Original Article

The lead content in biological media term infants with hypoxic-ischemic CNS

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Abstract:

Introduction: The frequency of births of infants with perinatal pathology has increased in recent years. The aim of this study is to determination of lead content in the biomedias of newborns with hypoxic-ischemic damage of the central nervous system (CNS). ***Materials and Methods:*** We studied influence of the lead content in children, which were born with hypoxic-ischemic lesion CNS (HIL CNS). Determination of this microelement was carried out in the blood serum, erythrocytes and urine of 30 newborn infants which were suffered from asphyxia after birth. The comparison group consisted of 30 healthy full-term newborns. ***Results****:* In the biomedias of children with the HIL of the central nervous system, a toxic trace element of lead has been identified which is poorly retained in the placenta, so the fetus is more vulnerable to its toxic effects in the prenatal period. In the article the features of the lead content in serum, erythrocytes and urine in term infants which were born with hypoxic-ischemic CNS lesions are investigated. This group of subjects had increased serum and erythrocyte concentration of lead. The high content of lead in the erythrocytes of children with hypoxia which is already at birth may indicate a transplacental penetration of this toxic trace element and the possibility of its negative impact on the course of pregnancy. ***Conclusions*****:** The prognostic significance of the lead content was high. Thus, the informative index ($\bar{I}$) for lead content in serum is 7.40, and the prognostic factor (PC) is + 15.1. As for the prognostic value of the lead content in erythrocytes and urine, very high predictor properties are established for them: $\bar{I}$ = 7.44; PC = + 7.0 and $\bar{I}$ = 13.42; PC = + 16.1 respectively.

Keywords: lead; hypoxia; full-term newborn.

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Introduction:

Hypoxic-ischemic lesions of the central nervous system today remain one of the most actual medical and social problem of modern neonatology and neurology. This is due to both the progressive increase in the rate of cerebral disorders among newborns (80%), high mortality rate of infants with this CNS pathology, and high incidence of cases in the structure of childhood disability[1-2] The influence of lead on postnatal development takes a special place[3].

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Worsening of the ecological situation in modern conditions leads to an increase in the body's load of toxic substances, including hard metals, which lead to the depletion of adaptation reactions of the fetoplacental system and perinatal pathology[3]. In turn, newborns with perinatal pathology have a high risk of metabolic disturbances[4].

In the case of the action of hard metals, the process of lipid peroxidation (LPO) is disrupted and an excessive amount of lipid peroxide is formed, which has the property of damaging cellular membranes. Free radicals formed during the activation of LPO change the chemical composition, physical properties, permeability and structure of biological membranes.

Lead is one of the most toxic and dangerous hard metals and is included in the list of priority pollutants of the environment[5].

Lead has the ability to penetrate the blood-brain barrier and significant gastrointestinal absorption, so newborns are among the most susceptible to contamination of this trace element population share[6]. The level of lead in serum refers to indicators of short-term interaction[7].

Thus, the study of role lead in the development of HIL CNS and the emergence of its long-term effects is very promising.

Purpose of the study:

Determination of lead content in the biomedias of newborns with hypoxic-ischemic involvement of the central nervous system (CNS).

Materials and Methods: The lead in the serum, erythrocytes of blood and urine of 30 newborns with HIL of the central nervous system was determined. All newborns diagnosed with HIL of the CNS were born in a state of asphyxia and responded to the developed inclusion criteria: according to order No. 225 of the Ministry of Health of Ukraine "Initial, resuscitative and post-reanimation care for newborns in Ukraine" of 28.03.2014 and ICD-10. To objectify the clinical signs of perinatal CNS damage and to observe the transformation of the observed structural cerebral disorders, all neonates underwent neurosonography and dopplerography. The gestational age of the examinees was 38 or more weeks.

To determine the Pb content in biosubstrates, the atomic absorption spectrophotometry method was used on a S-115M1 spectrophotometer manufactured by the Selmi NGO (Ukraine) equipped with a computer attachment for automatic calculation of the ME content.

Statistical processing of the research results was carried out with the help of the programs "Statistica" and "Exel". Methods of variational statistics, suitable for biomedical research, were used. To determine the predictor properties of lead, a non-uniform Wald-Genkin procedure was used[9].

Ethical approval: This study was approved by the Ethics Committee of Sumy State University, Ukraine.

Results:

The lead content in cord blood serum of healthy full-term newborns was 0.11 ± 0.01 μmol / L, while in erythrocytes its content reached the level of 0.26 ± 0.024 μg / mg ash. In the neonatal period, the indices of its content in the blood serum tended to increase, and in erythrocytes - to a decrease (Table 1).

When studying the concentration of lead in the serum of children with HIL of the central nervous system, it was found that its level on the 7th day of life exceeded that in healthy full-term newborns by 2.7 times ($p < 0.05$).

Table 1: The lead content in biological media term infants with hypoxic-ischemic CNS

Pathology	Age	Serum, μmol / l	Erythrocytes, mcg / mg popel	Urine,μmol / l
Healthy full-term newborns	At birth	0,11□ 0,01 n=30 CI 0,08-0,12	0,26□ 0,024 n=30 CI 0,2-0,30	0,112±0,01 n=20 CI 0,092-0,132
	7th day	0,14±0,03 n=5 CI 0,08-0,20	0,25±0,024 n=5 CI 0,2-0,30	0,128±0,02 n=16 CI 0,088-0,168
	1 month	0,16±0,02 n=5 CI 0,12-0,20	0,24±0,02 n=5 CI 0,2-0,28	0,134±0,02 n=15 CI 0,094-0,174
HIL CNS	At birth	0,26□ 0,02 n=30 p***	0,41□ 0,04 n=30 p***	0,085±0,002 n=30 p*
	7th day	0,38±0,02 n=28 p***	0,46±0,003 n=28 p***	0,086±0,002 n=28 p***
	1 month	0,46±0,03 n=26 p***	0,51±0,003 n=26 p***	0,089±0,001 n=26 p*

Note. p - reliability of indicators relative to the healthy full-term newborns. * - $p < 0.05$; ** - $p < 0.01$; *** - $p < 0.001$.

Given the ability of this element to penetrate the placenta and cause hypoxia, it is possible to foresee a high lead content in children with a central nervous system. By the end of the first month of life, all groups of children retained the changes established at the end of the early neonatal period.

Discussion

So, a high level of lead in the blood serum testifies to the possible role of this toxic trace element in the pathogenesis of hypoxia.

The biomarker of the effect of excess lead is its content in erythrocytes, which increases in proportion to the accumulation of this toxic metal in soft tissues, and reflects the presence of prolonged contact with this trace element[7,8,10].

It was established that all newborns with hypoxia on the 7th day of life had a high lead content in red blood cells, which was 1.9 times higher than that of healthy full-term newborns (Table 1). During the neonatal period, for all children with HIL of the central nervous system, the tendency to increase the saturation of red blood cells of lead was characteristic, while in healthy children its erythrocyte level remained constant.

The high content of lead in blood erythrocytes of children with hypoxia, which is already present at birth, indicates a transplacental penetration of this toxic trace element and the possibility of its negative impact on the course of pregnancy. The stable content of this trace element in erythrocytes during the neonatal period may indicate continuation of its entry into the body of the child after birth.

During the neonatal period, the concentration of lead in the urine of the healthy full-term newborns tended to increase (0.112 ± 0.01 μmol / L and 0.134 ± 0.02 μmol / L for the first day and 1 month of life, respectively).

In term infants with HIL of the central nervous system, the concentration of lead in urine was 1.3 times lower in the first day of life than in the comparison group. At the end of the first month of life, the concentration of this trace element in the urine of these children was lower by 32.8%. In newborns with HIL of the central nervous system compared with the control group, the loss of lead in the urine in the first day of life was 1.15 times less (Table 1).

With the help of two-factor analysis of variance, a high dependence of changes in the level of lead in serum, red blood cells and urine of newborns with HIL of the central nervous system on the degree of hypoxia was established. The strength of this factor is 69.6% ($p \leq 0.05$), 74.5% ($p \leq 0.05$) and 81.2% ($p \leq 0.05$), respectively.

Thus, for newborns with hypoxia, a high content of lead in the serum and red blood cells is inherent. In the urine of newborns with HIL of the central nervous system a slight elimination of this toxic trace element through the kidneys throughout the neonatal period. These violations can lead to the accumulation of this toxic element, causing the formation of various diseases and affects the physical and psychomotor development of children.

The prognostic significance of the lead content was high. Thus, the informative index ($\bar{I}$) for lead content in serum is 7.40, and the prognostic factor (PC) is + 15.1. As for the prognostic value of the lead content in erythrocytes and urine, very high predictor properties are established for them: $\bar{I}$ = 7.44; PC = + 7.0 and $\bar{I}$ = 13.42; PC = + 16.1 respectively.

Conclusions

The high content of lead in the erythrocytes of children with hypoxia, already at birth, indicated a transplacental penetration of this toxic trace element and the possibility of its negative impact on the course of pregnancy. In the urine of newborns with HIL of the central nervous system is a slight elimination of lead through the kidneys throughout the neonatal period. These violations can lead to the cumulation of these toxic elements, cause the formation of various diseases and affect the physical and psychomotor development of children. To maintain lead in serum, red blood cells and urine, very high predictor properties were established: $\bar{I}$ = 7,40; PC = + 15.1; $\bar{I}$ = 7.44; PC = +7.0 and $\bar{I}$ = 13.42; PC = + 16.1 respectively.

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