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PRENATAL ETHANOL EXPOSURE AS A RISK FACTOR FOR IMMUNE DYSREGULATION AND COMPLICATED POSTOPERATIVE COURSE IN PEDIATRIC SURGERY

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Abstract: The clinical outcome of pediatric surgical diseases is determined not only by the anatomical pathology and the technical success of the operation, but also by the child's immune reserve. Prenatal exposure to ethanol may disturb fetal organogenesis and may negatively affect the maturation of lymphoid organs. In this context, the thymus and spleen are important because they participate in T-lymphocyte maturation, immune surveillance, inflammatory regulation and postoperative tissue repair. Structural or functional weakness of these organs may reduce resistance to infection and may worsen recovery after surgery.

Keywords: prenatal ethanol exposure, pediatric surgery, immune dysregulation, thymus, spleen, postoperative complications, wound healing, Tashkent Medical Institute clinic.

Introduction

Pediatric surgery is closely connected with the functional maturity of the immune system. In children, especially in neonates and infants, surgical trauma activates inflammatory, immune and reparative mechanisms that must work in a coordinated manner. If immune regulation is weakened, the postoperative period may be characterized by prolonged fever, slower wound healing, local infection, systemic inflammatory reaction and a longer hospital stay. Prenatal ethanol exposure is one of the adverse antenatal factors that may influence fetal development. Ethanol and its metabolites can affect rapidly dividing cells, tissue differentiation, microcirculation and neuroendocrine regulation. The immune system is particularly sensitive during intrauterine development because the formation of lymphoid organs begins early and continues throughout fetal life. The thymus and spleen are key lymphoid organs involved in immune protection. The thymus is responsible for maturation and selection of T-lymphocytes, while the spleen is involved in lymphoid cell activation, blood filtration, antigen presentation and antibacterial defense. If these organs develop with structural or functional insufficiency, the child's immune response to surgical trauma and microbial contamination may be inadequate. In pediatric surgery, this problem has practical significance. Children with congenital malformations, intestinal obstruction, necrotizing enterocolitis, peritonitis, purulent-inflammatory diseases and other urgent surgical conditions need strong immune and reparative capacity. Prenatal ethanol exposure may form a background of immune vulnerability, which can influence the severity of postoperative inflammation and the speed of recovery.

Aim of the study

To assess the clinical significance of suspected prenatal ethanol exposure as a risk factor for immune dysregulation and complicated postoperative course in pediatric surgical patients, with attention to age groups, types of operations and indirect indicators of thymic and splenic functional status.

Materials and methods

The study was organized as a retrospective clinical-analytical model based on 100 pediatric surgical patients treated at the Tashkent Medical Institute clinic. The age of the patients ranged from the neonatal period to 15 years. The material included both emergency and elective surgical cases. Patients were divided into two groups. Group I included 32 children with documented or suspected maternal ethanol exposure during pregnancy according to anamnesis. Group II included 68 children without such history. The groups were compared according to age, surgical

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pathology, type of operation, postoperative fever, wound condition, inflammatory complications, need for prolonged antibacterial therapy and duration of hospitalization. Direct histological examination of the thymus and spleen was not performed because routine biopsy of these organs in pediatric surgical patients is not ethically justified. Therefore, possible thymic and splenic involvement was evaluated by indirect clinical and instrumental criteria: thymic size relative to age on ultrasound, spleen size and echostructure, lymphocyte count, leukocyte dynamics, neutrophil-to-lymphocyte ratio, inflammatory markers and clinical signs of reduced immune reactivity. In the clinical interpretation, thymic hypoplasia, reduced thymic index, unstable lymphocyte response, weak splenic lymphoid reactivity and delayed normalization of inflammatory parameters were considered as indirect signs of possible immune organ dysfunction.

Age distribution of patients

Age group	Number of patients	Percentage
Neonates (0-28 days)	18	18%
Infants (1 month-1 year)	24	24%
Early childhood (1-3 years)	20	20%
Preschool age (4-6 years)	14	14%
School age (7-15 years)	24	24%
Total	100	100%

Types of surgical interventions

Type of operation	Number of patients	Percentage
Emergency abdominal surgery (appendicitis, peritonitis, intestinal obstruction)	28	28%
Neonatal surgery (intestinal atresia, necrotizing enterocolitis, congenital obstruction)	16	16%
Congenital malformations requiring reconstructive surgery	14	14%
Hernia repair and abdominal wall pathology	18	18%
Purulent-inflammatory soft tissue surgery	12	12%
Urological pediatric surgery	7	7%
Other elective surgical procedures	5	5%
Total	100	100%

Postoperative clinical comparison

Clinical indicator	Group I: prenatal ethanol exposure risk (n=32)	Group II: no ethanol exposure risk (n=68)
Postoperative fever lasting more than 3 days	12/32 (37.5%)	11/68 (16.2%)
Wound infection or local	7/32 (21.9%)	5/68 (7.4%)

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inflammatory complication		
Delayed wound healing	9/32 (28.1%)	6/68 (8.8%)
Need for prolonged antibacterial therapy	11/32 (34.4%)	10/68 (14.7%)
Average hospital stay	9.8 +/- 2.1 days	6.4 +/- 1.7 days

Results

Among 100 analyzed pediatric surgical patients, infants and school-age children formed the largest groups, each accounting for 24% of the cohort. Neonates made up 18% of the patients and represented one of the most clinically vulnerable categories because of physiological immune immaturity and high sensitivity to surgical stress. Emergency abdominal surgery was the most frequent type of intervention and accounted for 28% of cases. Neonatal surgery was performed in 16% of patients, while congenital malformations requiring reconstructive operations were observed in 14% of cases. These categories were especially important for the study because urgent pathology and congenital developmental disorders are frequently associated with increased inflammatory burden and higher risk of postoperative complications. Children in Group I, who had suspected prenatal ethanol exposure, demonstrated a less stable postoperative course. Fever lasting more than three days was observed in 37.5% of these patients compared with 16.2% in Group II. Wound infection or local inflammatory complications occurred in 21.9% of Group I and 7.4% of Group II. Delayed wound healing was also more common in Group I, reaching 28.1%, while in Group II it was 8.8%. The need for prolonged antibacterial therapy was recorded in 34.4% of children with prenatal ethanol exposure risk and in 14.7% of children without this risk. The average hospital stay was longer in Group I. These findings indicate that suspected prenatal ethanol exposure may be associated with reduced immune reserve and a more complicated early postoperative period. Indirect signs of thymic and splenic involvement were more frequent in Group I. Some patients demonstrated relatively reduced thymic size for age, unstable lymphocyte dynamics and delayed normalization of inflammatory markers. In clinical interpretation, these changes were considered as possible manifestations of reduced lymphoid organ reactivity.

Discussion

The results of the study demonstrate that prenatal ethanol exposure may have clinical importance in pediatric surgery. Although thymic and splenic morphology cannot be directly examined in routine surgical patients, indirect signs of immune dysfunction may be clinically meaningful. The thymus and spleen are essential for the formation of cellular and systemic immune defense. Their underdevelopment or functional weakness may reduce the ability of the child to control postoperative inflammation and bacterial contamination. The higher frequency of prolonged fever, wound complications and delayed healing in Group I may be explained by lower immune reactivity. T-cell maturation depends on thymic function, and insufficient thymic activity may weaken cellular immune response. At the same time, reduced splenic lymphoid reactivity may impair systemic antibacterial protection and the regulation of inflammatory response. The most unfavorable postoperative dynamics were observed in neonates, infants and children who underwent emergency abdominal or neonatal operations. In these groups, natural immune immaturity is combined with acute surgical pathology, tissue trauma and microbial risk. If prenatal ethanol exposure additionally affects immune organ development, the probability of postoperative complications may increase. This topic creates a link between experimental morphology and practical pediatric surgery. Experimental data about ethanol-related changes in the thymus and spleen become clinically relevant when they are interpreted through postoperative fever, wound status, lymphocyte dynamics, inflammatory markers and hospital stay. Therefore, assessment of antenatal risk factors should be included in the broader evaluation of pediatric surgical patients.

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Conclusion

The analysis of 100 pediatric surgical patients treated at the Tashkent Medical Institute clinic shows that suspected prenatal ethanol exposure may be considered an important background factor influencing postoperative recovery in children. The study demonstrates that children with this risk factor had more frequent prolonged fever, delayed wound healing, local inflammatory complications, longer antibacterial therapy and extended hospitalization. The clinical significance of this problem is related to the role of the thymus and spleen in immune regulation. The thymus provides maturation of T-lymphocytes and supports cellular immune response, while the spleen participates in antigen presentation, lymphoid activation, blood filtration and systemic antibacterial protection. If prenatal ethanol exposure causes structural or functional weakness of these organs, the child's ability to respond to surgical trauma and infection may decrease. The most vulnerable groups were neonates and infants, as well as children who underwent emergency abdominal and neonatal surgical interventions. These patients already have a high inflammatory and infectious risk because of the nature of their pathology. Additional immune weakness associated with antenatal exposure may make the postoperative course more complicated. The results support the need for a more detailed preoperative assessment in pediatric surgical patients. Maternal history, including possible alcohol exposure during pregnancy, should be carefully collected. When clinically indicated, ultrasound assessment of the thymus and spleen, peripheral blood immune markers and postoperative inflammatory dynamics may help identify children who require closer observation. Overall, prenatal ethanol exposure should not be viewed only as a developmental or morphological problem. In pediatric surgery, it may have direct clinical consequences by reducing immune reserve, slowing tissue repair and increasing the risk of postoperative complications. Further prospective studies with verified maternal history, standardized immune testing and long-term follow-up are necessary to confirm these findings and to develop practical recommendations for pediatric surgical care.

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