed to ensure validity. The manuscript describes a comprehensive retrospective study that also incorporates a few of previously published data. Waiver of consent and exemption from review are requested, and institutional ethics committee approval is in progress.

RESULTS

Over 23 years, 704 laparotomies were performed in children aged 0 to 12 years for intestinal obstruction or perforation peritonitis resulting from diverse underlying conditions. Figure 1 presents the number of laparotomies performed for various abdominal pathologies in study phase I (previously reported cases, n=334) and study phase II (additional cases, n=370). Seventy percent of these surgical procedures addressed acute abdomen caused by intussusception (228), ileal perforation peritonitis (184), and symptomatic Meckel's diverticulum (86). Figure 2 illustrates the distribution of specific pathologies requiring laparotomy, revealing a higher frequency in boys (486; 69.03%) than in girls (218; 30.96%). Figure 3 demonstrates the age distribution of children who underwent laparotomy for abdominal pathology. More than one-third (274) of laparotomies were performed during infancy, one-fifth (160) in children aged 2 to 5 years, and another one-third (270) in children aged 6 to 12 years. Figure 4 summarizes the clinical presentations by pathology, indicating that 55% (388) of children exhibited symptoms and signs of intestinal obstruction, while 39% (274) exhibited signs suggestive of bowel perforation peritonitis. Six percent (42) of children presented with mild symptoms such as abdominal pain, abdominal lump, or recurrent vomiting, but without features of acute intestinal obstruction or

perforation peritonitis. In this study, over 90% of cases required emergently surgery due to features suggestive or supportive of acute intestinal obstruction or bowel perforation peritonitis. Surgical interventions included segmental ileal resection with ileo-ileal anastomosis, wedge resection and repair or repair of bowel perforation, ileostomy creation, adhesiolysis, and a few other procedures, as detailed in Figure 5. One-third (236) of cases underwent ileal resection and anastomosis, with 180 receiving ileo-ileal anastomosis and 56 receiving ileo-colic anastomosis. Approximately one-fourth (166) of cases were managed with primary bowel repair, without the need for resection and anastomosis. Figure 6 outlies the pathologies and age distribution of children requiring diverting ileostomies, with two-thirds of ileostomies created for ileal perforation and intussusception. In this study, 120 (17.04%) children, 86 (70.66%) boys and 34 (28.33%) girls, required a temporary ileostomy. It was created during the initial laparotomy/first operation in 110 cases, while it was created during the relaparotomy in the remaining 10 children. One-third (40) of ileostomies were created in infants, one-fifth (26) in children aged 2 to 5 years, and 54 (45%) in children aged 6 to 12 years. Figure 7 depicts the pathologies and age distribution of children necessitating relaparotomy for postoperative complications.

In this study, 58 (8.23%) children (37; 63.79% boys and 21; 36.2% girls) required relaparotomy to manage various postoperative complications. Among 58 relaparotomies performed, in 10 children, an ileostomy was created during relaparotomy for various postoperative complications and included in group B cases for calculation of mortality, while 48 were included in group C cases. Figure 8 illustrates the age profile of children who died following surgical management of their abdominal pathologies. In this study, 62 (8.8%) deaths occurred following laparotomies performed for various abdominal pathologies, comprising 39; 62.9% boys and 23; 37.09% girls. Among these, 15; 24.19% were infants, 19; 30.64% were aged 2 to 5 years, and 28; 45.16% were aged 6 to 12 years. Figure 9 reports mortalities following laparotomies (Group A), ileostomies (Group B), and relaparotomies (Group C). Mortality was higher among children undergoing laparotomies for perforation peritonitis (26; 14.13%), intussusception with bowel gangrene, those requiring ileostomy creation (17; 14.16%), and those who underwent relaparotomy (9; 18.75%) for postoperative complications. Figure 10 compares mortality rates between study phase I (previously reported, 34; 10.17%), and study phase II (additional cases, 28; 7.56%). Table 1 summarizes the outcomes of laparotomies, ileostomies, and relaparotomies performed in children.

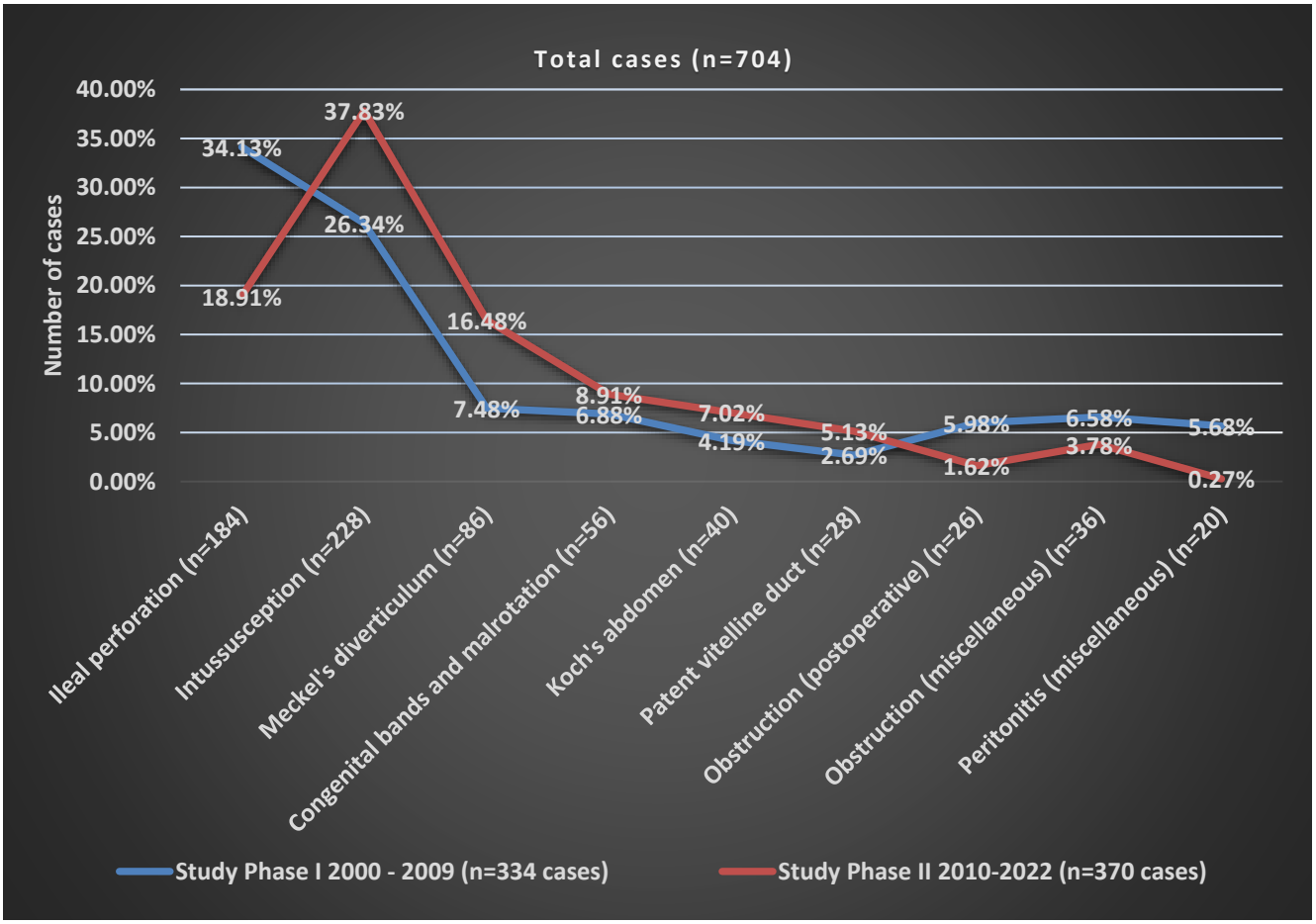


Figure 1: Laparotomies performed for various pathologies during study phases I and II in children.

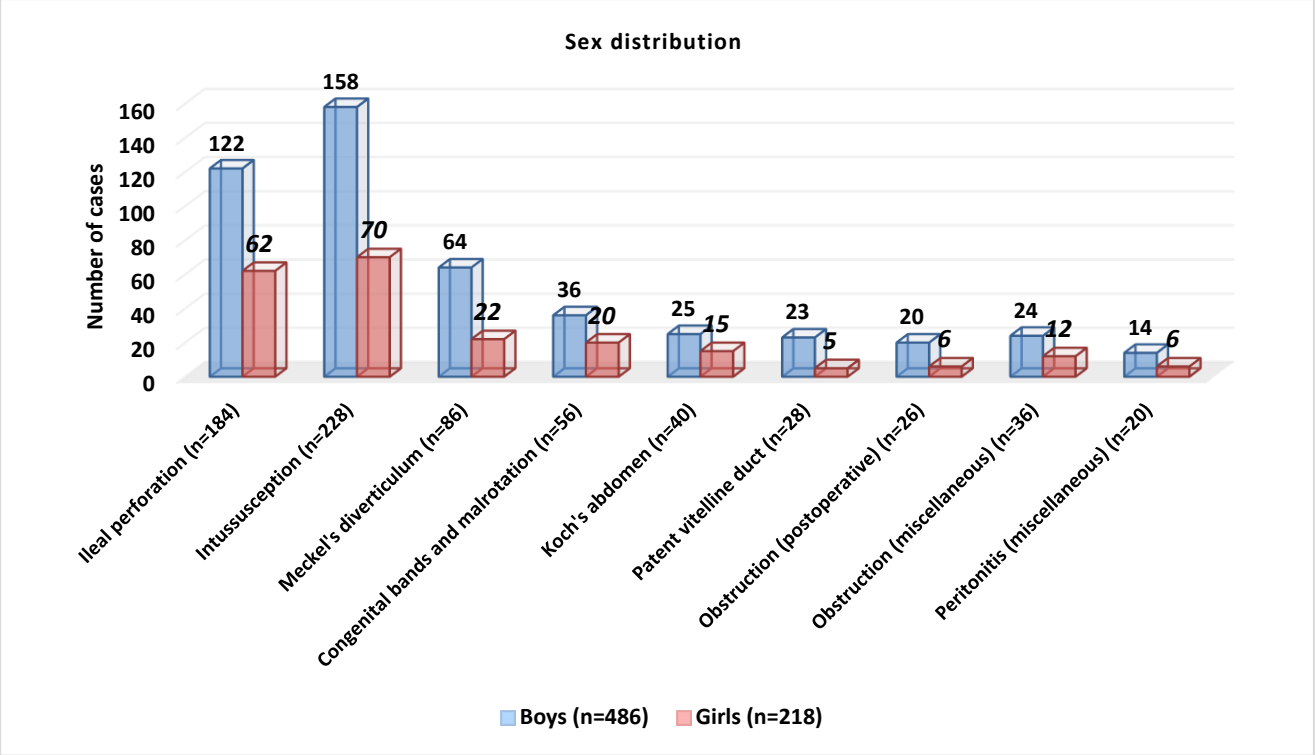


Figure 2: Distribution of the sex of children with specific pathologies requiring laparotomy.

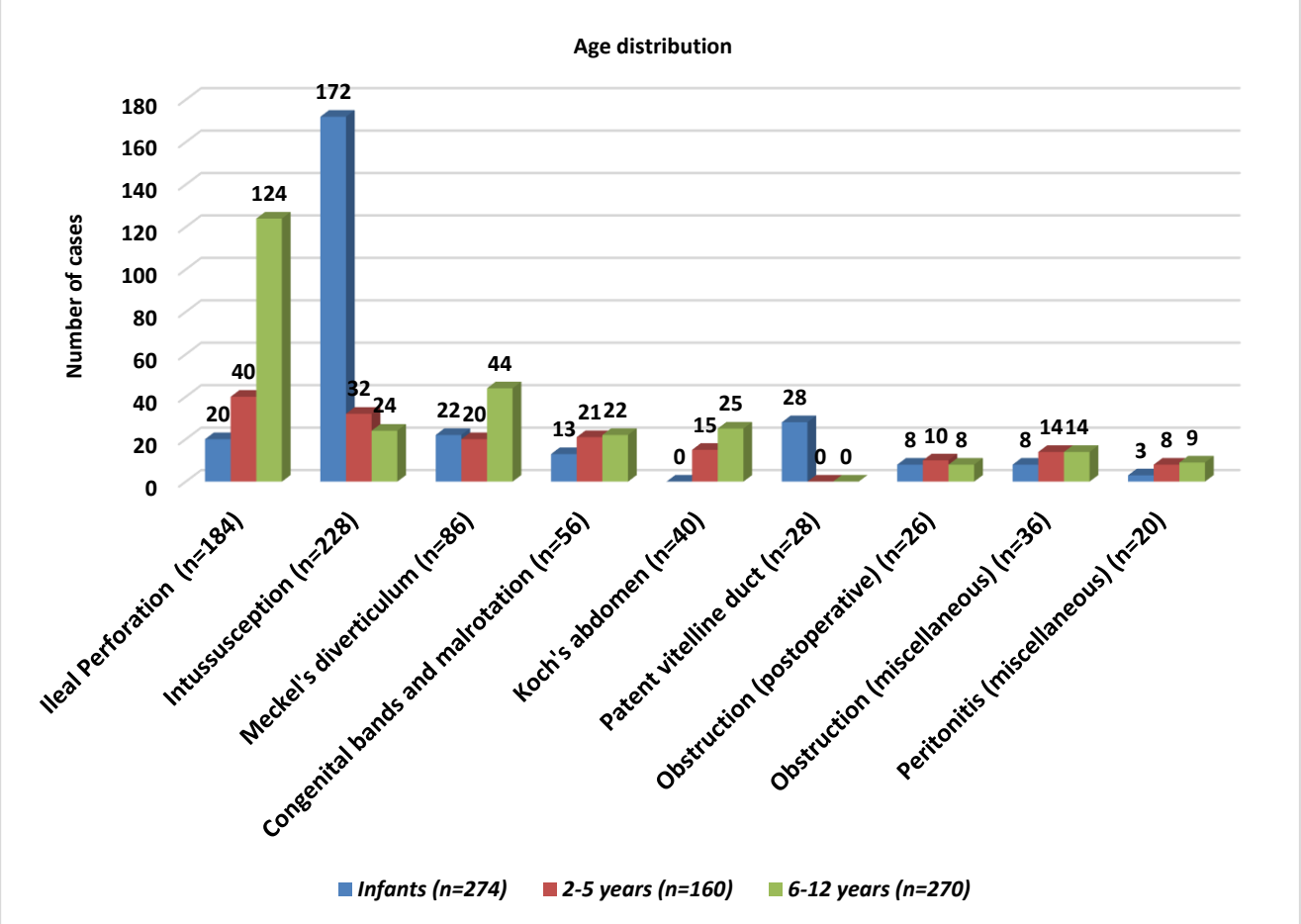


Figure 3: Distribution of the age of children who underwent laparotomy for abdominal pathology.

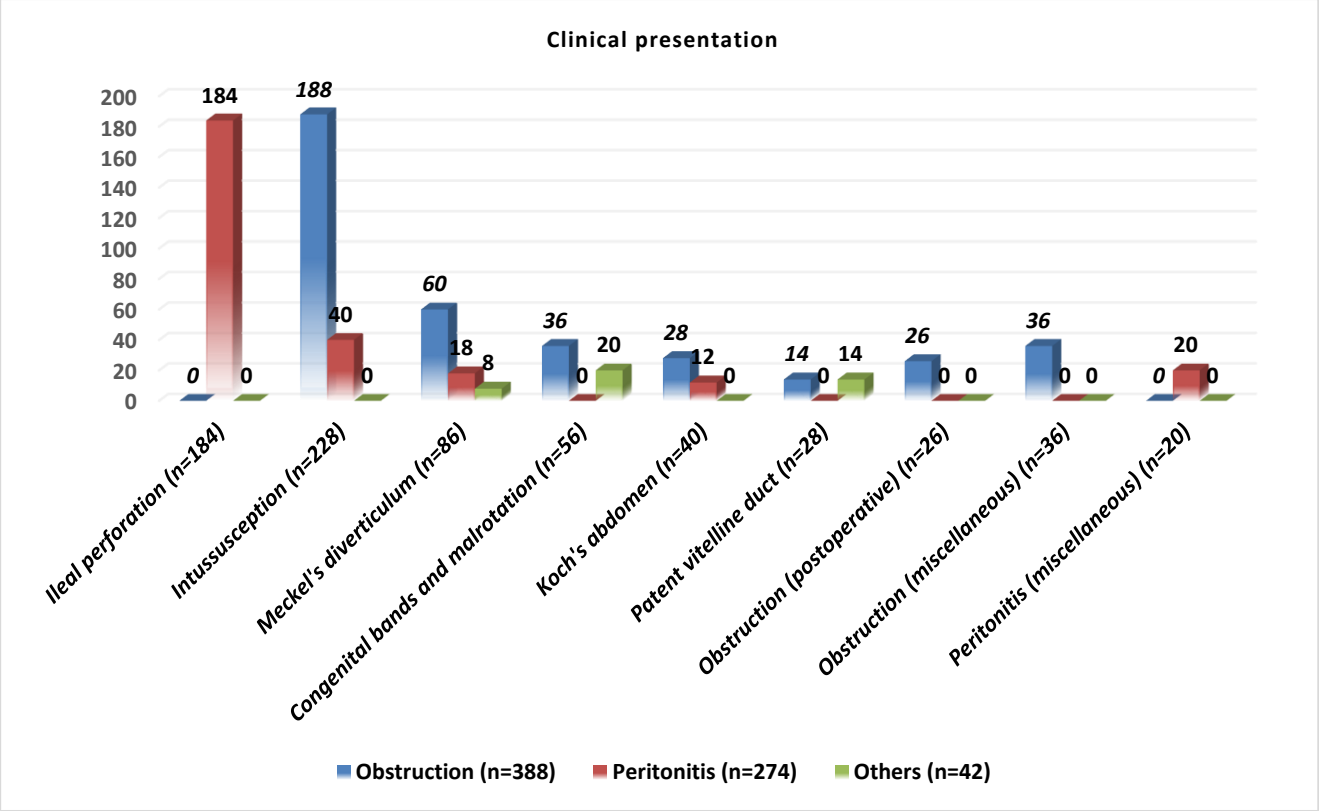


Figure 4: Clinical presentations of included cases by pathology.

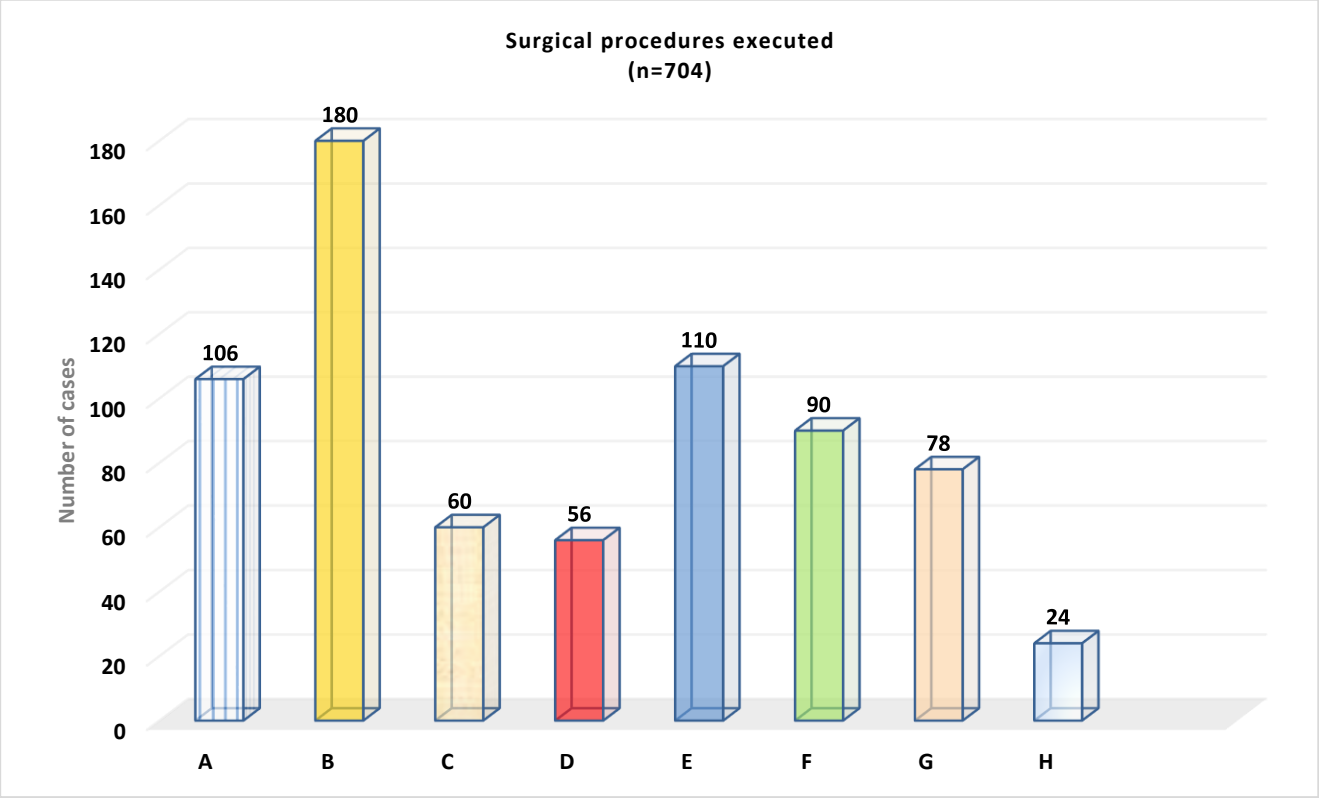


Figure 5: Surgical procedures performed for abdominal pathologies in children.

*A=Repair of bowel (ileal) perforation, B=Segmental resection of ileum and ileo-ileal anastomosis, C=Wedge resection (ileum) and repair, D=Ileo-colic anastomosis, E=Exploration and ileostomy, F=Operative reduction (intussusception), G=Adhesiolysis and others, H=Other procedures

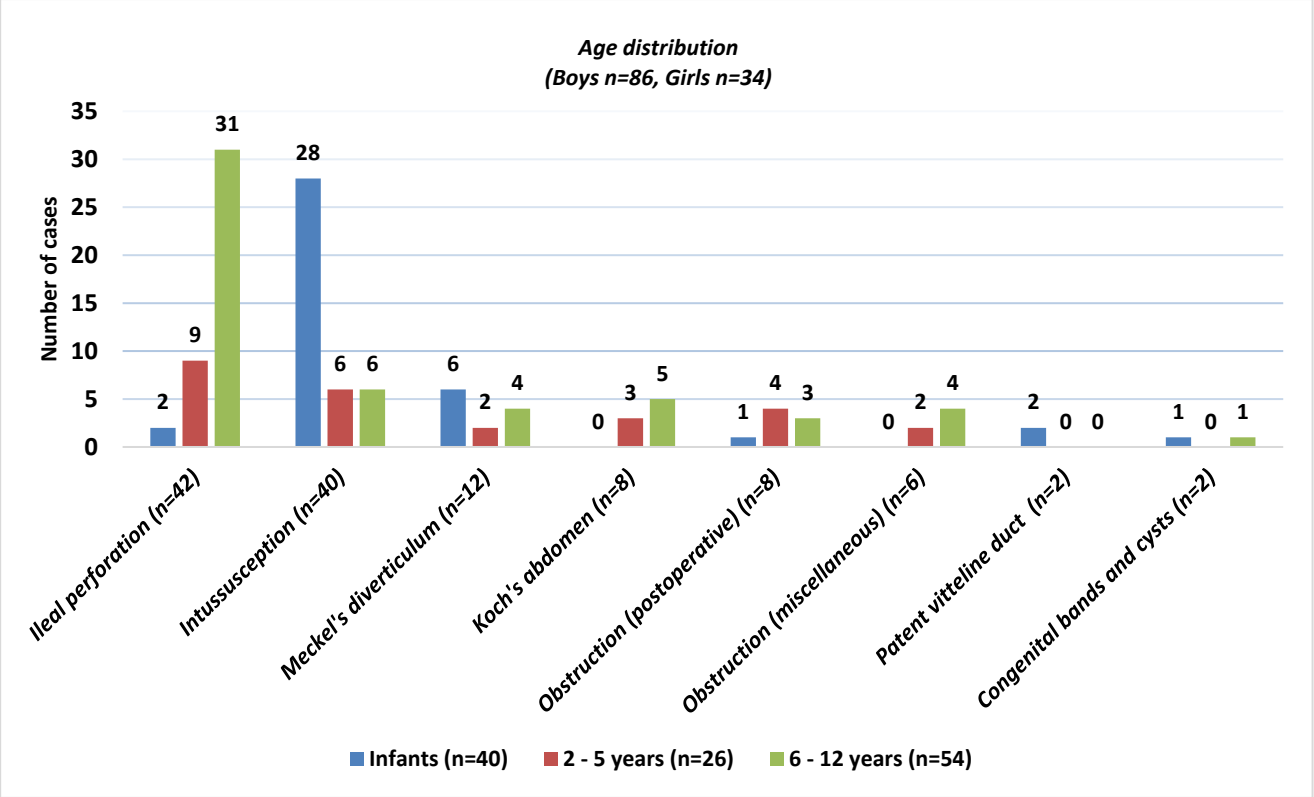


Figure 6: Distribution of the age of children requiring diverting ileostomies, (n=120).

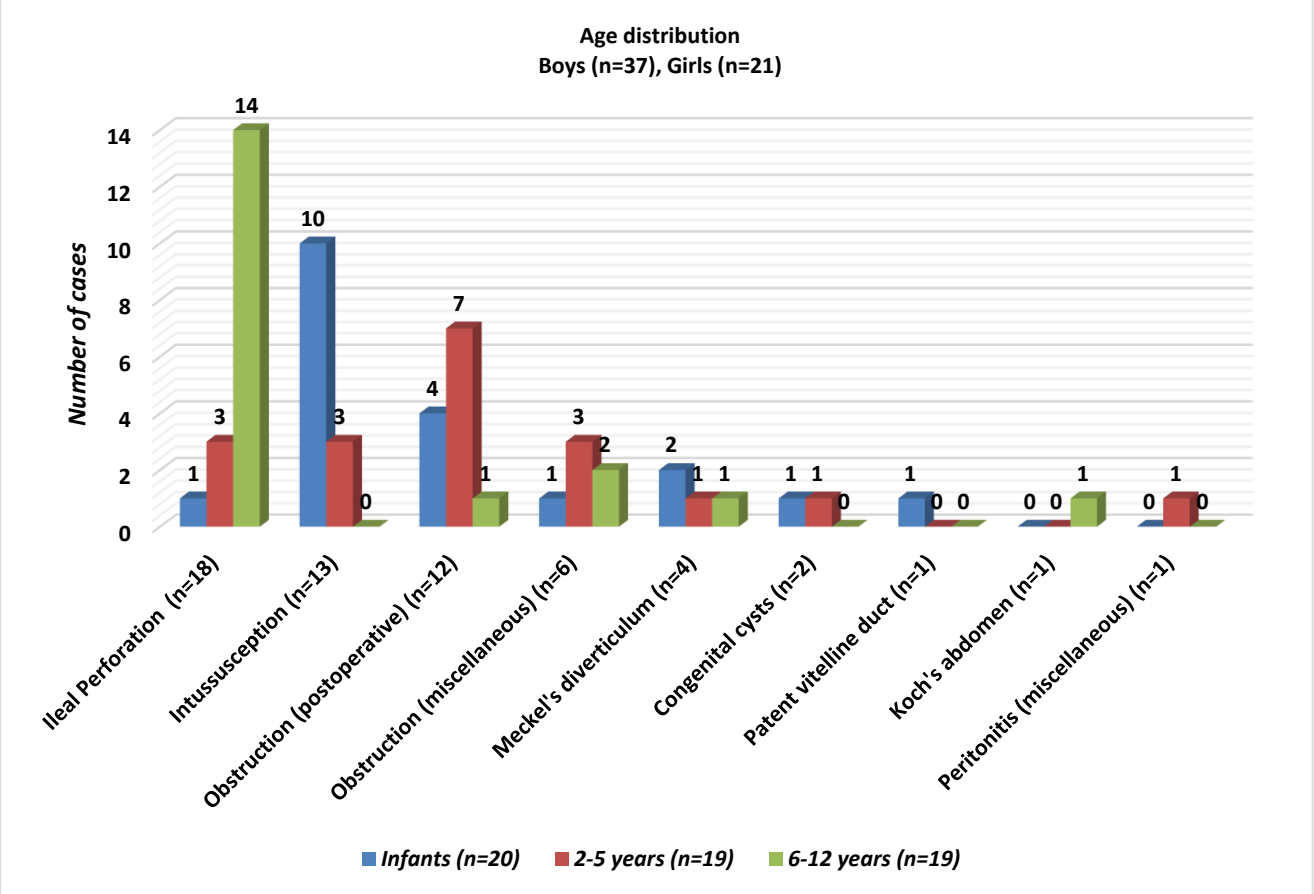


Figure 7: Distribution of the pathologies and age of children requiring relaparotomy (n=58).

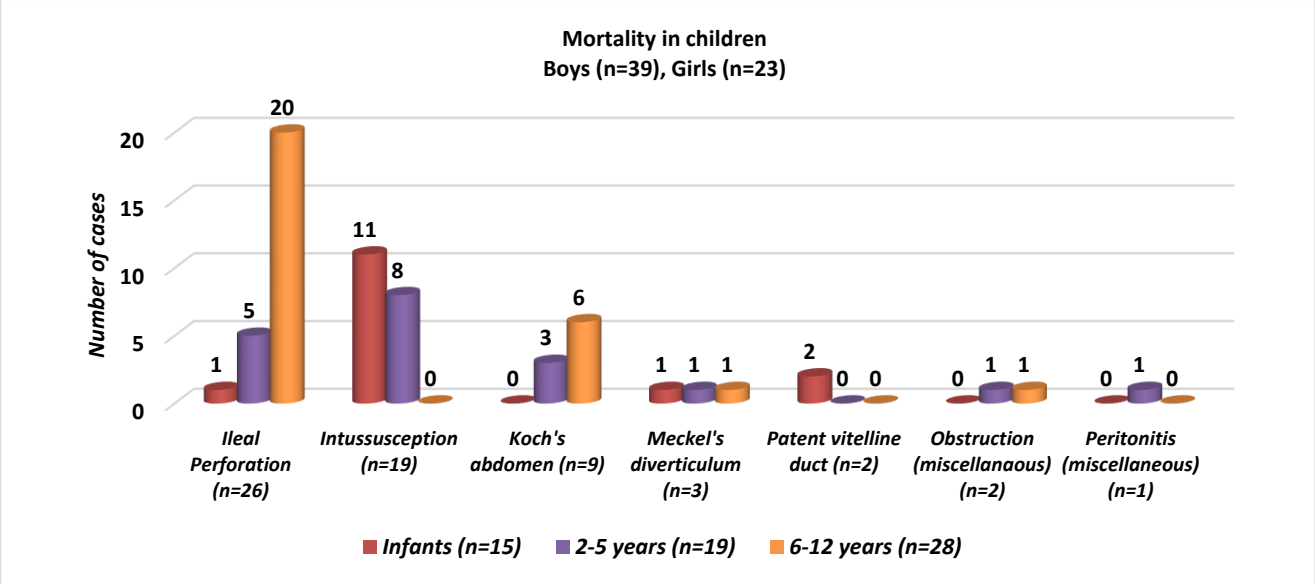


Figure 8: Distribution of age of children who died following surgical management for abdominal pathologies, (n=62).

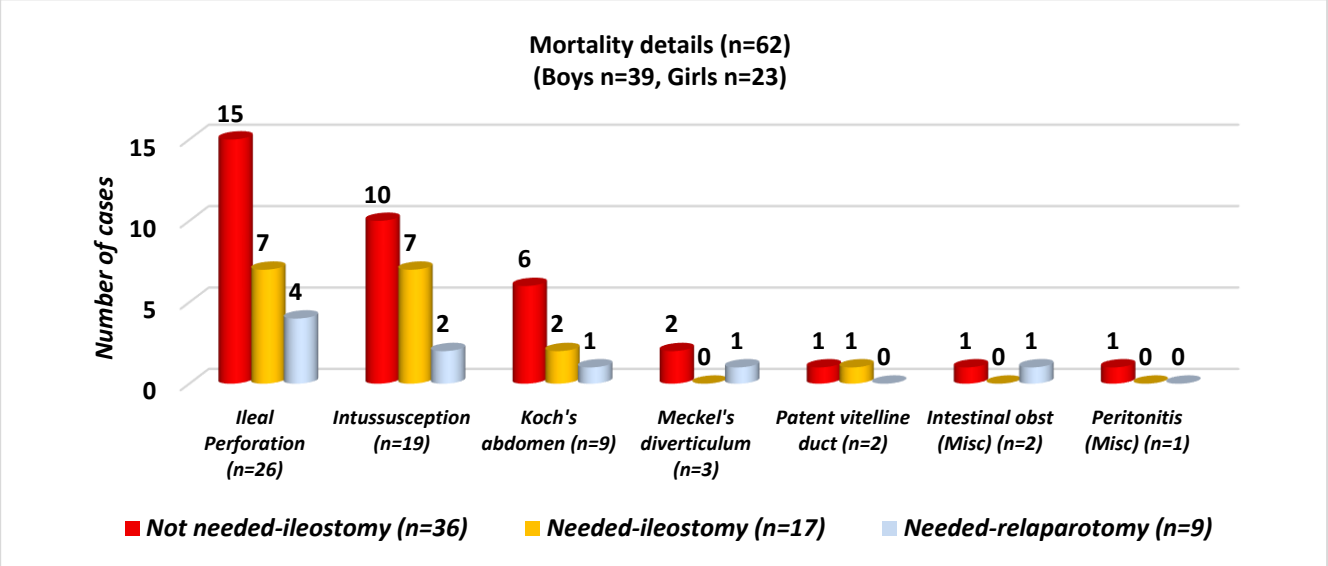


Figure 9: Presentation of mortalities following laparotomies, ileostomies, and relaparotomies in children.

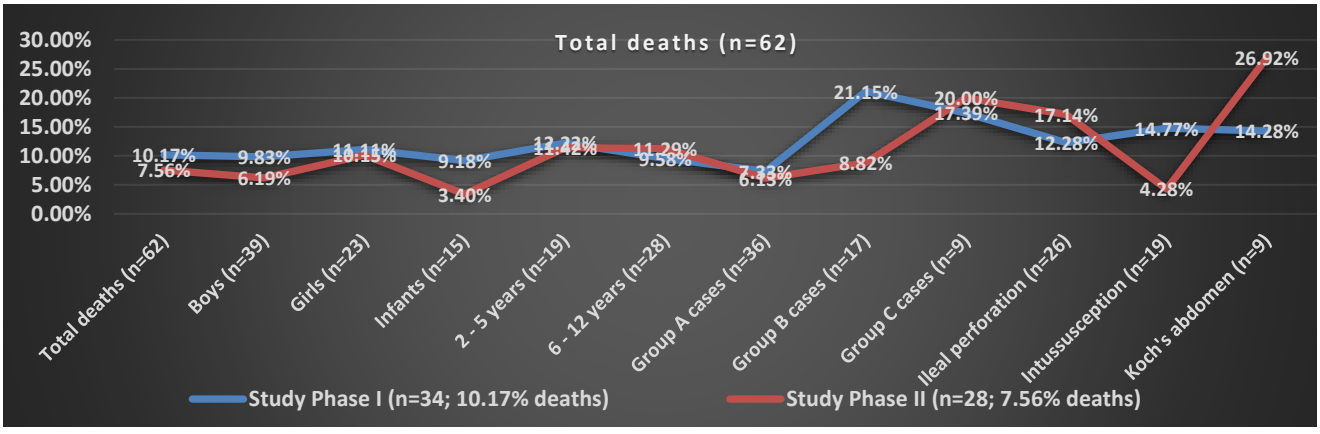


Figure 10: Comparative presentation of mortality rates between study phase II and study phase I.

Table 1: Summary of results of laparotomy, ileostomy and relaparotomy in children during 2000 to 2022.

Description	Cases included (%)	Phase I (%) (2000-2009)	Phase II (%) (2010-2022)	Phase I mortality	Phase II mortality	P value	Statistical significance of p value (Yes/No)
Cases	(704; 100%)	334 (100)	370 (100)	34 (10.17)	28 (7.56)	>0.05	No
Sex distribution	Boys (486; 69.03%)	244 (73.05)	242 (65.40)	24 (9.83)	15 (6.19)	>0.05	No
	Girls (218; 30.96%)	90 (26.94)	128 (34.59)	10 (11.11)	13 (10.15)	>0.05	No
Age distribution (in years)	Infants (274; 38.92%)	98 (29.34)	176 (47.56)	9 (9.18)	6 (3.40)	>0.05	No
	2-5 (160; 22.72%)	90 (26.94)	70 (18.91)	11 (12.22)	8 (11.42)	>0.05	No
	6-12 (270; 38.35%)	146 (43.71)	124 (33.51)	14 (9.58)	14 (11.29)	>0.05	No
Clinical features	Intestinal obstruction (388; 55.11%)	200 (59.88)	188 (50.81)	15 (7.5)	11 (5.85)	>0.05	No
	Perforation peritonitis (274; 38.92%)	134 (40.11)	140 (37.83)	19 (14.17)	17 (12.14)	>0.05	No
	Others (42; 5.96%)	-	42 (11.35)	-	-		
Pathologies	Intussusception (228; 32.38%)	88 (26.34)	140 (37.83)	13 (14.77)	6 (4.28)	<0.01	Yes
	Ileal perforation (184; 26.13%)	114 (34.13)	70 (18.91)	14 (12.28)	12 (17.14)	>0.05	No
	Meckel's diverticulum (86; 12.21%)	25 (7.48)	61 (16.48)	2 (8)	1 (1.63)	>0.05	No
	Congenital bands and malrotation (56; 7.95%)	23 (6.88)	33 (8.91)	-	-	-	-
	Koch's abdomen (40; 5.68%)	14 (4.19)	26 (7.02)	2 (14.28)	7 (26.92)	>0.05	No
	Patent vitelline duct (28; 3.97%)	9 (2.69)	19 (5.13)	1 (11.11)	1 (5.26)		
	Postoperative obstruction (26; 3.69%)	20 (5.98)	6 (1.62)	-	-	-	-
	Misc. obstruction (36; 5.11%)	22 (6.58)	14 (3.78)	1 (4.54)	1 (7.14)	>0.05	No
	Misc. peritonitis (20; 2.84%)	19 (5.68)	1 (0.27)	1 (5.26)	-	-	-
Initial operative procedures	Ileo-ileal anastomosis (180; 25.56%)	82 (24.55)	98 (24.48)	14 (17.07)	7 (7.14)	>0.05	No
	Ileostomy (110; 15.62%)	44 (13.17)	66 (17.83)	6 (13.63)	6 (9.09)	>0.05	No
	Repair of bowel peroration (106; 15.05%)	70 (20.95)	36 (9.72)	10 (14.28)	8 (22.22)	>0.05	No
	Reduction of intussusception (90; 12.78%)	30 (8.98)	60 (16.21)	1 (3.33)	2 (3.33)	>0.05	No
	Adhesiolysis and others (78; 11.07%)	52 (15.56)	26 (7.02)	2 (3.84)	3 (11.53)	>0.05	No
	Wedge resection and repair (60; 8.52%)	20 (5.98)	40 (10.81)	1 (5)	-	-	-
	Ileo-colic anastomosis (56; 7.95%)	24 (7.18)	32 (8.64)	-	2 (6.25)	>0.05	No
	Other procedures (24; 3.40%)	12 (3.59)	12 (3.24)	-	-	-	-
Group-wise operative procedures	Not-required ileostomy (536; 76.1%)	259 (77.54)	277 (74.86)	19 (7.33)	17 (6.13)	>0.05	No
	Required ileostomy (120; 17.04%)	52 (15.56)	68 (18.37)	11 (21.15)	6 (8.82)	>0.05	No
	Required relaparotomy (48; 6.81%)	23 (6.88)	25 (6.75)	4 (17.39)	5 (20)	>0.05	No

DISCUSSION

During the study period, 704 laparotomies were performed in children aged 0 to 12 years for variety of abdominal pathologies. Of these, more than two-third were boys, yielding a boys-to-girls ratio of 2.22:1. Sixty two percent (434) of laparotomies were performed in children younger than 5 years. More than half (388; 55.11%) of cases presented clinically with features of acute intestinal obstruction. All cases underwent basic hematological and biochemical investigations. Radiological investigations included plain abdominal X-ray and abdominal sonography. Preoperative management consisted of keeping patients' nil orally, nasogastric aspiration, intravenous fluids, and antibiotics administrated according to the child's weight. Blood was arranged preoperatively for selected children, as deemed necessary during the perioperative period. Majority of cases (662; 94.03%) required emergently surgery due to features suggestive of acute intestinal obstruction or

bowel perforation peritonitis. Seventeen percent of children required ileostomy creation and eight percent required relaparotomy to manage various postoperative complications.

This study included 184 cases of peritonitis resulting from ileal perforation. Enteric ileal perforations accounted for 40% of cases. In 138 cases (75%), a single or isolated ileal perforation was observed, whereas 46 cases involved two or more perforations. Additionally, 46 cases exhibited concomitant jejunal perforation alongside ileal perforation. Surgical interventions, listed in order of frequency, were primary repair of perforation(s) (104 cases; 56.52%), ileostomy creation (42 cases; 22.82%), ileo-ileal resection and anastomosis (28 cases; 15.21%), and other procedures (10 cases). Relaparotomy was required in 18 children to address postoperative complications. The selection and execution of these procedures aligned with existing literature.[17-20] Surgical approach was based on factors such as the number of perforations (single or multiple), severity of bowel edema, bowel adhesion, extent of peritonitis, and the patient's age and clinical condition.[17,18,20]

Pediatric intussusceptions are primarily managed through non-operative reduction.[3,10,21-23] According to a literature review by Wu et al laparoscopic reduction represents a safe and effective surgical alternative to open operative reduction in infants and children.[24] The literature supports that surgical therapy is reserved for complicated intussusception, detection of pathological lead points, and failure of medical therapy, and can be accomplished by either laparoscopic or open techniques.[21-24] In this study, 228 pediatric intussusceptions were treated by laparotomy during the study period; most (204) of the cases were idiopathic intussusception, while only 10.5% (24) of the cases were secondary intussusception, and pathological lead points were detected (Meckel's diverticulum was the most common) during the operative procedure. Forty five percent (102) of the children had documented bowel gangrene. Sixty percent of cases required bowel resection. Forty-three percent (98) cases were treated by resection of the diseased bowel segment and anastomosis, either as ileo-ileal anastomosis (54) or ileo-colic anastomosis (44). A total 90 (39.47%) of children were treated by operative reduction of intussusception, and a few of them also required the repair of minor serosal tears or bowel perforation that occurred during the operative reduction. A total of 40 (17.54%) of children required the creation of an ileostomy. Thirteen children required relaparotomy for the correction of their various postoperative complications.

Meckel's diverticulum is the most common congenital anomaly of the gastrointestinal (GI) tract, occurring in 1 to 3% of the population.[11,25,26] It may clinically present with recurrent lower GI bleeding, diverticulitis, intestinal obstruction, or bowel perforation with peritonitis.[11,25,26] Surgical resections of Meckel's diverticulum can be performed laparoscopically or by open laparotomy.[26-28] Eighty-six children were operated on for symptomatic Meckel's diverticulum during the study period. Bowel gangrene was detected in 37; 43.02% children and was documented during the operative procedure. Approximately half (42) of the cases were treated by resection of Meckel's diverticulum, the adjacent ileal segment, and anastomosis, either ileo-ileal (38) or ileo-colic (4). Wedge resection of the diverticulum with subsequent ileal repair (diverticulectomy) was carried out in 32. Twelve children required ileostomy creation, after resection of the diseased segment of ileum along with Meckel's diverticulum. Of the 84 children, four required reoperations for management of complications.

A patent vitelline duct (patent omphalomesenteric duct) is the rarest anomaly of the vitelline duct anomalies.[16] In general, it may present clinically with mucus, gas, and feces through the umbilicus, periumbilical redness, and bowel prolapse through the umbilicus.[28-30] A few cases may present with intestinal obstruction.[29,30] The surgical therapy mostly consists of resection of the patent duct along with a small segment of ileum containing the duct and ileo-ileal anastomosis or resection of the patent duct, wedge of ileum, and repair of the ileal defect, which are mostly performed through the periumbilical cosmetic incision.[30] During the study, 28 infants were operated upon for patent vitelline duct, and the surgical therapy provided were; ileal repair after the resection of a patent vitelline duct and it was performed in 13, ileo-ileal anastomosis after the resection of small segment of ileum along with the patent duct, it was performed in 13, and an ileostomy was created in 2 of infants (in one of infants it was created during the reoperation).

Abdominal tuberculosis is an extrapulmonary tuberculosis that may present with vague symptoms and a delay in diagnosis and treatment.[31,32] A few cases may require surgical intervention, mostly those presenting as acute abdomen, either acute intestinal obstruction or perforation peritonitis.[31,32] Forty children with abdominal tuberculosis who required surgical therapy during the study period were included in this review. More than one-third (15) were managed with adhesiolysis and mesenteric lymph node biopsy. Nine were treated by either ileo-ileal or ileo-colic anastomosis. Eight children required ileostomy creation during the surgical therapy provided. In 4 children, it was possible to repair the bowel perforation primarily, while in another 4 children who had bowel structures, stricturoplasty was performed.

The congenital anomalies of the abdomen, such as bands, cysts, and malrotation of the gut, although not frequent, also require surgical therapy and are treated either by laparoscopically or by open laparotomy.[7,33-35] In pediatric patients, Ladd's procedure can also be performed by robot-assisted techniques.[33] In this study, 56 children who were diagnosed with congenital bands, cysts, or malrotation of the gut also required surgical intervention, and all of them were treated by laparotomy.

During laparotomies performed for acute abdomen in children, for various pathologies, it is not always possible to repair the bowel perforation or restore bowel continuity, and a few children may require creation of temporary ileostomies, which is associated with considerable complications.[36-39] In this study, seventeen percent (120) children required a temporary ileostomy. Approximately three-fourths (94; 78.33%) of the ileostomies were created in children who were operated upon for ileal perforation peritonitis, intussusception, and Meckel's diverticulum. Further review revealed that children who were operated on for ileal perforation peritonitis, ileostomies were created mostly in children aged 6 to 12 years (31 of 42), while it was created frequently in infants who underwent operative procedures for intussusception (28 of 40). In the above categories of cases, the reasons for creation of ileostomy were preexisting poor general condition, severe peritonitis, unhealthy bowel, presence of gangrenous bowel, and anastomotic leak. Literature also supports that these factors may necessitate bowel diversion as an ileostomy.[38] The present study also documented that the proportion of creation of temporary ileostomy in children was higher and was attributed to the preexisting poor general condition, operative findings of either of severe peritonitis or bowel gangrene with bowel edema. A retrospective study revealed that laparotomies performed for intussusception in infants of a median age of 6 months found that 24.6% of them required the creation of an ileostomy.[38]

Relaparotomy refers to a repeat abdominal operation performed after the initial abdominal surgery.[40] It can be classified as early vs. late, planned vs. unplanned, and emergency *vs.* elective.[40] In this context, an "early relaparotomy" is defined as one performed within 30 days of the initial operation.[40] Negussie et al in a study, reported that 17.2% of children required relaparotomy within 30 days of their initial laparotomy.[40] Similarly, Seyi-Olajide et al in a review of pediatric laparotomies performed in Nigeria, found that 22.4% required relaparotomy, with intestinal obstruction, postoperative intra-abdominal abscess, wound dehiscence as indications for reoperation.[41] Netsere et al in a systematic review and meta-analysis, found an overall relaparotomy prevalence of 17.36%, with anastomotic leaks, burst abdomen, and peritonitis among the others main indications.[42] In this study, two-thirds (39) of relaparotomies were performed in children younger than 5 years. The main indications for relaparotomies were anastomotic leak (28; 48.27%), burst abdomen or wound dehiscence (18; 31.03%), postoperative small bowel obstruction or adhesion (10; 17.24%), and intra-peritoneal collections (2). Notably, three-fifths (43) of relaparotomies were performed in children who had previously undergone surgery for ileal perforation peritonitis, intussusception, or postoperative bowel obstructions. Anastomotic leakage was found in 28 children and was managed by re-repair of bowel perforation, segmental resection with ileo-ileal anastomosis, or creation of an ileostomy. In 10 children, an ileostomy was created during relaparotomy for various postoperative complications. During reoperation, 18 children required repair of burst abdomen or abdominal wound dehiscence.

In this study, 120 children required ileostomies, of whom 17 died. Bowel continuity was restored in 85% (87) of children with temporary ileostomies through ileostomy closure, ileo-ileal, or ileo-colic anastomosis. Ileostomy closures were performed using absorbable vicryl sutures, preferably with an interrupted, double-layer suturing technique. An intraperitoneal drain was always inserted before closure of abdominal wound. Prerequisite for ileostomy closure included a minimum interval of 2 to 3 months after creation, a distal bowel study such as an ileostogram or cologram, and bowel preparation with normal saline washes for at least two days.

A total of 704 children aged 0 to 12 years were included in this study. Of these, 334 children underwent surgery during study phase I (January 2000 to December 2009), while 370 children were operated on during study phase II (January 2010 to December 2022). Comparative analysis between the two groups revealed a notable increase in the number of children undergoing surgery for acute abdomen in study phase II for several etiologies. The proportion of children who underwent surgery for intussusception (26.34% vs 37.83%), Meckel's diverticulum (7.48% vs 16.48%), congenital abdominal anomalies (6.88% vs 8.91%), Koch's abdomen (4.19% vs 7.02%), and patent vitelline duct (2.69% vs 5.13%) was notably higher in those operated on between January 2010 and December 2022 compared to those operated on between January 2000 to December 2009. However, the percentage of children operated on for ileal perforation peritonitis was significantly lower during study phase II (18.91%) compared to study phase I (34.13%).

Sixty-two (8.8%) children died following laparotomies performed for various abdominal pathologies. More than four-fifths (54; 87.09%) children who died were operated upon for ileal perforation peritonitis, intussusception, and Koch's abdomen. Twenty-six children underwent surgery for ileal perforation peritonitis; their mean age was 8.38±2.8 years, and 16 were boys. Twelve cases involved multiple perforations, seven required ileostomy creation, and four underwent reoperations. Nineteen children who died had been operated on for intussusception; 16 of these had bowel gangrene and necessitating bowel resection, and two required reoperations for postoperative complications. Negussie et al reported a 26.4% mortality rates after relaparotomy in children aged 2 days to 12 years.[40] Birkhold et al in a literature review of children treated for typhoid intestinal perforation, reported a higher mortality attributed to delayed presentation, sepsis, prolonged perforation-to-surgery interval, and additional factors.[43] Similarly, Tayade et al identified multiple factors contributing to higher mortality in children undergoing abdominal procedures for non-traumatic pathologies.[44]

Outcome analysis of mortality across both study phases demonstrated higher mortality rates among cases operated on during study phase I compared to phase II. This reduction in mortality during phase II was observed in the following categories: overall mortality (10.17% vs 7.56%), boys (9.83% vs 6.19%), girls (11.11% vs 10.15%) infants (9.18% vs 3.40%), children aged 2 to 5 years (12.22% vs 11.42%), children operated for intestinal obstruction (7.5% vs 5.85%), perforation peritonitis (14.17% vs 12.14%), Meckel's diverticulum (8.00% vs 1.63%), patent vitelline duct (11.11% vs 5.26%), group A children who did not require ileostomy (7.33% vs 6.13%), and group B children who required ileostomy (21.15% vs 8.82%). However, none of these reductions in mortality rates (above-mentioned categories) between phase I and phase II reached statistical significance, as all p values obtained exceeded 0.05. Therefore, the observed mortality between the two phases were not statistically significant**.** The mortality rate for children who had surgery for intussusception was 14.77% in phase I of the study and dropped to 4.28% in phase II. This drop in mortality during phase II is unlikely to be due to random chance. The p value is lower than the standard alpha threshold of 0.01, indicating high statistical significance. This reduction in mortality during phase II study for above-mentioned case categories is most likely attributed to earlier referral, admission, diagnosis, and surgery, as well as improved patient care, infrastructure, and staffing over time.

Analysis of mortality outcomes across both study phases revealed lower mortality rates among cases operated on during phase I compared to phase II for a few of the categories. This increase in mortality during phase II was noted in the following categories: children aged 6 to 12 years (9.58% vs 11.29%), ileal perforation peritonitis (12.28% vs 17.14%), Koch's abdomen (14.28% vs 26.92%), and group C children who required relaparotomy (17.39% vs 20.0%). The p values obtained for these categories were greater than 0.05, exceeding the standard threshold for statistical significance. Therefore, the observed differences in mortality rates between phase I and phase II were not statistically significant.

Analysis of mortality across both study phases for various surgical techniques revealed that mortality rates were higher in cases operated on during study phase I compared to phase II. This reduction in mortality during phase II was observed for the following surgical techniques: ileo-ileal resection and anastomosis (17.07% vs 7.14%), and ileostomy creation (13.63% vs 9.09%). This study observed increased mortality rates during study phase II in children treated with repair of bowel perforations (14.28% vs 22.22%), adhesiolysis and procedures (3.84% vs 11.53%), and ileo-colic anastomosis (0.0% vs 6.25%). The deference in mortality rates among all surgical techniques for treating children with acute abdomen during the study period were not statistically significant. The p values obtained were greater than the standard threshold of 0.05. Children treated with operative reduction of intussusception had similar mortality rates (3.33% vs 3.33%) in phase I and phase II, and the p value was greater than 0.05, indication no statistical difference in mortality.

Children operated for perforation peritonitis had a significantly higher mortality (36; 13.13%) rate compared to children who underwent operation for intestinal obstruction during the same study period (26; 6.70%). The obtained p=0.0065, is well below the standard threshold, indicating high significance. The risk of mortality is significantly higher in pediatric patients operated on for perforation peritonitis (13.14%) compared to those operated on for intestinal obstruction (6.70%). The above findings indicate the strong probability that children operated on for bowel perforation peritonitis have a higher risk of mortality. Further analysis of mortalities in children assigned to group B (needed-ileostomy creation) revealed a significantly higher mortality rate than those in group A (ileostomy or reoperation not needed). The relative risk of mortality in group B (17; 14.16%) was approximately twice (2.11 times) higher the risk of death compared to children operated in group A (36; 6.71%). The difference in mortality rates between the two groups, with a p=0.0117, which is less than standard threshold, indicating high statistical significance. Analysis of mortality between groups A and group C (needed reoperation) revealed that the relative risk of mortality in group C (9; 18.75%) was 2.79 times higher than the risk of death compared to children operated in group A (36; 6.71%). The p=0.0073, which is less than 0.01, indicating high statistical significance.

Limitations

This study is limited by its retrospective, single-center design and includes children aged 0-12 years who were operated on via open laparotomies for a range of abdominal pathologies. As this study included a range of pathologies and may have bias, in the results. Statistical analysis is limited to numbers, percentages, p values, and a few others. Additionally, the study period spanned 23 years, which may introduce bias/variability in surgical techniques and patient management over time.

CONCLUSION

In pediatric patients, laparotomy performed and ileostomy created for acute abdomen were linked to significant postoperative complications and substantial mortality. This retrospective study found that 17% of children required a diverting ileostomy, primarily those operated on for ileal perforation or intussusception. Mortality was notably higher among children undergoing surgery for bowel perforation/peritonitis, those requiring ileostomy, and those needing reoperation to manage postoperative complications.

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