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Pneumonia in Children with Vitamin D Deficiency

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Abstract. This article discusses the course of pneumonia in children with vitamin D deficiency. In the article, newborn children and their mothers are taken as examples

Keywords: vitamin D, pneumonia, inflammatory and infectious diseases, newborns.

Introduction

Vitamin D is a steroid hormone necessary for calcium metabolism and homeostasis and maintaining bone health [1, 2]. Other effects of vitamin D have also been reported. A number of studies have demonstrated that vitamin D deficiency increases the risk of developing many common types of cancer, type I diabetes, rheumatoid arthritis and multiple sclerosis, and type II diabetes [3].

In addition, vitamin D is known to play a role in human antimicrobial response and lung function. At the present stage, accumulated data on the biological role of vitamin D have made it possible to talk about its role in the functioning of the immune, endocrine and cardiovascular systems [4].

Materials And Methods

Among the risk factors for vitamin D deficiency in premature infants, one should consider its deficiency in the mother, long-term parenteral nutrition, irrational feeding, treatment with barbiturates, cholestasis and malabsorption syndromes. It was also found that vitamin D significantly affects the development of a child's lungs during intrauterine development, including the synthesis of surfactant. And a number of studies have demonstrated that low concentrations of 25(OH)D in umbilical cord blood correlate with a greater need for respiratory support, its longer duration and the need for higher oxygen concentrations in premature infants.

Vitamin D promotes the formation of an anti-inflammatory cytokine profile: increases the production of interleukins (IL) 10, 4 and reduces IL-6, IL-12, interferon-gamma and tumor necrosis factor alpha (TNF-alpha); suppresses the expression of TNF-alpha in macrophages and the inflammatory activity of T cells. The aim of the study was to determine the relationship between serum 25-hydroxyvitamin D (25(OH)D) concentrations in neonates with pneumonia and their mothers.

Results And Discussion

This work was carried out in 2021-2022 at maternity hospital bases. Under our observation there were 30 newborns with pneumonia and their mothers (12 children with congenital pneumonia, 18 patients with respiratory distress syndrome (RDS), complicated by pneumonia); the comparison group consisted of 15 "conditionally healthy" newborns without pathologies of the respiratory tract and their mother. All patients received informed consent from the mother for examination and treatment. All children with pneumonia were premature with a gestational age of 32–36 weeks, a birth weight of 1780–2260 g and a length of 39–45 cm.

The comparison (control) group included premature newborns (n=15) without signs of respiratory system diseases. In the control group, gestational age (GA) was 33–36 weeks of gestation, birth weight 1,740–2,490 g, length from 42 to 47 cm. Children in this group had disorders in their neurological status, for which they were transferred to the second stage of nursing.

Blood sampling was carried out on days 5-7 of life and from mothers at the same time. Venous blood was collected in a volume of 1 ml for subsequent determination of 25 (OH) D in tubes with ethylenediamine tetraacetate. After centrifugation (2,000 rpm) for 10 minutes, we collected serum (0.5 ml). We stored this biological material in test tubes without using a preservative at a temperature of -20. The concentration of 25 (OH) D in blood serum was determined by ELISA using polyclonal antibodies using reagents from Immunodiagnostic Systems Ltd.

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The result was expressed in ng/ml. A normal vitamin D content is indicated by a concentration of 25 (OH) D in the blood serum of 30 ng/ml, an insufficient content - 20–29 ng/ml, a vitamin D deficiency of 10–19 ng/ml, a severe deficiency - a concentration of 25 (OH)D less than 10 ng/ml.

To identify risk factors for the development of respiratory disorders in newborns, we studied the somatic and obstetric-gynecological anamnesis of mothers, the presence of somatic pathology, and features of the course of this pregnancy and childbirth. We also analyzed the condition of the child at birth and identified risk groups for the development of complications in the neonatal period.

Data are presented as M±SD,

where M is the arithmetic mean, SD is the standard deviation.

In cases of distribution different from normal, the data were presented in the form

Me (Pr 25 ÷ Pr 75),

where Me is the median,

(Pr25÷Pr75) – upper and lower quartiles.

In an in-depth study of the somatic and obstetric-gynecological history of mothers of newborns with respiratory disorders, we identified the following risk factors: artificial termination of previous pregnancies, isthmic-cervical insufficiency, the presence of extragenital pathology, which led to a complicated course of this pregnancy and childbirth. All of the above factors contributed to intrauterine infection and/or antenatal chronic hypoxia.

With a more careful study of the anamnesis of the group of mothers of the group of children with pneumonia, information about previous induced abortions and a history of premature birth was significantly more often observed ($p = 0.015$). Also, in the group of children with pneumonia, their mothers significantly more often had arterial hypertension and exacerbations of infectious diseases during pregnancy, as well as premature rupture of amniotic fluid. All of the above factors led to intrauterine infection, intrauterine hypoxia and, as a consequence, the birth of children in a more severe condition (low Apgar score and decreased pH of venous blood).

In the newborns of this group, respiratory failure was observed during the first days after birth; 21 patients underwent artificial ventilation. 19 children in this group received surfactant therapy. Repeated administration of Kurosurf due to an increase in the severity of respiratory failure was required in 2 (6.66%) children in this group. Clinically, cyanosis was observed against the background of generalized pallor of the skin. During breathing, the participation of auxiliary muscles was noted. On auscultation, weakened breathing was heard over the lungs, then scattered fine-bubbly moist rales began to be heard. All newborns in this group required primary resuscitation measures in the delivery room. In all children in this group, pneumonia was confirmed radiographically.

The comparison (control) group included premature newborns (n=15) without clinical and laboratory signs of respiratory disorders. In the control group, gestational age (GA) was 33–36 weeks of gestation, birth weight was 1,740–2,490 g, 9 (60%) children in this group were born from complicated pregnancy and against the background of somatic pathology in mothers. Complications of labor (primary labor weakness leading to the use of medications, repeated entanglement of the umbilical cord around the fetal neck, etc.) were present in 12 women (80%). Children in this group had higher Apgar scores: 6 points at the 1st minute of life, at the 5th minute of life – 7 points. Children in this group in the clinical picture of the disease had signs of disorders in the neurological status (syndrome of depression of the central nervous system, cerebral ischemia of the first degree, syndrome of increased neuro-reflex excitability). Intrauterine growth retardation syndrome was observed in 3 children. Examination and treatment of this group of patients was also carried out according to clinical protocols.

The immune system of newborns is in a state of transient physiological suppression, which intensifies in pathological situations, especially in premature newborns [3].

Taking into account the data on the role of vitamin D in the body's immune defense [4], we examined the content of 25 (OH) D in the blood serum of newborns and their mothers.

The mean serum concentrations of 25(OH)D in newborns in the study group were lower than in the control group (6.23 ± 4.33 and 18.54 ± 8.27 ng/ml, respectively, $P = 0.0134$). Also, the mean serum concentrations of 25(OH)D in mothers of the study group were lower in mothers of the control group (11.89 ± 5.17 and 16.73 ± 9.36 ng/ml, respectively, $P = 0.0127$). Mothers who took vitamin D during pregnancy had

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higher serum 25(OH)D concentrations than mothers who took little or no vitamin D (P=0.001). We would like to note the fact that children with an unfavorable outcome of congenital pneumonia had lower levels of vitamin D than children who recovered from pneumonia and RDS. We can conclude that this fact may be the result of insufficiency of innate immune factors in this group.

Neonate 25(OH)D concentrations were significantly correlated with maternal serum levels (r=0.65, P<0.05) in the study group. The correlation between 25(OH)D concentrations in newborns and their mothers in the control group is also significant (r=0.44; P<0.05).

Conclusion

Data show that at a 25(OH)D deficiency threshold of 10 ng/mL, 73.4% of newborns and 77.8% of mothers were vitamin D deficient. The majority of newborns with serum 25(OH)D< 10 ng/ml (OR: 3.5; 95% CI 1.8–12.7; P=0.049) were more likely to develop pneumonia.

Newborns with vitamin D deficiency may have an increased risk of developing pneumonia. Some recent studies also show that adequate concentrations of vitamin D stimulate the genetic expression of antimicrobial peptides in monocytes, neutrophils and other cell lines in the newborn. In addition, adult patients with higher vitamin D concentrations have significantly better lung function compared to patients with lower vitamin D concentrations. Thus, the main conclusion of the study is that reducing vitamin D deficiency in newborns may reduce the risk of morbidity. In conclusion, we would like to note that subclinical vitamin D deficiency in newborns may increase the risk of developing pneumonia. In addition, 25(OH)D concentrations in neonates with pneumonia correlate significantly with 25(OH)D concentrations in their mothers. Maternal 25(OH)D deficiency suggests that intake of 500–1,000 IU of vitamin D during pregnancy is insufficient. The use of more than 500–1,000 IU per day during pregnancy and follow-up remains an area of research to achieve adequate vitamin D levels in mothers and their newborns.

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