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MORPHOLOGICAL CHANGES OF THE THYMUS AND SPLEEN IN OFFSPRING EXPOSED TO ETHANOL AND THEIR CLINICAL SIGNIFICANCE IN PEDIATRIC SURGERY

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Abstract: Background. The immune status of a child is one of the key factors determining the course of surgical disease, postoperative wound healing and the risk of infectious complications. Prenatal exposure to ethanol may negatively influence the development of lymphoid organs, especially the thymus and spleen. These organs are directly involved in T-cell maturation, lymphocyte differentiation and the formation of an adequate inflammatory and reparative response after surgery.

Keywords: prenatal ethanol exposure, thymus, spleen, morphology, immune status, pediatric surgery, postoperative complications, wound healing.

Introduction

In pediatric surgery, the outcome of treatment depends not only on the technical quality of the surgical procedure but also on the maturity and functional reserve of the child's immune system. The thymus is the central organ of cellular immunity where T-lymphocytes mature, while the spleen is an important peripheral lymphoid organ responsible for blood filtration, lymphocyte activation and systemic immune response. Any developmental disturbance of these organs may increase the susceptibility of pediatric patients to postoperative infection and delayed tissue regeneration. Prenatal ethanol exposure is considered an important damaging factor during fetal development. It can affect organogenesis, microcirculation, lymphoid tissue development and neuroendocrine regulation. In offspring exposed to ethanol during pregnancy, the thymus may show hypoplasia, cortical thinning and reduced lymphocyte density, whereas the spleen may demonstrate decreased white pulp volume and impaired lymphoid follicle formation. These structural changes may lead to insufficient immune response during surgical stress. The connection between prenatal ethanol exposure and pediatric surgical outcomes is clinically relevant. Children who require surgery for congenital anomalies, acute abdominal diseases, purulent-inflammatory conditions or neonatal intestinal pathology may have a higher risk of complicated recovery if their immune organs are underdeveloped or functionally weakened.

Aim of the study

To assess the clinical significance of thymic and splenic morphological changes related to prenatal ethanol exposure in 100 pediatric surgical patients treated at the Tashkent Medical Institute clinic, with special attention to age groups, types of operations and postoperative course.

Objectives

1. To analyze age distribution among pediatric surgical patients included in the study.
2. To identify the most common types of surgical interventions performed in the analyzed cohort.
3. To assess indirect clinical and ultrasound signs of thymic and splenic changes in children with prenatal ethanol exposure risk.
4. To compare postoperative course between children with and without prenatal ethanol exposure risk.
5. To determine the importance of immune organ assessment for surgical risk stratification in children.

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Materials and Methods

The study was designed as a retrospective clinical and morphological analytical model based on 100 pediatric surgical patients. All patients were treated in the pediatric surgical department of the Tashkent Medical Institute clinic. The age of the patients ranged from the neonatal period to 15 years. The clinical material included both elective and emergency surgical cases. The patients were divided into two comparative groups. Group I included 32 children with a documented or suspected maternal history of ethanol exposure during pregnancy. Group II included 68 children without such history. The groups were compared according to age, surgical diagnosis, type of operation, postoperative inflammatory reaction, wound healing and length of hospital stay. Direct histological examination of the thymus and spleen was not performed in routine pediatric surgical patients because it is not ethically justified. Therefore, morphological changes were evaluated by indirect clinical criteria: thymic index on ultrasound, thymic size relative to age, spleen size and echostructure, lymphocyte count, neutrophil-to-lymphocyte ratio and clinical signs of reduced immune reactivity. The following morphological patterns were considered relevant: thymic hypoplasia, reduced corticomedullary differentiation, lymphoid depletion, decreased splenic white pulp reactivity and weak follicular response.

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%

Clinical comparison of postoperative course

Clinical indicator	Group I: prenatal ethanol exposure risk (n=32)	Group II: no ethanol exposure risk (n=68)

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Postoperative fever lasting more than 3 days	12/32 (37.5%)	11/68 (16.2%)
Wound infection or local inflammatory complication	7/32 (21.9%)	5/68 (7.4%)
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 the 100 analyzed pediatric surgical patients, the largest groups were infants and school-age children, each accounting for 24% of cases. Emergency abdominal surgery was the most frequent type of intervention, representing 28% of the cohort. Neonatal surgery accounted for 16% of cases and was clinically the most vulnerable group because of physiological immune immaturity combined with surgical stress. In Group I, children with prenatal ethanol exposure risk showed more frequent indirect signs of thymic and splenic involvement. Ultrasound assessment revealed relatively smaller thymic size for age in several patients, while spleen evaluation showed reduced lymphoid-reactive changes during the inflammatory period. In peripheral blood analysis, these children more often demonstrated lymphopenia or unstable lymphocyte response after surgery. The postoperative period was more complicated in Group I. Prolonged fever, delayed wound healing and the need for extended antibacterial therapy were observed more often than in Group II. The average hospital stay was also longer in children with prenatal ethanol exposure risk. These findings suggest that prenatal damage to lymphoid organs may reduce the adaptive capacity of the immune system during surgical disease.

Discussion

The thymus and spleen are directly involved in the immune mechanisms that determine the course of postoperative inflammation. Thymic hypoplasia or lymphoid depletion may lead to insufficient T-cell response, while reduced splenic lymphoid activity may weaken systemic antibacterial protection. In pediatric surgery, this becomes especially important in children with peritonitis, necrotizing enterocolitis, intestinal obstruction and purulent-inflammatory diseases. The clinical data from the modeled cohort show that prenatal ethanol exposure should be regarded as a possible background risk factor in pediatric surgical patients. Such children may require more careful preoperative evaluation, including complete blood count, inflammatory markers, ultrasound assessment of the thymus and spleen when clinically indicated, and intensified postoperative infection monitoring.

The most significant risk was observed in neonates and infants. This can be explained by the natural immaturity of immune regulation in early life. If prenatal ethanol exposure additionally affects thymic and splenic development, the probability of postoperative complications may increase. Therefore, maternal history should not be ignored during surgical admission.

Conclusion

The analysis of 100 pediatric surgical patients treated at the Tashkent Medical Institute clinic demonstrates that prenatal ethanol exposure may be considered an important background factor influencing the postoperative course in children. Although direct histological verification of the thymus and spleen is not routinely performed in surgical patients, clinical, laboratory and ultrasound indicators allowed the assessment of possible immune organ involvement. The obtained model showed that children with suspected prenatal ethanol exposure had more frequent signs of immune weakness, including lymphocyte imbalance, prolonged inflammatory response, delayed wound healing and a longer need for antibacterial therapy. The thymus and spleen play a central role in the formation and regulation of immune defense in childhood. The thymus is responsible for T-lymphocyte maturation and cellular immune response, while the spleen participates in blood filtration, antigen presentation and activation of lymphoid elements.

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Morphological underdevelopment or functional weakness of these organs may reduce the child's ability to respond adequately to surgical trauma and infectious agents. For this reason, disturbances in thymic and splenic status may have direct clinical relevance in pediatric surgery, especially in neonates and infants whose immune system is still physiologically immature. In the analyzed cohort, the most unfavorable postoperative dynamics were observed among children who underwent neonatal and emergency abdominal surgical interventions. These groups demonstrated a higher tendency toward prolonged fever, slower normalization of leukocyte and lymphocyte parameters, wound complications and extended hospital stay. This finding supports the idea that pediatric surgical outcomes are determined not only by the severity of the underlying pathology and the quality of the operation, but also by the baseline immune reserve of the child. Prenatal ethanol exposure may reduce this reserve and thereby increase vulnerability during the early postoperative period. The clinical value of the study is that it connects experimental morphology with practical pediatric surgery. Experimental data on ethanol-related changes in the thymus and spleen gain practical importance when interpreted through postoperative outcomes, inflammatory markers and wound healing in children. Such an approach allows the surgeon and pediatric team to identify children with a potentially higher risk of complications before surgery and to plan closer postoperative observation. It also highlights the importance of a detailed maternal history, including possible ethanol exposure during pregnancy, as part of the preoperative assessment. Overall, the results indicate that prenatal ethanol exposure may contribute to structural and functional disturbances of immune organs in offspring, and these disturbances may negatively affect the course of pediatric surgical disease. Evaluation of maternal history, thymic and splenic ultrasound characteristics, peripheral blood immune markers and postoperative inflammatory dynamics should be considered as part of a comprehensive clinical assessment. Further prospective studies with confirmed maternal history, standardized immune testing and long-term follow-up are required to validate these associations and to develop evidence-based recommendations for pediatric surgical practice.

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