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Clinical Features, Diagnostic Methods, and Treatment Approaches for Meckel's Diverticulum in Children and Adolescents: Experience of One Center

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Abstract

Background: Meckel's diverticulum is one of the most common congenital anomalies of the gastrointestinal tract, which is often detected in children. This study aims to conduct a comparative analysis of the clinical manifestations of Meckel's diverticulum complications across different pediatric age groups, based on surgical interventions performed at the Emergency Medical Care Center.
Methods and Results: During the period from 2017 to 2024, at the Republican Scientific Center of Emergency Medical Care (RSCEMC), in the Department of Pediatric Emergency Surgery, surgical treatment was provided to 132 children and adolescents aged from 4 months to 18 years with various forms of complicated and uncomplicated Meckel's diverticulum. Taking into account the generally accepted pediatric age classification, the material was divided into three age groups: the infancy-to-toddler group (Group 1), from 4 months to 3 years – 39 (29.5%) children, mean age of 1.47±0.91 years; the early-to-middle childhood group (Group 2), 4–11 years – 64 (48.5%) patients, mean age of 8.6±2.29 years; the adolescence group (Group 3), 12–18 years – 29 (22%) children, mean age of 14.93±1.72 years. The study involved a retrospective analysis of patients' medical records, including clinical, instrumental, and laparoscopic methods.
The clinical manifestation of Meckel's diverticulum varies. In some cases, it mimics acute appendicitis, in others, acute intestinal obstruction, which depends on the patient's age and the time of admission from the onset of the disease. In children aged 0–3 years with gastrointestinal bleeding, Meckel's diverticulum is most often suspected. In children aged 0–3 years, when Meckel's diverticulum is suspected, it is advisable to begin the intervention with laparotomy, which is associated with a high proportion of complicated forms (diverticulitis, necrosis, intussusception). In older children, the choice of surgical access is determined by the clinical picture and the preliminary diagnosis. In children aged 4-11 years, it is more often possible to perform less traumatic interventions; complicated forms are less common; however, the diverticulum is frequently removed simultaneously with the appendix due to a similar clinical presentation. In adolescents aged 12-18 years, laparoscopic and combined interventions predominate, characterized by lower invasiveness; complicated forms are recorded much less frequently. (**International Journal of Biomedicine. 2025;15(4):679-684.**)

Keywords: Meckel's diverticulum • pediatric surgery • acute abdomen • complications

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Introduction

Meckel's diverticulum is a congenital anomaly of the vitelline duct of the ileum.[1,2] First described in 1809 by the German anatomist J. Meckel, it resembles the vermiform appendix in shape. The prevalence of this pathology is about 2–3% in the general population, and it is most frequently identified in children and adolescents.[3] The diverticulum can

present in various forms, but most commonly appears as a protrusion of the ileal wall on the antimesenteric border, with a free communication to the intestinal lumen.[1] The clinical presentation of Meckel's diverticulum can vary widely, ranging from an asymptomatic course to serious complications such as gastrointestinal bleeding, intussusception, Meckelitis (intestinal inflammation), intestinal obstruction, or perforation.[3-5] Therefore, timely diagnosis and appropriate management are crucial in preventing complications of Meckel's diverticulum.

This study aims to conduct a comparative analysis of the clinical manifestations of Meckel's diverticulum complications across different pediatric age groups, based on surgical interventions performed at the Emergency Medical Care Center.

Materials and Methods

During the period from 2017 to 2024, at the Republican Scientific Center of Emergency Medical Care (RSCEMC), in the Department of Pediatric Emergency Surgery, surgical treatment was provided to 132 children and adolescents aged from 4 months to 18 years with various forms of complicated and uncomplicated Meckel's diverticulum. Taking into account the generally accepted pediatric age classification, the material was divided into three age groups: the infancy-to-toddler group (Group 1), from 4 months to 3 years – 39 (29.5%) children, mean age of 1.47±0.91 years; the early-to-middle childhood group (Group 2), 4–11 years – 64 (48.5%) patients, mean age of 8.6±2.29 years; the adolescence group (Group 3), 12–18 years – 29 (22%) children, mean age of 14.93±1.72 years. Among them, boys accounted for 99 (75%), which confirms the higher incidence of this pathology in males, whereas girls accounted for 33 (25%). The study involved a retrospective analysis of patients' medical records, including clinical, instrumental, and laparoscopic methods, and statistical analysis using IBM SPSS Statistics 23, with descriptive statistics applied. Baseline characteristics were summarized as frequencies and percentages for categorical variables. Group comparisons concerning categorical variables were performed using chi-square or Fisher's exact tests. A *P*-value of < 0.05 was considered statistically significant.

Results

According to data from the Statistics Department of the RSCEMC, a total of 107,976 emergency and delayed surgeries were performed from 2017 to 2024, of which 16,095 were performed in the Pediatric Surgery Department (Fig. 1).

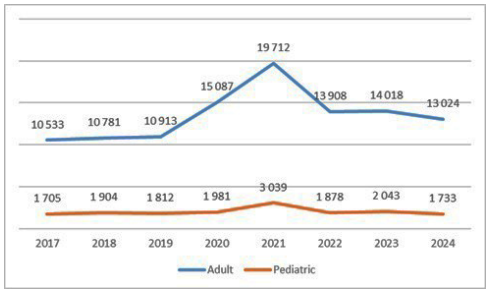

Fig. 1. *Number of surgeries at the RSCEMC in the Department of General Surgery and the Department of Pediatric Surgery for 2017–2024.*

From the analyzed surgical intervention data at the RSCEMC, surgeries performed due to complications of Meckel's diverticulum accounted for 0.82% (Fig. 2).

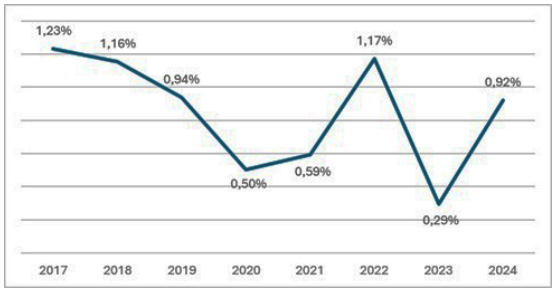

Fig. 2. *Dynamics of surgeries for complications of Meckel's diverticulum in children by year.*

In our series, the clinical presentation of Meckel's diverticulum was nonspecific, and most often patients were admitted under the guise of other acute surgical diseases of the abdominal cavity, including symptoms of complications of an undiagnosed underlying condition (Table 1).

Table 1.

Preoperative diagnosis in patients with Meckel's diverticulum.

Preoperative diagnosis	Group 1 n=39	Group 2 n=64	Group 3 n=29	*P-value*
Meckel's diverticulum			1 (3.4%)	
Bleeding from Meckel's diverticulum	15 (38.5%)	13 (20.3%)	3 (10.3%)	0.018
Acute appendicitis	7 (17.9%)	36 (56.3%)	12 (41.4%)	0.001
Acute intestinal obstruction	13 (33.3%)	9 (14.1%)	12 (41.4%)	0.009
Gastrointestinal bleeding of unknown etiology	2 (5.1%)	2 (3.1%)		>0.05
Peritonitis of unknown etiology		1 (1.6%)	1 (3.4%)	>0.05
Abscess of the abdominal cavity		2 (3.1%)		
Strangulated hernia: (inguinal and umbilical)	2 (5.1%)			
Colon developmental anomaly. Rectal form of Hirschsprung's disease Meckel's diverticulum		1 (1.6%)		

Bleeding from Meckel's diverticulum was found in 38.5%, 20.3% and 10.3% of patients in Groups 1, 2, and 3, respectively. The assumption of bleeding from Meckel's diverticulum was based on the following diagnostic signs: absence of a bleeding source in the large intestine during colonoscopy, absence of pathological changes in the stomach and duodenum on esophagogastroduodenoscopy, and presence of fresh blood in the terminal ileum during ileoscopy. In Group 1, complications of Meckel's diverticulum mainly manifested with symptoms of acute intestinal obstruction (33.3%) and

acute appendicitis (17.9%). In contrast, in Groups 2 and 3, the symptoms of acute appendicitis (56.3% and 41.4%, respectively) predominated over the symptoms of acute intestinal obstruction (14.4% and 41.4%, respectively). This may be explained by the fact that in younger children, Meckel's diverticulum is more often complicated by intussusception or perforation due to the smaller diameter of the ileal lumen, immaturity of the intestinal neuromuscular apparatus, and rapid development of mucosal edema and inflammation. These pathophysiological features contribute to the early onset of mechanical intestinal obstruction. In older age groups, by contrast, the inflammatory process in the diverticulum is more localized, mimicking acute appendicitis clinically. In addition, in older children, compensatory mechanisms of intestinal motility are better developed, and the ability to subjectively describe pain is more pronounced, facilitating differential diagnosis from obstructive forms of the disease.

The surgical approach depended on the preoperative diagnosis. In cases with a precise diagnosis of Meckel's diverticulitis, laparotomy was performed. If there were signs of bleeding, surgery was initiated laparoscopically, or laparotomy was performed. If acute appendicitis was suspected, surgery began with a McBurney incision, either laparoscopy or laparotomy. In the presence of clinical signs of acute intestinal obstruction, laparotomy was performed in most cases. In Group 1, the most common surgical approach for Meckel's diverticulitis was laparotomy (51.3%), compared with 26.6% and 34.5% in Groups 2 and 3, respectively (P=0.039) (Table 2). McBurney's incision was performed in 37.5% of cases in Group 2, and in 17.2% and 12.8% in Groups 3 and 2, respectively (P=0.010). In cases in which the operation was initiated laparoscopically, conversion to laparotomy was required in 28.2% of Group 1, 20.3% of Group 2, and 31.0% of Group 3 (P=0.466). In children under 3 years of age in Group 1, only one case was laparoscopic, in which a simple diverticulectomy was performed.

Table 2.

Surgical approach in the study groups.

Surgical approach	Group 1 n=39	Group 2 n=64	Group 3 n=29	*P-value*
McBurney's incision	5 (12.8%)	24 (37.5%)	5 (17.2%)	0.010
McBurney incision → → Laparotomy		1 (1.6%)		
Laparoscopy	1 (2.6%)	9 (14.1%)	5 (17.2%)	0.107
Laparoscopy → → Laparotomy	11 (28.2%)	13 (20.3%)	9 (31.0%)	0.466
Laparotomy	20 (51.3%)	17 (26.6%)	10 (34.5%)	0.039
Access through a strangulated hernia	2 (5.1%)			

Table 3 shows that in Group 1, the most common operation was laparotomy with diverticulectomy (28.2%), with a high proportion of bowel resection with anastomosis (25.6%) and bowel resection with ileostomy (12.8%), which indicates severe complications (gangrene, perforation, intussusception). Laparoscopy was performed in only 1 case (2.6%). In Group 2, the most frequent operations were laparotomy with diverticulectomy (26.6%) and appendectomy with diverticulectomy through the McBurney approach (28.1%). A smaller number of bowel resections were performed (6.3% with anastomosis, 4.7% with ileostomy). Laparoscopy was used more often than in the younger group (14.1% vs. 2.6%). In Group 3, the most significant proportion of laparoscopic interventions was observed (17.2%). Laparotomy with diverticulectomy accounted for 20.7%, which was lower than in Groups 1 and 2. Bowel resections were less common, but in cases of complications, they were performed both with anastomosis (10.3%) and with ileostomy (13.8%). A greater number of combined operations were noted (for example, appendectomy + diverticulectomy).

Table 3.

Types of operations performed in the study groups.

Operation	Group 1 n=39	Group 2 n=64	Group 3 n=29	*P-value*
McBurney. Appendectomy (diverticulum unchanged)		1 (3.1%)	1 (3.4%)	>0.05
McBurney. Appendectomy. Diverticulectomy	4 (10.3%)	18 (28.1%)	4 (13.8%)	0.056
McBurney. Appendectomy. Bowel resection with anastomosis.	1 (2.6%)	5 (7.8%)		>0.05
Laparoscopy. Diverticulectomy		5 (7.8%)	5 (17.2%)	>0.05
Laparoscopy. Appendectomy. Diverticulectomy.	1 (2.6%)	4 (6.3%)		>0.05
Laparotomy. Diverticulectomy	11 (28.2%)	17 (26.6%)	6 (20.7%)	0.766
Laparotomy. Appendectomy. Diverticulectomy.	3 (7.7)	2 (3.1%)	6 (20.7%)	0.018
Laparotomy. Bowel resection with anastomosis	10 (25.6%)	4 (6.3%)	3 (10.3%)	0.015
Laparotomy. Bowel resection with ileostomy	5 (12.8%)	3 (4.7%)	4 (13.8%)	0.231
Laparotomy. Appendectomy. Bowel resection with anastomosis.		2 (6.3%)		
Laparotomy. Intestinal disinvagination. Diverticulectomy	1 (2.6%)	3 (4.7%)		>0.05
Laparotomy. Diverticulectomy. Abdominoperineal procto-plasty with extraperitoneal resection of the colon with application of end-to-end colon-colonic anastomosis according to Swenson-Hiath-Isakov		1 (6.1%)		
Herniotomy. Diverticulectomy.	2 (5.1%)			

A comparative analysis of surgical interventions in children of different age groups revealed the following:

- Laparotomy with diverticulectomy is the most common operation in all groups, but the proportion decreases with age (28.2% → 26.6% → 20.7%).
- Appendectomy with diverticulectomy through the McBurney approach is more common in the early-to-

middle childhood group (28.1%), less in the infancy-to-toddler group (10.3%), and the adolescence group (13.8%).
•Bowel resection with anastomosis is typical mainly for the infancy-to-toddler group (25.6%) (P=0.015).
•Laparoscopy proportion increases with age (2.6% → 7.8% → 17.2%).

In Group 1, the most common postoperative diagnosis was bleeding from Meckel's diverticulum (38.5%), which confirms the anatomical and physiological features in younger children (thin mucosa, tendency to peptic ulcers) (Table 4). Acute catarrhal Meckel's diverticulum (28.2%), intussusception (7.7%) (Fig. 3), and strangulated intestinal obstruction (7.7%) indicated a severe course of complications. In Group 2, the leading diagnosis was phlegmonous Meckel's diverticulum (20.3%) and gangrenous Meckel's diverticulum (Fig. 4) (18.8%), reflecting more pronounced inflammatory complications. Catarrhal changes were rare (6.3%). Bleeding was detected in 20.3% of patients, a rate lower than in younger children. The incidence of intestinal obstruction decreased sharply, but isolated cases of strangulated intestinal obstruction (1.6%) and obstructive intestinal obstruction (3.1%) were noted. In Group 3, acute catarrhal Meckel's diverticulum (34.5%) (Fig. 5) and adhesive intestinal obstruction (20.7%) were more common, which were absent in the younger groups. Gangrenous Meckel's diverticulum was noted in 13.8% of adolescents, which was lower than in the early-to-middle childhood group. No bleeding was recorded in this group.

Table 4.

Postoperative diagnosis in the study groups.

Postoperative diagnosis	Group 1 n=39	Group 2 n=64	Group 3 n=29	*P-value*
Acute catarrhal Meckel's diverticulum	11 (28.2%)	4 (6.3%)	10 (34.5%)	0.001
Phlegmonous Meckel's diverticulum	4 (10.3%)	13 (20.3%)	2 (6.9%)	0.158
Gangrenous Meckel's diverticulum		12 (18.8%)	4 (13.8%)	0.558
Simple (unchanged) Meckel's diverticulum	6 (15.4%)	13 (20.3%)	9 (31.0%)	0.287
Acute appendicitis	9 (23.1%)	33(51.6%)	11 (37.9%)	0.016
Strangulated intestinal obstruction	3 (7.7%)	1 (1.6%)	4 (13.8%)	0.064
Obstructive intestinal obstruction	1 (2.6%)	2 (3.1%)		
Adhesive intestinal obstruction			6 (20.7%)	
Intussusception	3 (7.7%)	2 (3.1%)	1 (3.4%)	0.530
Meckel's diverticulum bleeding	15 (38.5%)	13 (20.3%)		0.045

A comparative analysis of postoperative diagnosis in children of different age groups revealed the following:

•Bleeding from Meckel's diverticulum is characteristic predominantly of the infancy-to-toddler group (38.5%), whereas it does not occur in the adolescence group (P=0.045).
•Phlegmonous and gangrenous forms were more frequently diagnosed in the early-to-middle childhood group (20.3% and 18.8%, respectively), confirming the age-related features of the inflammatory response.
•Acute catarrhal Meckel's diverticulum predominated in the infancy-to-toddler group (28.2%) and adolescence group (34.5%), but it was less common in the early-to-middle childhood group (6.3%) (P=0.001)
•Intestinal obstruction in the infancy-to-toddler group was represented by strangulation/intussusception (7.7%/2.6%), while in the adolescence group, adhesive intestinal obstruction was predominant (20.7%), indicating different mechanisms of complications.
•A simple (unchanged) diverticulum was found in all groups (15.4% in Group 1, 20.3% in Group 2, 31.0% in Group 3), without statistically significant differences.

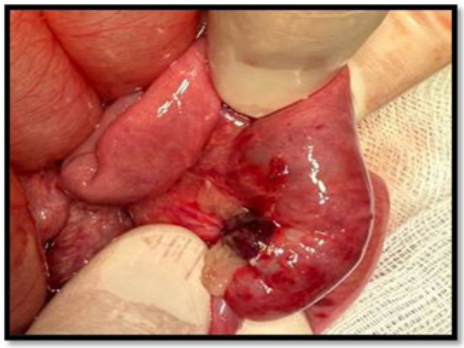

Fig. 3. *Intussusception of Meckel's diverticulum.*

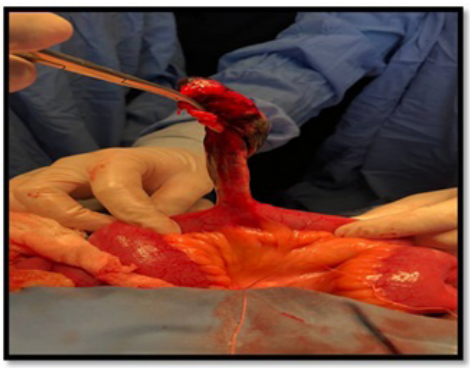

Fig. 4. *Gangrenous form of Meckel's diverticulitis.*

Fig. 5. *Catarrhal form of Meckel's diverticulitis.*

Discussion

According to several authors,[6,7] in children aged 0–3 years, performing a complete examination and establishing an accurate diagnosis in cases of "acute abdomen" is difficult. This is associated with the nonspecific nature of the clinical picture, the inability to fully communicate with the child, the rapid development of complications, and challenges in interpreting instrumental data due to the anatomical and physiological characteristics of the pediatric organism. Meckel's diverticulum often manifests only with signs of acute intestinal obstruction or internal bleeding, which significantly complicates differential diagnosis. Since preoperative diagnosis is virtually impossible, children frequently present to emergency surgical departments with suspected acute abdominal pathology. Indications for surgery most commonly include complicated forms of the diverticulum, such as inflammation mimicking appendicitis, gastrointestinal bleeding of unknown origin, the presence of free intraperitoneal air due to perforation, or intestinal obstruction.

In children aged 0–3 years, the preoperative diagnosis of Meckel's diverticulum coincided with the intraoperative finding in only 38.5% of cases. Almost always, this was associated with the presence of gastrointestinal bleeding, which prompted surgeons to suspect this pathology. In other cases, the clinical picture mimicked other acute surgical diseases of the abdominal cavity — primarily acute intestinal obstruction (33.3%) and acute appendicitis (17.9%). This confirms that in children of the infancy-to-toddler group, complicated forms of the diverticulum prevail, often requiring emergency bowel resection or ileostomy formation. Similar data are presented in a study by St-Vil et al.[8] In children under 4 years, intestinal obstruction, bleeding, and intussusception predominated, requiring more radical interventions.[8] In our study, the infancy-to-toddler group also showed a severe course and a high frequency of resections.

In adolescents (12–18 years), the concordance between the preoperative diagnosis and intraoperative findings was 13.7%. Despite the formally lower percentage, clinical diagnosis in this group was facilitated by clearer symptomatology, the possibility of using an extended set of instrumental methods (ultrasound, CT, laparoscopy), and a complete medical history. For this age group, the predominance of acute appendicitis (41.4%) and intestinal obstruction (41.4%) was characteristic, which allowed for a more targeted choice of surgical access already at the planning stage. At the same time, an increase in the proportion of laparoscopic interventions (up to 17.2%) was noted, which coincides with the conclusions of Shalaby et al.,[9] who demonstrated that laparoscopy for Meckel's diverticulum in children is safe, effective, and provides accurate diagnosis and treatment with minimal trauma and rapid recovery. Similarly, St-Vil et al.[8] noted that, in adolescents, less complex forms were more common, and laparoscopic access was used more frequently—a pattern that aligns fully with our results for Group 3.

Special attention should be given to the early-to-middle childhood group (4–11 years), where the concordance between preoperative and intraoperative diagnoses was observed in 20.3% of cases. In this cohort, the clinical picture most often resembled acute appendicitis (more than 50%), which explains the high percentage of combined interventions — removal of Meckel's diverticulum together with the appendix. Such a tactic allows the simultaneous elimination of both potential sources of inflammation and pain, reducing the risk of future repeat operations. This finding is consistent with data from a monographic review by Nissen et al.,[10] which indicated that in 62% of patients, the diagnosis was established before age 5, with obstruction (41%) and bleeding (27%) predominating. In older age groups, severe manifestations were less common, as evidenced in our study: in Group 1, bleeding and complications predominated, whereas in Groups 2 and 3, the proportion of severe forms was significantly lower.

Thus, the obtained data convincingly demonstrate that the patient's age decisively influences the clinical course and diagnostic accuracy in Meckel's diverticulum. In younger children, the disease predominantly presents in a complicated form, which complicates preoperative diagnosis and requires a more aggressive surgical approach (resections, open interventions). In adolescents, the proportion of laparoscopic and combined interventions increases, and preoperative diagnosis becomes more accurate as instrumental capabilities expand. The presented patterns are entirely consistent with the results of St-Vil et al., Shalaby et al., and Nissen et al.,[8-10] which confirm the reliability and reproducibility of our observations.

Conclusions

- The clinical manifestation of Meckel's diverticulum varies. In some cases, it mimics acute appendicitis, in others, acute intestinal obstruction, which depends on the patient's age and the time of admission from the onset of the disease.
- In children aged 0–3 years with gastrointestinal bleeding, Meckel's diverticulum is most often suspected.
- In children aged 0–3 years, when Meckel's diverticulum is suspected, it is advisable to begin the intervention with laparotomy. In contrast, in older children, the choice of surgical access is determined by the clinical picture and the preliminary diagnosis.
- In children aged 0–3 years, open surgeries predominate, which is associated with the high proportion of complicated forms (diverticulitis, necrosis, intussusception).
- In children aged 4-11 years, it is more often possible to perform less traumatic interventions; complicated forms are less common; however, the diverticulum is frequently removed simultaneously with the appendix due to a similar clinical presentation.
- In adolescents aged 12-18 years, laparoscopic and combined interventions predominate, characterized by lower invasiveness; complicated forms are recorded much less frequently.

Ethical Approval

This study was approved by the Ministry of Health of the Republic of Uzbekistan Ethical Committee (Approval No. 4/11-1878, dated 01.11.2025).

Competing Interests

The authors declare that they have no financial/ commercial conflicts of interest concerning this article.

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