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Article

Characteristics of Cerebral Cortex Bioelectric Activity in Neonatal and Postneonatal Children With Bilirubin Encephalopathy

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Abstract: We used cerebrocortical electrical activity as a measure of bilirubin neurotoxicity in our investigation. Particularly impacted by elevated bilirubin levels are the cerebral hemispheres and thalamic cortex. The connection between the thalamus and the cortex of the cerebral hemispheres produces the rhythmic waves in the EEG, which increases the electrophysiological influence of bilirubin on the brain's bioelectric potential in the long term postnatal age on rhythmic oscillations. examined. The development of the brain's bioelectrical activity, as well as the waves' aberrant characteristics and quantitative power spectrum analysis, were investigated. 25 full-term newborns with bilirubin encephalopathy and 40 healthy infants provided 195 EEG recordings for this purpose (the first assessment was in the first week, the second examination was at 3 months, and the third examination was at 6 months). Delta and theta frequencies make up the primary frequency component in all recordings for both groups. In the initial recordings, the group with hyperbilirubinemia had a greater delta frequency than the control group, but their theta, alpha, and beta frequencies as well as amplitude levels were lower ($p < 0.001$). The amount of bilirubin was found to be substantially correlated with these changes ($p < 0.001$). The hyperbilirubinemia group's wave amplitude grew to a level comparable to the control group during the second assessment. Delta and theta frequency bands showed substantial alterations associated to postnatal age ($p < 0.001$). As we age, the frequency of theta rises while the frequency of delta falls in all regions of the cerebral hemispheres. Additionally, we detected abnormal bielectric activity and recorded epileptiform waves in newborns with bilirubin encephalopathy. This shift in bioelectric activity is particularly indicative of encephalopathy. Despite the disparities in all brain regions, there were differences in delta frequency and theta frequency between children in the hyperbilirubinemia group and those with moderate bilirubin encephalopathy. These differences vanished by the third month. In the third month, there was no difference between the two groups in terms of vertex, K complex, and sleep spindles ($p>0.05$). We discovered that the amount of bilirubin in the blood, the permeability of the blood-brain barrier, and the clinical course of bilirubin encephalopathy all influence the effects of hyperbilirubinemia on cerebrocortical electrical activity.

Key words:hyperbilirubinemia,cerebrocortical,EEG,encephalophathy,blood-brain barrier

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Introduction

During the newborn stage, hyperbilirubinemia is one of the most prevalent conditions. In newborns and young children, jaundice and its clinical symptoms can cause neurological problems. The World Health Organization states that in underdeveloped as well as industrialized nations, neurological factors can occasionally be involved in the extension of newborn jaundice or its severe manifestations. resulting in difficulties.[1,2] The exact mechanism of bilirubin's primary accumulation in the brain's deep roots during hyperbilirubinemia is yet unknown.[3]The basal ganglia, hypothalamus, brain column nuclei (such as the oculomotor, cochlear, vestibular, and olivary nuclei), and the brain itself become yellow due to the buildup of bilirubin. Worldwide morbidity and mortality from acute bilirubin encephalopathy (ABE) are common, with infants and children in the postnatal period being particularly vulnerable.[8] It is still unclear how this potentially fatal acute infantile episode and its progression to kernicterus are pathophysiologically explained. Although uncommon, bilirubin encephalopathy still exists in newborns and cannot be cured. [10]Infants who pass away with slightly raised serum bilirubin levels but no clinical evidence of kernicterus have also been shown to have yellow staining of the brain. Atrophy of the affected fiber system, reactive gliosis, and neuronal death are seen in the later stages of the disease.[11,13] In brain mitochondria, bilirubin interferes with respiration and oxidative phosphorylation. EEG research has been utilized in postneonatal and newborn infants to examine the brain's lifetime development in addition to identify abnormalities in the electrical activity of the brain, including delays in brain development.[18-20]

Research material

Infants who are newborns or older From the Department of Infant Reanimation and Pathology of Newborn Babies of the Perinatal Center of Surkhandarya Region, 25 infants with hyperbilirubinemia in the neonatal and post-neonatal era were chosen. Forty healthy kids were chosen from the Department of Infant Physiology to be in the control group. Ten of the 25 individuals being watched are boys, and 15 are girls. Full-term newborns with a Kramer score of 4-5, a blood biochemical analysis total bilirubin level of greater than 256 μmol/L, and a history of jaundice lasting longer than two weeks were chosen for the evaluation. The "Newborn development percentile table" was used to assess the physiological development of neonates**.**

Research methods

In order to determine the cause and development factors of bilirubin encephalopathy, the mother's age, hereditary diseases, epidemiological history, as well as somatic diseases of the mother, obstetric and gynecological history, the course of pregnancy and childbirth complications, the course of childbirth were studied. Objective assessment of newborns: general condition, anthropometric indicators of adaptation to the external environment were evaluated. The level of jaundice was evaluated based on Kramer's scale. Clinical anamnestic and laboratory examinations of all newborns were carefully observed. Accurate diagnosis and examination of newborns is more complicated than other group of diseases. BIND scale - The identification and assessment of the clinical and neurological status of encephalopathy caused by bilirubin intoxication was checked by the BIND scale. The clinical evaluation of those in the control group was carried out regularly. The general neurological examination of newborns and early-aged children was carried out several times during the day. The children in the control group were re-evaluated every month from the clinical and neurological examination up to one year of age. General blood analysis, blood biochemical analysis: bilirubin and its fractions determine the level and course of complications of bilirubin intoxication. To study the bioelectrical activity of the brain, bilirubin and its fractions in the blood analysis of each subject were repeatedly checked and monitored, because bilirubin and its fractions evaluate the acute or chronic course of the disease and the neurophysiological state. Each baby in the study had an initial EEG examination in the first week (first week of life), because the level of bilirubin was the highest before treatment. For the next examination, the patients were taken to the outpatient clinic. The second examination was done at 3 months of age. The last examination was carried out when the children were 6 months old. The studies were conducted in a controlled environment in which sound, light, humidity, and tactile stimulation were carefully monitored. EEG was performed during sleep in all infants. No infant received medication. For each EEG recording, the infant was recorded during a quiet sleep period of 1 h. It was carried out on the basis of a regular pediatric examination. The EEG apparatus was manufactured by Neurosoft (Russia) in Neuron spectrum 3. In the first three EEG recordings, digitized data were collected from 19 brain electrodes placed according to the modified International 10/20 system for newborns (Fp1,

Fp2,F3,F4,Fz , C3, C4 Cz,P3,P4 ,Pz T3, T4,T5,T6 O1, O2, A1, and A2). Nineteen channels were used for recording. At the third month and at 6 months, 19 brain electrodes were placed according to the international 10/20 system (10).The analyzed results are delta waves given in four different frequency ranges 0 – 3.5 Hz; theta waves, 4 – 8 Hz; alpha (a), 8-13 Hz; and beta (b), 13–35 Hz] as a percentage of each frequency band. Average amplitude values were obtained from each channel. In the third and sixth months, sleep spindles, vertex and k complex were analyzed.

Results The study of the distribution of the frequency characteristics of brain bioelectric activity in the examined newborns with bilirubin encephalopathy revealed significant deviations from the standard deviations of normal values in healthy children. It should be noted that with a significant number of typical variants of frequency representation in the EEG, the most common variant of the deviation was found in almost all examination groups with a decrease in alpha activity, an increase in delta activity, and a specific pattern of frequency activity was found, a decrease in beta activity ($x2 = 15.72$; $p = 0.0001$) was observed. The study of brain bioelectric activity in EEG, as an energy indicator of brain bioelectric activity, shows the superiority of normal parameters of EEG power in children in the main and comparison groups. Among the rare but significant deviations in the EEG spectrum, there was an increase in the strength of β-activity and a decrease in its amplitude with an increase in the strength of activity. The characteristic of the transition from rhythm to rhythm in children with bilirubin encephalopathy was a high range of the number of transitions. in children, an increase in the number of rhythm-to-rhythm transitions was noted in the right parietal area of the brain (P4). and also made it possible to determine the correlation with the decrease in the number of transitions from rhythm to rhythm. In the main group, 5 (10%) and 4 (8%) convulsion syndromes were detected in the comparison group. Among them, OBE was detected in 4 infants, SBE was detected in 5 infants. According to the results of EEG examinations, specific slow waves and their complex were detected. The character of the convulsion is tonic, and slow waves appear in the EEG in a generalized type

At 1 week of examination, there was a significant difference between the bilirubin levels of the two groups ($p < 0.001$; Table 1). In the 3rd month, the bilirubin level was lower than the pathological bilirubin level, and there was no difference between the two groups ($p>0.05$). Delta frequency was the dominant frequency component during the procedure in both groups. Delta frequency activity decreased and other frequency bands increased with age. When we compared the results of the first recordings in both groups, the delta frequency in the study group was higher, but the alpha, theta and beta frequencies and amplitude levels were significantly lower than those in the control group ($p < 0.001$). We observed that amplitude levels in the second recording study group were similar to those in the control group, and amplitude levels were found to be similar in both groups over a 3-month period ($p > 0.05$; Table 2). There were significant postnatal age-related changes in delta and theta frequencies ($p < 0.001$). Delta frequency decreased and theta frequency increased with age in all brain regions ($p < 0.001$). However, in the hyperbilirubinemia group, delta frequency was higher and theta frequency was lower than the control group ($p < 0.05$). We found that alpha and beta frequencies in the study group were lower than those in the control group in all recordings ($p < 0.05$). A slight increase in alpha frequency with postnatal age was found in the control group, which was not statistically significant. However, the difference between the first and second tests in the study group was significant ($p < 0.05$). Differences in beta frequency with postnatal age were significant only for the left frontal region ($p < 0.05$). In our study, delta activity was the dominant frequency component. Delta frequency in the study group was significantly higher than in the control group, and this activity decreased with age in both groups. On the other hand, theta frequency was lower in the study group than in the control group. Theta frequency increased with age. This may be due to the effect of bilirubin on neuronal functions.

Conclusions

Hyperbilirubinemia has also been observed to cause a temporary delay in brain maturation. . There were significant postnatal age-related changes in delta and theta frequency bands ($p < 0.001$). The frequency of delta decreases in all parts of the cerebral hemispheres and the frequency of theta increases with age. Also, when we conducted babies with bilirubin encephalopathy, abnormal bielectric activity was observed and epileptiform waves were recorded, especially this change in bioelectric activity is a clinical steal of encephalopathy. However, among children in the hyperbilirubinemia group and mild bilirubin encephalopathy, the delta frequency was higher and theta frequency was lower, and the changes between the groups disappeared between the third and sixth months, despite the differences in all brain regions. . In terms of vertex, K complex and sleep spindles, there was no difference between the two groups in the third

month (p>0.05). We found that hyperbilirubinemia affects the cerebrocortical electrical activity, and it depends on the clinical course of bilirubin encephalopathy, the amount of bilirubin in the blood, especially the permeability of the blood-brain barrier.

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