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EVALUATION OF HEAD BRAIN BIOELECTRIC ACTIVITY ON THE BACKGROUND OF UTERINE BLEEDING IN PUBERTY AGE

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Abstract:

Study objective: *To evaluate the functional state of the central nervous system in adolescent girls on the background of dysfunctional uterine bleeding by the electroencephalography method.*

Materials and methods of study. *We examined 30 adolescent girls. The mean age was 14.7 ± 2.0 years old. We gave the qualitative and quantitative characteristics of the alpha rhythm: regularity, zonal distribution, modulation, index, amplitude, frequency. To assess the degree and nature of the reactivity of cortical and subcortical brain structures, we performed some functional tests with the opening and closing of the eyes, rhythmic photostimulation and dosed hyperventilation.*

Results. *It is statistically significant that the violation of almost all criteria of alpha rhythm has been confirmed. Most of the patterns indicated the presence of diffuse cerebral nonspecific changes in the regulatory plan. The changes revealed mainly concerned the middle brain structures and were of a mild to moderate functional nature.*

Summary. *The bioelectric brain activity in patients with functional disorders of menstrual cycle was within the age limit. The deviations were of a functional nature.*

Key words: *adolescent girls, dysfunctional uterine bleeding, puberty period, electroencephalography, alpha rhythm.*

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INTRODUCTION:

At the end of the XX century, the interest in the health of adolescents was reasonably increased, since many chronic adult diseases were the prolonged pathology of adolescents [1, 2]. There is a hope for improving the quality of health of the next generation with adolescents, they are carriers of the reproductive potential of the next decades. However, the violations of menstrual function among adolescents - the most important marker of women's reproductive health - tend to increase [3]. The results of an earlier study showed that the incidence of menstrual irregularities among adolescent girls aged 15-17 years old in the Belgorod Region increased by 2.2 times (from 2834.1 ± 102.4 to 6199.6 ± 142.2; p <0.001), among girls aged 10-14 years old - by 5.3 times (from 500.5 ± 18.5 to 2676.8 ± 85.7, p <0.001) over the 10-year period (1999-2008) [4]. The first place in the structure of menstrual cycle disorders was occupied by the hypomenstrual syndrome with a large margin, whose proportion was 47.5 ± 1.1%, the second place - irregular cycle (21.7 ± 0.9%), the third - dysfunctional uterine bleeding in puberty period in the form of menorrhagia, menometrorrhagia, polymenorrhea (20.7 ± 0.9%).

According to E.V. Uvarova (2006) [3], menstrual cycle disorders predominate among adolescents aged 15-18 years old in the structure of gynecological diseases, accounting for exactly half of all pathology-50.7%, and the main place is occupied by uterine bleeding and secondary amenorrhea in the structure of disorders.

Due to the experimental and clinical studies of the second half of the last century, the pathogenesis of uterine bleeding has been thoroughly studied to date. According to modern views, a dysfunctional uterine bleeding in the puberty period is associated with a violation of the function of brain regulatory centers, namely the hypothalamic-pituitary system, which reflects the age characteristics of the adolescent organism - the physiological immaturity of regulatory centers and their unsteady connections with the ovaries. The functional state of higher nervous activity, which controls the regulatory mechanisms of the reproductive system, is unstable during puberty, the development of differentiations in the cerebral cortex and, especially, in the hypothalamic-pituitary centers is insufficient. The uterus is not yet completing its final development, its receptors are imperfect. A potential for the perception of irritations by the uterus and their carrying into the central nervous system is poorly expressed. At the same time, the pituitary receives perverse impulses and does not coordinate the synthesis of gonadotropic hormones - the follicle-stimulating hormone production prevails and the luteinizing hormone and prolactin are not produced in sufficient quantities. The various external and internal stimuli acting against this background can easily violate the regulatory mechanisms of the reproductive system, preventing the establishment of its stereotype, which can be accompanied by uterine bleeding [5, 6, 7, 8, 9, 10, 11, 12].

The modern objective methods of studying the functional state of higher brain regulatory centers, including the functional state of hypothalamic structures, include the study of electrical brain activity by the electroencephalography method (EEG) [13].

Study objective. To assess the functional state of the central nervous system of adolescent girls suffering from dysfunctional uterine bleeding.

MATERIALS AND METHODS OF STUDY:

The study group consisted of 30 adolescent girls who had consulted about uterine bleeding, which, on the basis of anamnestic data and clinical examination, was regarded as moderate and did not require urgent interventions in all patients. The criterion for inclusion in the group was the diagnosis of dysfunctional uterine bleeding, the criterion for exclusion was the organic pathology of pelvic organs. The organic nature of uterine bleeding was excluded during the echographic examination, paying special attention to anatomical abnormalities and structural changes in the internal genitalia. Evaluation of the degree of maturity of internal genital organs was carried out by determining the individual ratio of body length and cervix. It is considered normal, if the uterus length exceeds the cervix length by 2 times. Almost all patients had the ratio of 2:1, 3 girls - 1.8 and 1.9:1, which made it possible to exclude the echographic signs of genital infantilism in all cases. The mean age of the girls was 14.7 ± 2.0 years old. Most of them (73.3 ± 8.1%) were the pupils of secondary schools, 24 patients were virgo intakta, six girls had experience of sexual contacts at the age of 15-16. This episode of uterine bleeding was the first in 23 (76.7 ± 7.7%) girls and repeated in the remaining 7. None of the patients in the history used hormonal sex steroids, had no inflammatory diseases and surgical interventions on the pelvic organs and all the girls gave voluntary informed consent to participate in the study.

A satisfactory status of patients allowed us conducting the EEG on the day of treatment without prejudice to their health. Electroencephalography was taken with the Nicolet Biomedical EEG apparatus, observing all the standards regulated for the use of this method. The study was conducted in the morning hours not earlier than two hours after eating. EEG recording was conducted in a quiet environment, the patient sat in a special chair or lie on a couch in a room with a temperature of 20-22 degrees Celsius. The number of electrodes applied on the convective skull surface was at least twenty-one. For unipolar detection, we placed a buccal electrode, which was

placed between the round and chewing muscles of the mouth. Two electrodes were applied to the edges of the eye sockets to record eye movements and the ground electrode. The electrode location on the head was carried out according to the standard "ten-twenty" scheme.

To assess the degree and nature of the reactivity of cortical and subcortical brain structures, we performed some functional tests with the opening and closing of the eyes lasting for 15 and 10 seconds respectively, rhythmic photostimulation (rhythmic light flashes) and dosed hyperventilation. When assessing the response to a light sample, we took into account such indicators as the degree of amplitude decrease, the time of reaction appearance, and the recovery time of the alpha (α)-rhythm. When evaluating the brain response to the rhythmic photostimulation, we noted the time of reaction appearance, the degree of alpha rhythm depression, the presence or absence of the assimilation reaction of a given rhythm. When assessing the test for hyperventilation, the degree of amplification of the amplitude waves and the slowing of the alpha rhythm were taken into account, and in the presence of pathology - the character of high-amplitude slow waves. Low-frequency and high-frequency flashes of light were used for photostimulation. The test with hyperventilation has been carried out for 3 minutes, the patients breathed deeply and regularly with a frequency of about 20 respiratory movements per minute. The depth of inspiration and exhalation was maximal, with the subsequent intensification of exhalation.

Statistical processing of the study results was carried out using Statistica 6 program. The probability of a fair null hypothesis (p) was taken at 5% significance level ($p<0.05$) [14].

STUDY RESULTS AND THEIR DISCUSSION:

The normal electroencephalogram recording is a moderately organized curve that has certain zonal differences in the distribution of rhythms and adequately varies with functional loads. At its core, the normal rhythm reflects the overall organization of the brain electrical activity. It is generally accepted that the normal background electroencephalogram is characterized by the order and regularity of waves with a predominance of alpha activity, which means rhythmic oscillations of the potential with a frequency of 8-13 per second, an average amplitude of 30-70 μV, usually modulated into spindles and expressed predominantly in the brain posterior departments decreasing to the frontal departments.

In response to opening of the eyes, it is registered a single-stage reaction in the form of the alpha rhythm depression, which is completely restored within 3-4 seconds in response to closing of the eyes in the norm. There should be a distinct reaction on photostimulation in the form of rhythm assimilation. A sample with dosed hyperventilation is normally accompanied by a slight increase in the alpha rhythm amplitude in the posterior brain regions [15, 16, 17, 18].

In view of the foregoing, the main diagnostic criteria for evaluating the EEG results were regularity, zonal distribution of the alpha-rhythm, its modulation, index, wave amplitude and frequency, as well as the presence of other types of non-pathological and pathological activity. The individual analysis of each case made it possible to reveal quite diverse options of brain bioelectric activity that concerned these criteria and allowed judging in each specific case about the nature of functional disorders of brain structures.

A generalized EEG analysis is presented in Table 1, from which it follows that a regular alpha rhythm was recorded only in 9 (30.0 ± 8.4%) of 30 patients, and it was not strictly regular in the remaining 21 cases (70.0 ± 8.4%, $p<0.01$).

Table 1: Characteristics of the alpha rhythm of the electroencephalogram during uterine bleeding in puberty.

Parameters of alpha-rhythm	**Characteristics of the alpha rhythm (n=30)**		
The regularity of rhythm	regular	irregular	
	9 (30.0±8.4%)	21 (70.0±8.4%)**	
Zonal distribution	well-marked	indistinct	
	10 (33.3±8.6%)	20 (66.7±8.6%)*	
Modulation	well expressed	poorly expressed or absent	
	6 (20.0±7.3%)	24 (80.0±7.3%)***	
Index (%)	low (less than 25.0)	average (26.0-70.0)	high (more than 70.0)
	6 (20.0±7.3%)	10 (33.3±8.6%)	14 (6.7±9.1%)
Amplitude (μV)	norm (30-70)	high (more than 70.0)	
	9 (30.0±8.,4%)	21 (70.0±8.4%)**	
Frequency Hz	10.1±1.1		

Note: * – $p<0.02$; ** – $p<0.01$; *** – $p<0.001$;

The ordered work of neurons in the cerebral cortex assumes a correct distinct zonal distribution of the alpha rhythm. Normally, the pointed waves of alpha rhythm should predominate in the occipital parietal divisions, decreasing towards the frontal sections. Such a distribution was found only in every third patient - in 10 patients (33.3 ± 8.6%). 20 (66.7 ± 8.6%; p<0.02) girls had the EEG patterns that showed flattening or disruption of the alpha-rhythm zonal distribution as a transition to different areas of anterior regions, which was typical for small diffuse changes in the brain bioelectrical activity.

The alpha rhythm modulation means alternating waves of bioelectrical activity. Initially, the wave amplitude increases, then it decreases, which is visualized in the form of characteristic "spindles" and confirms the normal brain bioelectric activity on the EEG patterns. The distinctly expressed waves with the correct alternation of the amplitude increase and its subsequent decrease occurred only in six girls surveyed (20.0 ± 7.3%). In the majority of patients - 24 (80.0 ± 7.3%, p <0.001), we observed a weakly expressed formation of these spindle-shaped rhythms; they were completely absent in some cases. Similar patterns indicate an increased functional activity of the brain.

The index should be understood as the percentage of time during which an activity of alpha or any other rhythm is expressed on any segment of the EEG curve. In our observations, a high index of alpha rhythm was the most frequent (46.7 ± 9.1%), when it occupied more than 70% of the time. However, the alpha-rhythm index was average in every third patient (33.3 ± 8.6%) and low - in every fifth (20.0 ± 7.3%). A large percentage of time was occupied by other rhythms (beta-β, delta-δ, theta-θ) in these patients on the EEG curves.

The amplitude of the EEG alpha-rhythm in the range of normal values (up to 100 μV) was detected in nine (30.0 ± 8.4%) patients. It was above the norm in 21 (70.0 ± 8.4%, p <0.01) girls, often exceeding 100 μV, in individual cases it reached 120-150 μV, which characterized the picture as a hypersynchronous type of the EEG. Increasing the alpha rhythm amplitude to 120 and especially to 150 μV is considered by specialists as a borderline option between the norm and pathology and is treated as paroxysmal activity. The patterns with excessively high amplitude were recorded in patients with recurrent episodes of uterine bleeding.

The frequency of alpha rhythm was within the normal range in all patients, averaging 10.1 ± 1.1 Hz.

The results were not unambiguous, when we performed the functional tests. In the sample for opening the eyes, all patients in all leads had a reaction in the form of a clear alpha rhythm depression, which corresponded to the accepted norms. However, its recovery in response to eye closure for 1 minute (instead of 3-4 seconds) was fully observed in 16 (53.3 ± 9.1%) patients; the alpha rhythm was not fully restored or its recovery was not observed at all in 14 (46.7 ± 9.1%) patients.

Such a reaction to the sample may indicate the presence of diffuse cerebral nonspecific changes, which most often can be caused by encephalopathy due to vascular problems, or by neuroinfection. In our observations, we are inclined to explain these general cerebral changes in the high infectious morbidity of girls during childhood and puberty. The infectious index, which implies the multiplicity of episodes of infectious diseases transferred during the last calendar year, has been 3.4 ± 0.5 among the patients examined. It is known that acute and chronic infections, especially in the nasopharynx, play an important role in the development of the reproductive function of adolescents of both genders. The danger of acute viral infections is associated with the cytopathic pathogen action on the cells. At present, it has been established that the viruses of mumps, chickenpox and rubella have gonadotoxic effects. Intoxication accompanying the course of chronic purulent infections (tonsillitis, otitis, sinusitis), especially during their exacerbation, affects primarily those organs and systems that are in the establishment process in this period. In adolescence, the most vulnerable system is the hypothalamic-pituitary-ovarian.

When conducting a provoking sample with photostimulation in the frequency range of 8-20 Hz, there should normally be a distinct reaction in the form of rhythm assimilation. The assimilation reaction of light flashes at frequencies close to the alpha rhythm was noted in practically all girls except for two in the study. The rhythm activation, which was manifested by an increase in the amplitude of waves of varying degrees of severity, was recorded from one to three times or more. Similar reactions were interpreted as evidence of sufficient ability of the cerebral cortex to perceive external stimuli.

The hyperventilation test is provocative, because forced breathing contributes to reducing the partial pressure of carbon dioxide in the blood and shifting metabolic processes in the body towards hypocapneemia. The artificially created respiratory alkalosis causes the activation of brain stem structures and, in connection with this, provokes the appearance of pathological changes on the EEG [19]. In response to the test, 22 patients (73.3 ± 8.1%, p <0.001) had the emergence of bilateral synchronous outbreaks in the anterior parts of the brain, predominantly alpha and delta rhythms of varying severity at the end of the first minute, which was regarded as a consequence of thalamo-cortical relationships of a regulatory nature.

SUMMARY:

The individual analysis of each encephalogram makes it possible to consider that the bioelectrical

activity of the brain in adolescent girls on the background of dysfunctional uterine bleeding is within the limits of the age norm. Changes in the alpha-rhythm consisted in the fact that its regularity, modulation, zonality of distribution was not always clearly traced, as well as a moderate increase in amplitude was noted. The generalized assessment results of the main diagnostic criteria showed that the majority of patterns indicated the presence of diffuse cerebral nonspecific changes in the regulatory plan in patients. The changes revealed mainly concerned the middle brain structures and were of a mild to moderate functional nature according to the classification of E.A. Zhyrmunskaya (1991) [13]. Consequently, electroencephalography, as a method of objective research, makes it possible to exclude the organic nature of damage to the brain structures and confirmed the functional nature of the uterine bleeding genesis in patients of the puberty period.

CONCLUSIONS:

1. The method of electroencephalography can be useful in the algorithm for examining adolescent patients who have consulted for uterine bleeding.

2. The most informative criteria for the EEG patterns inherent in the dysfunctional uterine bleeding in adolescence should be considered a weakly expressed modulation of the alpha-rhythm, the absence of its strict regularity, an increase in the amplitude and blurriness of the distribution area.

3. The response to functional tests indicates general cerebral disorders of thalamo-cortical relationships of a regulatory nature.

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