Over the last decade, the stable increase in the number of children with autonomic dysfunction symptoms is observed. According to modern ideas autonomic dysfunction is regarded not only as a disease that embeds in the narrow confines of a particular nosology, but also as a manifestation of systemic psycho-endocrine-immune disorders. Paroxysmal autonomic dysfunction is the clinical form of autonomic dysfunction resulting from autonomic nervous system overload and is characterized by disturbances in adaptation processes [1].

Recent studies have conclusively demonstrated the thyroid gland pathology influence on the autonomic nervous system functioning. It was defined that even at the early stages, thyroid dysfunction affects psycho-emotional state, as well as central and autonomic nervous system action [2–4]. Recently, autonomic dysfunctions in case of hypothyroidism in adults were widely studied. In these researches, the attention is paid to the frequent mood changes and emotional instability in patients, almost 73.1 % of them reported irritability, tearfulness, hyperactivity, anxiety, susceptibility to phobic state. The last of them in 35 % of cases occurred as nonspecific panic attacks and clinically resembled sympathoadrenal crisis [5].

According to the World Health Organization (WHO), 30 % of the world population is at the risk of iodine deficiency. Despite the iodine key role in such cases, endemic goiter today has mixed origin and is a result of interaction between endogenous and exogenous factors. According to the literature, the reduction not only of the iodine intake, but also the deficiency of related minerals is of great importance.

Microelement concentration in tissues is balanced owing to homeostasis. Changes in the concentration of each microelement, distribution, metal ions deposition lead to the macroorganism biochemical regulation. Ionic balance determination in biological substances allows understand the metabolic changes in metal-bearing...
molecules in the macroorganism. It is known that human hair accumulates microelements, whereby their concentration may be objective indicator of organism microelement state in general [6].

The WHO recommends defining iodine in urine when the prevalence of iodine deficiency among the population should be determined [7]. However, iodine amount in the urine shows current intake of iodine, therefore, it doesn’t represent genuine iodine state in the body. The iodine content in depot tissues (hair) indicates its intake for the prolonged time. A.L. Gorbachev et al. conducted the comparative analysis of iodine content with the standard evaluation of its level in the urine, with simultaneous determination in the hair to confirm iodine content in the hair in order to establish the iodine deficiency. Thus, according to the research, the iodine determination in the hair is being more sensitive method and allows determining endogenous iodine and other microelements deficiency [8].

Until now, the situation with microelement state in patients with paroxysmal autonomic failure (PAF) on the background of thyroid gland pathology is uncertain. It is relevant, because obtained results give a chance to treat patient with regard to detected pathology.

The aim of the research was to determine microelement state in patients with paroxysmal autonomic failure on the background of thyroid pathology.

Materials and methods

The study included 44 patients aged 7 to 17 (14.06 ± 0.18) years with PAF, who underwent a comprehensive screening in the Center of Autonomic Dysfunction of the Children’s Clinical Hospital N 6 in Kyiv, Ukraine. A detailed survey of complaints of children and their parents was conducted. All patients underwent comprehensive examination using clinical and instrumental methods. Screening involved the methods of autonomic homeostasis condition, cerebral blood flow and brain biopotential activity evaluation, thyroid ultrasound, thyroid hormone blood test and endocrinologist’s professional advice. The diagnosis of paroxysmal autonomic failure was established according to V.G. Maidannyk classification (2000) [1]. The composition of macro- and microelements in the blood plasma and the hair root zone was studied by measuring mass fraction of chemical elements in the hair and plasma using X-ray fluorescence method with the help of portable energy-dispersive X-ray fluorescence spectrometer ElvaX. Children’s individual microelement profile deviations were evaluated by means of biologically acceptable levels of toxic chemical elements and normal limit of essential chemical elements in patients’ hair defined by M.G. Skalna (2009).

Statistical analysis was performed using mathematical software package MS Excel and SPSS 22.0.

Results and discussion

Most patients with PAF complained of headache (96.9 %), loss of consciousness (47.4 %), emotional liability (57.5 %), pain in the heart (33.3 %), fear (47.4 %). Thyroid ultrasound has been carried out in all patients with PAF, as well as additional T3/T4 and thyroid-stimulating hormone blood test. Thyroid disorders were found in 47.8 % of all examined patients (Fig. 1).

After endocrinologist’s professional advice, the following disorders were determined (Fig. 2): nontoxic goiter — in 12.8 % of patients, the Grave’s disease (diffuse toxic goiter) — in 7.7 %, multinodular goiter — in 5.1 %, autoimmune thyroiditis — in 6.4 %, hypothyroidism — in 7.7 %. In other patients, detected disorders were interpreted as iodine deficiency that indicates the need to determine iodine state in patients.

In all patients with PAF, microelements state was evaluated and their content in the hair and blood plasma was determined.

The following changes in the microelement concentration in the hair and blood plasma were defined (Fig. 3, 4).

As shown in Fig. 3, in all children with PAF, iodine and selenium deficiency was determined. Also, half of patients had reduced zinc concentration, and 63.6 % had reduced calcium. Besides, in 9.1 % of patients, sulfur deficiency was revealed.

As shown in Fig. 4, the blood plasma fractionation shows reduced concentration: of bromide — in 100 % of patients with PAF, calcium — in 61.6 %, sulfur — in 54.5 %, selenium and zinc — in 86.3 and 29.5 %, respectively. Iodine concentration in the blood plasma was not measured due to its minimal concentration and insufficient sensitivity of the X-ray fluorescence test systems.
Interestingly, when comparing the microelement parameters in patients with PAF on the background of thyroid pathology and without it, a statistically significant difference was found only in sulfur concentration sulfur in plasma (61.5 versus 29.0 %, p < 0.05). All other microelements were found almost in the same amount in both groups.

The correlation analysis was performed between the microelement content in the hair and blood plasma and thyroid indices (Fig. 5).

Enlargement of the thyroid gland has a positive statistically significant correlation with the content of bromide in the hair (r = 0.312, p < 0.05), while thyroid gland heterogeneity correlates with the iodine content in the hair (r = 0.384, p < 0.05). In addition, changes in the T4 hormone correlate with the sulfur content in the hair (r = 0.384, p < 0.05), and T3 — with iodine content (r = 0.384, p < 0.05). The fact is that the microelement content in plasma (Br, Se, Zn, Ca) has a positive mutual statistically significant correlation.

There are a lot of reliable facts about iodine necessity for the thyroid gland functioning and human organism as a whole, but its competitive interactions with the microelement of bromide similar in chemical group (halogen) are also important. It is also known that selenium and zinc are directly involved in the formation of thyroid gland and its hormones. Thus, selenium is an integral part of iodotyrosine deiodinase enzyme responsible for the peripheral transformation of T4 (thyroxine) hormone into active T3 (triiodothyroine), while zinc as a part of more than 200 metalloproteinases is a part of triiodothyronine nuclear receptor. It is important that selenium and zinc are directly involved in the formation of thyroid gland and its hormones. Thus, selenium is an integral part of iodotyrosine deiodinase enzyme responsible for the peripheral transformation of T4 (thyroxine) hormone into active T3 (triiodothyroline), while zinc as a part of more than 200 metalloproteinases is a part of triiodothyronine nuclear receptor. It is important that the T4 hormone breakdown leads to increased calcium loss in the urine and to the bone resorption. At the same time, calcium range lowering is associated with a decrease in calcitonin hormone concentration, while sulfur is known as a constituent part of calcitonin. As a result, the concentration of parathyroid hormone grows and resorption of bone tissue increases with the subsequent development of osteopenia. Consequently, the disorders in the microelement state in patients with PAF on the background of thyroid gland pathology are of great significance and require appropriate correction.

Conclusions

1. Thyroid disorders were found in 47.8 % of patients that proves the necessity of obligatory thyroid gland screening in such patients using ultrasound and thyroid hormones blood test.
2. In 100 % of patients with PAF, iodine deficiency was found after microelement determination in the hair that indicates the necessity of iodine deficiency prevention in such patients.
3. The correlation between the microelements involved in thyroid functioning (Ca, Br, Se, S, Zn) and their content in the hair and blood plasma has been established that indicates a significant imbalance of the microelement state in patients with PAF and requires an appropriate correction.

References

Состояние микроэлементного обеспечения у пациентов с пароксизмальной вегетативной недостаточностью на фоне патологии щитовидной железы

Резюме. Изучив изменения концентрации микроэлементов в организме пациентов с пароксизмальной вегетативной недостаточностью (ПВН) на фоне патологии щитовидной железы, можно установить взаимосвязь с изменениями физического состояния. Материалы и методы. Было обследовано 44 ребенка в возрасте 7–17 (14,06 ± 0,18) лет с ПВН. Всем больным был проведен комплекс клинико-инструментальных исследований. Состав макро- и микроэлементов в плазме крови и прикорневой зоне волос изучался посредством определения массовой доли химических элементов в волосах и плазме крови рентгенофлюоресцентным методом с помощью портативного энергодисперсионного рентгенофлюоресцентного спектрометра «ElvaX». Отклонения индивидуального микроэлементного профиля ребенка также фиксировались. Результаты. У 100 % пациентов с ПВН обнаружено йододефицитное состояние по результатам определения уровня микроэлементов в волосах, что указывает на необходимость профилактики йододефицита у таких больных. Выводы. Установлена корреляционная связь между микроэлементами, которые принимают участие в функционировании щитовидной железы, а также выявлено нарушение их содержания в волосах и плазме крови, что свидетельствует о значительном дисбалансе микроэлементов у больных с ПВН и требует соответствующей коррекции.

Ключевые слова: вегетативная дисфункция; патология щитовидной железы; микроэлементы; рентгенофлюоресцентный спектрометр; дети