METHOD OF VISUAL EVOKED POTENTIALS IN THE ASSESSMENT OF THE CONDITION OF THE CENTRAL NERVOUS SYSTEMS IN NEWBORNS

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Brain lesions in newborns are one of the basic causes of perinatal mortality and disability in childhoood. At the same time, their diagnosis presents certain difficulties, due to the fact that the immature brain does not give a differentiated response to injury. The physician, as a rule, observes general symptoms: depression or excitation, muscular hypotonia or spasms, etc. The introduction of the ultrasound method into perinatology has fundamentally altered the situation: the diagnosis during life of intraventricular hemorrhages, periventricular leukomalacia, gross defects in the development of the hemispheres and the cerebellum, and hydrocephalus, has become possible. However, it is not possible to verify severe diffuse lesions of the brain substance by means of neurosonography.

At the present time, the method of evoked cortical potentials, in particular visual evoked potentials (VEP) is widely used in neurological clinics. Despite the fact that investigations of VEP in newborns have been carried out for 25–30 years, the diagnostic and prognostic significance of this method remains undetermined, and its use, limited.

It has been established that the VEP can already be recorded in 25–week fetuses in the form of negative waves with a latent period of about 300 msec [4, 5, 18, 20]. The response in 33 to 36–week fetuses becomes more complex as a result of the appearance of an early positive potential and of secondary components [4, 13, 17, 20]. A regular decrease in the latent period of the primary response with age is used for the determination of the maturity of the visual analyzer [5, 13, 17, 20]. Various opinions exist regarding the influence of the level of cerebral activity on the VEP. According to the data of some authors [1, 2, 14, 19], the most stable responses are recorded in the slow phase of sleep; according to others' information [21], in the rapid phase of sleep or in the state of resting wakefulness; according to the data of a third article [20], it is felt that the VEP recorded in the slow and rapid phases of sleep do not reveal substantial differences. Changes in VEP with severe asphyxia consist in an increase in the latent periods and a decrease in the amplitude of the potentials, all the way to the point of complete disappearance of the early positive peak and the secondary waves [8, 12, 13]. The VEP quickly react to change in oxygen content and CO_2 in the blood [10]. Slowing of the maturation of VEP has been identified in prematurely born children who have suffered hemorrhage into the cerebral ventricles [16]. The interpretation of VEP is made difficult by their variability [19]. The absence of adequate mathematical analysis which takes into account the structural features of the tracings is a principal obstacle on the road to the creation of automatic analysis of VEP [14, 17].

The principal purpose of our study was the development of a quantitative analysis of VEP and the determination of the effectiveness of parameters for the objectivization of brain damage. Fifty newborns were examined (22 girls and 28 boys), including 15 healthy infants and 35 with cerebral pathology. All of the children were aged from 4 to 15 days, and were born at from 36 to 40 weeks of gestation. The data of a genealogical analysis, an obstetrical history, and the results of neurological examination and neurosonography (Table 1) were used in the investigatory process.

A syndrome of excitation (in 14) and focal neurological symptomatology (in 17) predominated in the clinical picture of the ill newborns. Changes were identified in 17 children through echographic investigation.

Patients were distributed by nosological types in the following manner: 17 had hypoxic-ischemic encephalopathy (HIE); encephalitis, 7; dyscirculatory encephalopathy, 9; posthemorrhagic hydrocephalus, 2. HIE was diagnosed in the presence of intranatal asphyxia in accordance with the clinical classification of Sarnat (1976). The diagnosis of encephalitis was based on the data of the clinical picture, neurosonography, and serological examination (immunofluorescent screening for cytomegalic

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TABLE 1. The Clinical-Echographic Characteristics of the Ill Newborns

Illness	Total number of children	Clinical picture									Brain echography						
		hydroencephalic syndrome	paroxysmal syndrome	excitation syndrome	depression syndrome	muscle hypertonia	muscle hypotonia	pseudobulbar syndrome	bulbar syndrome	focal symptomatology	no disturbances	calcium deposits	ventricular enlargement	subependymal cysts	subependymal hemorrhages	uni- or multilocular cysts in periventricular divs. of frontal lobes	periventricular leukomalacia
HIE																	
I degree	11	1	0	11	0	0	1	0	0	0	9	0	0	0	2	0	0
II degree	5	0	1	0	3	0	4	1	0	3	1	0	0	0	1	0	4
III degree	1	0	1	0	1	0	1	0	1	1	0	0	1	0	0	0	0
Encephalitis	7	0	2	1	1	1	2	2	0	5	0	2	0	4	2	4	1
Dyscirculatory encephalopathy	9	1	1	2	0	0	1	1	0	8	8	0	0	0	1	0	0
Posthemorrhagic internal hydrocephalus	2	1	1	0	2	0	0	2	0	0	0	0	2	2	2	0	1
Total	35	3	6	14	7	1	9	6	1	17	18	2	3	6	8	4	5

TABLE 2. Frequency of Disturbances of VEP Indices in Ill Children

Illness	AI	AP	FI	DI	CV	No disturbances
HIE						
I degree	2	1	4	6	0	2
II degree	3	2	4	3	0	0
III degree	0	0	1	1	0	0
Encephalitis	2	3	5	4	1	1
Dyscirculatory encephalopathy	1	2	9	6	1	0
Posthemorrhagic internal hydrocephalus	1	1	1	1	0	1
Total . . .	9	9	24	21	2	4

infection). A strongly positive reaction for cytomegalic inclusion disease was obtained in three out of seven encephalitis patients, a doubtful reaction in two, and the the etiology of the remaining patients remained unknown. Dyscirculatory encephalopathy was characterized by increasing focal neurological symptomatology, as a rule, against the background of somatic disease (pneumonia, polycythemia, intrauterine wasting disease, arterial hypertension against the background of a renal artery anomaly, etc.). All of the children with dyscirculatory encephalopathy were born with an Apgar score of 8–9 points at one minute; three had sustained marked mechanical effects in the second period of labor. Posthemorrhagic hydrocephalus was verified with ultrasound examination.

The recording of the VEP in the newborns was carried out 15–20 min following feeding in a state of deep or shallow sleep. A "Medelek" apparatus was used (England): an averager with an analyzer and an ER-94-a amplifier, a pulse generator, and eyeglasses with a red light-emitting diode. Bursts of 100% intensity illumination of the light-emitting diode were utilized. The frequency of stimulation was 0.5 Hz. The responses were recorded through a bipolar lead with the localization of the active electrodes at points O_1 and O_2, the indifferent electrode at point F_2, and the ground, on the wrist. The resistance of the electrodes was less than 2 kΩ. The pass band of the amplifier was from 1 to 125 Hz., the sensitivity 10 μB. The analysis time was 1 sec. The number of stimuli was 32.

Oscillations ranging from 50 to 1000 msec after the stimulus were taken into account in analyzing the curves. In order to exclude subjective bias in determining the peaks, all fluctuations not exceeding 25% of the amplitude of the maximal potential for the period investigated were ignored. Further calculations were carried out on a microcomputer. For purposes of inventorying the morphology of the VEP the following indices were taken into account: the average potential (AP)

$$AP = \frac{A_1 \cdot t_1 + \ldots A_n \cdot t_n}{2\,(t_1 + \ldots t_n)},$$

where A represents the amplitude between neighboring peaks; t is the interval between these peaks; the depolarization index (DI), taking the time gradient into account

$$DI = \frac{AP_1/LP_1 + \ldots + AP_n/LP_n}{AN_1/LN_1 + \ldots + AN_n/LN_n},$$

where AP is the amplitude of the positive potential; AN, the amplitude of the negative potential; LN, the latent period of the peak of the negative potential; LP, the latent period of the peak of the positive potential; frequency index (FI)

$$FI = \frac{N}{T},$$

where N is the number of potentials; T , the sum of the interpeak intervals; asymmetry index (AI)

$$AI = \frac{|AP_r - AP_e)|}{AP_r + AP_e},$$

where AP_r is the average potential on the right; AP_l is the average potential on the left; coefficient of variation (CV)

$$KD = \frac{A_{max}}{AP},$$

where A_{max} is the maximal amplitude.

In the healthy children the VEP parameters ranged in the following limits: AP, from 2.2 to 8.5 μV; the DI, from 0.25 to 2.6; the FI from 6.1 to 11.3 sec^{-1}; the AI from 0 to 0.25; the CV, from 1.8 to 3.4.

The frequency of the disturbances in these indices is presented in Table 2.

The FI and the DI turned out to be the most sensitive characteristics, and the magnitude of their decrease correlated with the severity of the brain damage. Thus, low FI and DI were recorded in patients with a cytomegalovirus etiology with multilocular cystic formations in the periventricular divisions of the frontal lobes (2.0 sec^{-1} and 0.3, respectively) and in newborns with HIE of III degree severity (2.2 sec^{-1} and 1.9). In both of these children gross disturbances in psychomotor development were noted at four months of age; they did not hold up their heads, did not coo, and did not smile. A tendency toward a decrease in the average values of the FI was detected, as a function of the degree of HIE: 6.4 sec^{-1} in HIE of I degree severity; 4.4 sec^{-1} in HIE of II degree severity; 2.2 sec^{-1} in HIE of III degree severity (6.9 sec^{-1} in the norm). The character of the illness and the administration of phenobarbital did not exert any specific influence on the individual parameters or their combinations. Dyscirculatory encephalopathy, associated with a decrease in the FI in 100% of cases, was an exception. In all patients with a paroxysmal syndrome, a simultaneous decrease in the FI and the DI was observed in the inter-attack period.

One child out of four newborns with gross interhemispheric asymmetry (AI > 1.0) had a clinical picture of hemiparesis and ultrasound features of edema of the cerebral hemisphere (collapse of the lateral ventricle, blurring of structures, and increase in their echogenic character). A marked increase in the intensity of the evoked response was recorded on the side of the lesion (AP = 52.3 μV), in addition to a pronounced hyperpolarization of the cortex (DI = 0.04).

Asymmetry of the AP was the only anomaly of the VEP in the remaining children. At the same time, focal neurological symptomatology was combined in one child with the presence of large subependymal cysts; in two there were no clinical or neurosonographic features of focal brain damage.

Thus, our investigations enable us to assert that the VEP method, which is one of the noninvasive procedures, significantly increases the possibilities for the early diagnosis of cerebral injuries in the newborn. At the same time, the quantitative analysis of the VEP makes it possible to obtain more complete information regarding the state of the CNS, and to increase the diagnostic capacity up to 88.7% (48.5% with echography). In this context, it is advisable to include the VEP method in the complex of neurological examinations of the newborn.

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