MEDICAL SCIENCES

THE CONCEPT OF REGULATORY CONNECTIONS OF THE FOLATE CYCLE AND THE PITUITARY-THYROID AXIS IN CHILDREN FROM AREAS AFFECTED BY THE ACCIDENT AT THE CHERNOBYL NUCLEAR POWER PLANT

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30 years after the accident at the Chernobyl Nuclear Power Plant (ChNPP), thyroid diseases are widespread among the adult and child population living near the Chernobyl Exclusion Zone (ChEZ) [1, p. 273].

Research conducted in 2014–2017, within the framework of the European Commission projects «Health and Ecological Programs around the Chernobyl Exclusion Zone: Development, training and coordination of health-related projects» and the Regional Council of Rhone-Alpes (France), revealed a large number of children teenagers living near the ChEZ with thyroid dysfunction [2, p. 264], as well as with an increased level of homocysteine (H_{cy}) in the blood, a metabolic product of the amino acid methionine (Met), which is essential for the body [3, p. 29].

The process of H_{cy} and Met metabolism is closely related to the enzymes of the folate cycle (FC), in particular, methylenetetrahydrofolate reductase (MTHFR), B_{12}-methionine synthase (MS) and methionine synthase reductase (MSR).

An increase in H_{cy} content in the body, or hyperhomocysteinemia, is associated in adults with a number of serious diseases [4, p. 33].

However, the etiopathogenesis of this condition in children has been very poorly studied.

In order to assess the connections between FC and the pituitary-thyroid axis, a group of children aged 12-17 years from the settlements of Ivankovsky and Polessky districts of the Kyiv region, located near the ChEZ, was examined.

In April and December 2015, genetic, laboratory and mathematical-statistical studies were carried out, in which a significant place was occupied by the analysis of correlations of the obtained indicators.

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In the examined group of children, a high frequency of mutations in the FC genes regulating H_{cy} metabolism was detected [4, p. 42].

Genetic mutations that reduce the activity of FC enzymes are an internal cause of hyperhomocysteinemia.

The external cause of this condition is radioactive elements present in the environment.

After forest fires in the ChEZ in the spring and summer of 2015, an increase in the level of H_{cy} in the blood of the majority of the children examined was recorded [5, p. 25].

We attribute this to the effect of radioactive elements and wood combustion products on metabolic processes.

As a result of this, a disruption in energy supply occurred in the body of many children, leading to disruption of H_{cy} metabolism.

The consequence of this process was the activation of the production of thyroid-stimulating hormone of the pituitary gland (TSH), as well as increased utilization of H_{cy} in the cycle of transsulfuration reactions [6, p. 383].

At the same time, in peripheral tissues there was an increase in the formation of cysteine and activation of the process of deiodination of thyroxine (T_4) with the formation of triiodothyronine (T_3) [7, p. 206].

A direct correlation between T_3 and vitamin B_9 as well as inverse relationships between T_3 and H_{cy}, T_3 and TSH, indicate an increase in the process of H_{cy} methylation under conditions of genetic risk and environmental exposure.

Based on this, it can be argued that T_3 plays an important role as a regulator of FC.

The conducted studies made it possible to formulate the concept of interaction between the FC and the pituitary-thyroid axis in children living in areas affected by the Chernobyl accident.

An increase in the level of H_{cy} in the blood of children living in Chernobyl areas is a reflection of metabolic distress associated with mutations in FC genes and environmental radiation exposure.

As a result, the functioning of a number of important FC enzymes involved in the process of H_{cy} methylation and the formation of internal Met is disrupted.

An increase in the level of H_{cy} in the blood triggers a cycle of compensatory and adaptive reactions with the participation of hormones of the pituitary-thyroid axis and transsulfuration reactions (Figure 1).

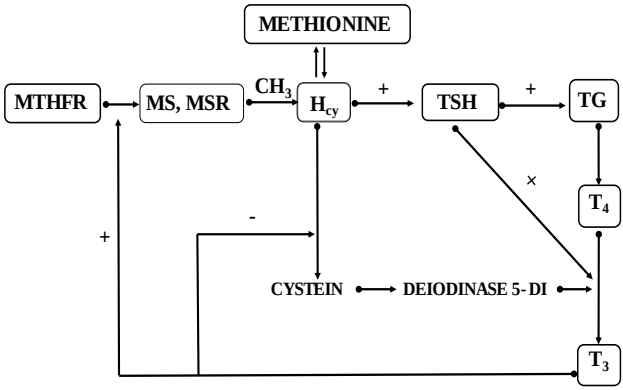

Figure 1. Regulatory connections between the folate cycle and the pituitary-thyroid axis

In peripheral tissues, as a result of deiodination of T_4, T_3 is formed, which is capable of stimulating FC enzyme systems, in particular MTHFR, MS, MSR, and thereby enhancing the process of H_{cy} methylation with the formation of internal Met.

At the same time, the load on the transsulfuration cycle is reduced, and as a result, the intensity of T_4 deiodination and T_3 formation decreases.

References:

1. Tkachenko V. I., Maksymets Ya. A., Vydyborets N. V., Kovalenko O. F. (2018). Analiz poshyrenosti tyreoidnoi patolohii ta zakhvoriuvanosti na nei sered naselennia Kyivskoi oblasti ta Ukrainy za 2007–2017 rr. [Analysis of the prevalence of thyroid pathology and its incidence among the population of Kyiv region and Ukraine for 2007–2017]. *Mizhnarodnyi endokrynolohichnyi zhurnal*, t. 14, no. 3, pp. 272–277. DOI: https://doi.org/10.22141/2224-0721.14.3.2018.136426 (in Ukrainian)

2. Bandazhevsky Yu. I., Dubova N. F. (2022). Hyperhomocysteinemia in Ukrainian children living near the Chernobyl Exclusion Zone. *International scientific conference "New trends and unsolved issues in medicine": conference proceedings* (July 29-30, 2022. Riga, the Republic of Latvia). Riga, Latvia: Baltija Publishing, pp. 263–266. DOI: https://doi.org/10.30525/978-9934-26-226-5-69

3. BandazhevskyYu. I., Dubova N. F. (2017). Comparative assessment of metabolic processes in children living in the areas affected by the Chernobyl Nuclear Power plant accident. *Environment&Health,* no. 4 (84), pp. 27–30. DOI: https://doi.org/10.32402/dovkil2017.04.027

4. Bandazhevsky Yu. I., Dubovaya N. F. (2022). Chernobyl catastrophe and childrens health. 35 years of world tragedy. Ivankov: PI Coordination and Analytical Center "Ecology and health". Kyiv: Alyant LLC, 158 p.

5. Bandazhevsky Yu. I., Dubovaya N. F. (2021). Forest fires in the Chernobyl exclusion zone and children's health. Ivankov: PI Coordination and Analytical Center "Ecology and health". Kyiv: Aliant LLC, 44 p.

6. Bandazheuski Yu., Dubovaya N. (2023). Hyperhomocysteinemia and pituiyary-thyroid axis among children living near the Chornobyl exclusion zone. *Theoretical and practical aspects of science development: Scientific monograph*. Part 2. Riga, Latvia: Baltija Publishing, pp. 368–390. DOI: https://doi.org/10.30525/978-9934-26-355-2

7. Bandazheuski Yu., Dubovaya N. (2023). Folate cycle genes and the endocrine system in children living in the territory affected by the accident at the Chernobyl nuclear power plant. *Science, technology and innovation in the modern world: Scientific monograph*. Riga, Latvia: Baltija Publishing, pp. 188–210. DOI: https://doi.org/10.30525/978-9934-26-364-4