THE NEW ARMENIAN MEDICAL JOURNAL
Vol.7 (2013), No 4, p. 82-89

ELECTROPHYSIOLOGICAL MONITORING OF AMBLYOPIA PLEOPTIC TREATMENT IN CHILDREN

SARGSYAN I.S.

Ophthalmology Clinic, Yerevan State Medical University, Yerevan, Armenia

Received 8/05/2013; accepted in final form 12/25/2013

ABSTRACT

The visual images recognition is one of the most difficult processes among physiological mechanisms of the brain. Over the past years significant progress was achieved in neurophysiological analysis and insight into the functional basis of these operations of the brain; nevertheless, there is still a "terra incognita" – the great unknown. Most often clinical manifestations of diseases of the retina might be similar, making diagnosis setting difficult. It is precisely for those cases that assessment of functional changes might help in predicting the course of the pathological process.

At the Ophthalmology Clinic of the Yerevan State Medical University after M. Heratsi up to three thousand children receive pleoptic treatment every year. In some cases, treatment may continue for years without the expected result.

Our investigation was primarily aimed to study the role of disturbances at the retinal level in pathogenesis of amblyopia based on the changes in the amplitude and latency of b-wave on electroretinogram, the presence of functional defects in cones of the central zone of the retina in patients with amblyopia at preservation of the cone system. Our first results signified to the appropriateness of clinical electrophysiological control and monitoring on the course of pleoptic treatment in children with amblyopia; hence, an attempt was made to identify pathognomonic signs in electrophysiological indices: electroretinogram and visual evoked potentials of the brain. According to research findings, on the background of the pleoptic treatment a decrease of efferent inhibition and/or the predominance of excitation processes are observed merely in the retina and the visual system. However, mentioned excitation processes are not stable and at termination of pleoptic treatment before the age of the visual fixation final formation (at 12-15 years old) the recovery of visual functions and, thereby, cure of amblyopia are not always possible.

Thus, electrophysiological monitoring of amblyopia pleoptic treatment can be considered as a clinically significant tool to increase the efficiency of amblyopia treatment in children.

Keywords: *amblyopia, treatment, visual system, visual evoked potentials, retina, electroretinography.*

INTRODUCTION

The emergence of amblyopia is associated with inadequate visual experience exceptionally in relatively early childhood as a result of uncorrected anomalies of refraction, strabismus, impaired transparency of refracting media and other states that disrupt the normal formation of the external world images [*Avetisov E., 1968; 1977; Abramov V. 1993*]. Without adequate treatment, the consequences of these conditions can be unavoidable. Clinically it is manifested in the form of functional scotoma of stable inhibition. Hence, the optimal time of amblyopia diagnosis and treatment is early childhood and, most importantly, before the completion of a critical period for visual fixation development (before the age of 5 years).

Amblyopia is a very complex disorder of neuronal interactions both at the level of sensory retina and at central parts of the visual system, in the lateral genicular bodies and visual cortex.

For diagnosis of amblyopia a number of objec-

Yerevan State Medical University after M. Heratsi
60/1 Abovyan Street, 0025, Yerevan, Armenia
Tel.: (+374 91) 330 145
E-mail: sargsyan.inga@gmail.com

tive and subjective methods of ophthalmic research are required. To investigate the functional state of retina the most optimal method is electoretinography (ERG), as well as the study of visual evoked cortical bioelectric potentials of the brain [*Shamshinova A., 1986; Shevelev I., 2006*].

Great difficulties in diagnosis arise in a deep or high degree of amblyopia with no expressed or changes specific to any organic pathology of the retina or the optic nerve (the optic tract). In this regard, we must know and differentiate the symptoms of organic lesions in central and peripheral regions of the retina, optic nerve, optic chiasmus, and central parts of the visual system, which can help in diagnosis setting and identification of amblyopia with its characteristic functional impairments [*Shamshinova A., Volkov V., 1998*].

Therefore, it is important to compare the results of such electrophysiological research methods as ERG, visual evoked potentials (VEP) and psychophysical methods, by which the field of vision and light sensitivity of the eyes, color vision, functional retinal topography of cone system (on/off activity of cone system), the topography of contrast and color sensitivity are studied [*Shamshinova A., 1988; Shpak A., 1993*].

The basis of training effects that could be aimed at restoration of visual functions should imply impacts (in addition to correcting ametropia of optical lenses, occlusion and penalization) not only on various channels involved in the visual system and defining the dysfunction, but also, further on, embrace neurons that retained their function at the level of both retina (cone and rod cells system) and at the level of the visual centers. Therefore, for the recovery of visual functions an amblyopic eye "requires" a whole set of specific and non-specific stimuli [*Campbell F. et al., 1978; Dubovskaya L., Averkina L., 1983; Cherednichenko V., 1994; Vakurina A., 1996; Kashchenko T. et al., 2001; Donahue S. et al., 2007*]: rotating, moving, reversible, color and contrast, temporary and spatial.

In some works attempts were made to use data of ERG and VEP for evaluation of the effectiveness in amblyopia treatment [*Slyshalova N., Shamshinova A., 2008*]. However, there is still an unsolved problem: to identify possible shifts of electrophysiological parameters, which could be considered as pathognomonic at characterizing functions of the central vision and thus correct the course of pleoptic treatment through objective estimation of the effectiveness at various pleoptic interventions.

The ERG refers to one of the most important methods of diagnostic ophthalmology that allows to objectively assess the functional status of various layers and neurons in the retina. The new technology enables to identify subtle violations of bioelectrical activity of the retina; this latter is the basis of the initial and differential diagnosis of retinal diseases of different origin.

The electroretinogram is a graphic expression of the bioelectrical activity of the retina that occurs in response to light stimulation. It reflects the bioelectrical activity of all cellular elements of the retina, ion channels of cell membranes, the neuronal interaction of photoreceptors and retinal neurons. The ERG is used to diagnose diseases of the retina in impairment of rod-and-cone system, for differential diagnosis setting, identification of the process localization, predicting the possibility to recover visual functions and to control the treatment course [*Fishman G. et al., 2001*].

The VEP are electrical signals generated by neurons in the brain in response to light stimulation of eyes. The VEP-based study takes one of the leading places in the diagnosis of visual system-related lesions. The VEP reflect electrical activity of the macular area, which is associated with its larger representation in the *calcarine sulcus* compared to the peripheral parts of the retina, "the cortical magnification factor", which can be expressed linearly in millimeters of the cortical area corresponding to 1 degree of visual angle. Therefore, the VEP value will decrease with the increase of scotomas in the visual field. In this regard, the research methods relevant to VEP provide an opportunity such as changing the value of chess squares for stimulation of the central and paracentral regions of the retina.

The purpose of the study was to identify possible changes of electrophysiological parameters, which could be considered as pathognomonic at characterizing functions of the central vision and, among these latter, correct the course of pleoptic treatment through objective estimation of the effectiveness of various pleoptic interventions in children.

Based on the foregoing it was planned:

- to assess the effectiveness of traditional and modern

methods if applied for pleoptic treatment of children with monolateral strabismic and refractive amblyopia of moderate and high degree through the analysis of ERG data and studies of VEP – for further appropriate correction of therapy tactics;
- to develop techniques for physiologically adequate correction of pleoptic treatment in children with amblyopia based on electrophysiological and clinical efficiency evaluation of applied interventions.

MATERIAL AND METHODS

The study embraced 30 children (18 girls, 12 boys) aged 7 to 15 years with a monocular amblyopia of various degree and maximum corrected visual acuity below 0.3 on the amblyopic eye, without any ophthalmoscopic changes in the fundus and with visual acuity in the fellow eye within the normal range.

It should be noted that by the start of the study 15 children were previously observed in the clinic and received treatment at least twice; these patients made Group 1. Previously untreated children presented the second half of patients (15 children), who formed Group 2.

The patients were examined by conventional methods (visiometry, biomicroscopy, ophthalmoscopy, static and dynamic refractometry, deviametry, etc.). Studies on retinal electrogenesis (mixed, photopic and rhythmic ERG) in binocular manner (both eyes) with a narrow pupil were done. Dysfunction of the higher parts of the visual analyzer was diagnosed with a pattern- and/or flash-VEP. Electrophysiological studies were performed in accordance with the accepted standards of the International Society for Clinical Electrophysiology of Vision (ISCEV) [*Marmor M. et al., 2009*] on ophthalmic diagnostic system ("LKC", USA) before the pleoptic course of treatment and upon its completion.

The following medical techniques of pleoptics were used: direct occlusion, local "blinding" light irritation of the central fovea of the retina, reverse occlusion, general irritation of the retina with light, exercise using Haidinger phenomenon, training of the amblyopic eye on the principle of similarity, exercises in the localization and exercises to overcome the difficulties of separate vision, adapted programmes of computer-based pleoptics.

We analyzed the electrophysiological parameters and identified pathognomonic symptoms, which might indicate a correlation of the studied parameters with the increase in post-therapeutic data on basic visual functions in children, both previously treated and initially receiving pleoptic treatment within our study.

RESULTS

In healthy eyes normal electroretinogram and VEP values were obtained according to the standard clinical ERG under all conditions of stimulation in both groups. The visual acuity remained within normal limits (1.0), both before and after the pleoptic treatment.

At ERG registration in amblyopic eyes of Group 1 children the following was revealed: normal mixed ERG (Table 1) was recorded in 13 children, with a slight decrease in the amplitude of the a- and b-waves – in two of them. The indicators obtained after pleoptic treatment significantly increased in 12 (80%) patients, in other cases the indicators were either unchanged, or close to pretreatment values. Indicators of photopic (Table2) and rhythmic photopic ERG (Table3) were recorded in the normal range, but after treatment there was an increase in the amplitude of a-and b-waves in 75% of cases.

After the next pleoptic treatment we did not observe any expected increases on the part of visiometric data in the specified group of children.

At ERG registration in amblyopic eyes of Group 2 children the normal mixed (Table1) and photopic ERG (Table 2) was recorded in all of them, but the amplitudes of a- and b- waves were significantly lower than in children from Group 1. After treatment, in 33.3% of cases there was an increase in studied parameters, while in two children indices decreased by 10-15% as compared to pretreatment levels; this latter will be obviously considered in our further expected research. Interestingly, the analysis of rhythmic photopic ERG (Table 3) outcomes revealed an increased amplitude indicators in 87% of cases, thus exceeding the values in Group 1 children; after treatment there was an increase visual acuity in all patients.

As regards the VEP study (chess pattern 64×64 (Table 4), 32×32 (Table 5), 8×8 (Table 6)), the high correlation of amplitudes increase was observed with increasing data of visiometry in children of both groups. However, more pronounced changes in the amplitude of P_{100} component towards its increase

Table 1.

Scotopic 0 dB flash ERG

	Before treatment										After treatment									
	OD					OS					OD					OS				
	a		b		diff	a		b		diff	a		b		diff	a		b		diff
	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV
I group (with positive changes)																				
1	-393.8	17.5	315.1	37.0	708.9	-444.8	17.0	67.9	32.0	376.9	-393.0	12.0	420.2	37.0	813.2	-445.0	17.0	70.0	35.0	515.0
2	-281.6	17.5	63.2	31.0	344.8	-133.3	22.0	318.4	37.0	451.7	-264.4	23.5	367.4	39.5	631.9	-133.3	22.0	418.4	37.0	551.7
3	-370.0	22.5	12.1	37.0	382.1	-421.3	22.0	93.8	34.5	515.1	-428.5	22.5	43.3	36.0	471.8	-436.0	22.0	272.3	49.0	708.3
4	-246.9	21.0	303.1	37.0	550.0	-399.6	20.5	258.9	37.0	658.5	-394.6	15.5	365.9	34.0	760.5	-544.8	13.0	452.0	44.0	996.8
5	-288.7	21.0	169.0	30.0	457.7	-400.5	22.5	164.8	32.0	565.2	-439.7	19.5	185.2	35.5	624.9	-350.0	17.5	288.2	40.5	638.2
6	-259.1	18.5	170.2	27.3	429.3	-244.2	20.9	251.3	32.0	495.5	-311.1	19.0	215.3	35.0	525.4	-305.2	18.0	301.2	41.0	606.4
7	-251.6	19.0	311.1	27.9	562.7	-154.1	22.1	321.4	32.0	475.5	-301.1	20.0	415.1	35.0	716.2	-315.4	19.5	426.2	41.0	741.6
8	-172.3	18.0	396.2	31.5	568.5	-216.2	22.0	518.4	32.5	734.6	-276.6	21.5	417.9	35.0	694.5	-141.5	22.5	734.1	47.0	875.6
9	-373.1	17.5	215.1	37.0	588.2	-344.8	17.0	167.6	32.0	512.4	-493.0	12.0	420.2	37.0	913.2	-445.3	17.0	170.0	35.0	615.3
10	-381.2	17.5	163.3	31.0	444.5	-233.1	22.0	218.1	37.0	451.2	-164.4	23.5	387.0	39.5	551.4	-233.1	22.0	418.3	37.0	651.4
I group (without positive changes)																				
1	-72.9	19.0	396.2	31.5	469.1	-116.2	22.0	718.4	36.5	834.6	-76.6	21.5	417.9	35.0	494.5	-141.5	22.5	734.1	47.0	875.6
2	-269.1	17.5	91.9	34.5	361.0	-228.5	17.0	195.8	34.5	424.3	-269.0	17.6	92.0	35.0	361.0	-228.5	17.0	199.0	35.5	424.5
3	-254.4	18.0	256.2	31.0	510.6	-215.5	22.0	324.3	32.0	539.8	-263.4	18.0	282.2	31.0	545.6	-215.5	22.0	334.3	32.0	549.8
4	-360.1	22.5	212.1	37.0	572.2	-321.1	22.0	93.2	34.5	414.3	-438.5	22.5	143.4	36.0	581.9	-336.0	22.0	98.3	49.0	434.3
5	-270.2	17.5	112.4	37.0	382.6	-321.3	22.0	103.8	34.5	425.1	-438.5	22.5	143.3	36.0	581.8	-436.3	22.0	272.3	49.0	708.6
II group (with positive changes)																				
1	-229.9	21.5	253.0	34.5	482.9	-234.3	21.0	418.4	35.5	652.7	-269.8	20.5	314.2	36.0	584.0	-308.1	19.5	438.0	35.5	746.1
2	-258.9	24.0	217.9	40.5	476.8	-246.2	18.5	279.2	46.0	525.4	-291.1	20.5	282.4	36.0	573.5	-298.9	19.5	311.0	35.0	609.9
3	-259.3	18.2	170.5	27.5	429.8	-244.5	21.9	251.1	32.2	495.6	-311.5	19.0	215.4	35.2	525.9	-305.4	18.0	301.4	41.1	606.8
4	-251.4	17.0	214.2	35.2	465.6	-194.2	18.0	321.0	32.5	515.0	-251.0	17.2	314.2	34.5	565.2	242.1	18.0	350.0	32.5	592.1
5	-253.6	18.0	313.1	27.8	566.7	-153.1	22.1	325.4	32.2	478.5	-301.6	18.0	415.2	35.2	716.8	-315.6	19.5	426.3	41.0	741.9
II group (without positive changes)																				
1	-231.1	18.0	321.4	35.2	552.5	-189.1	18.9	234.2	35.5	468.4	-227.7	18.2	323.9	35.2	551.6	-200.0	19.0	201.5	35.2	401.5
2	-281.0	17.5	163.2	31.0	444.2	-133.0	22.0	312.4	37.0	445.4	-244.4	23.2	127.4	39.5	371.8	-100.3	22.0	328.4	37.0	428.7
3	-269.3	17.5	91.1	34.5	360.4	-228.2	17.0	195.4	34.5	424.6	-269.1	17.6	92.5	35.0	361.6	-223.2	17.0	222.2	35.5	445.4
4	-211.5	17.5	215.2	35.5	426.7	-194.1	18.5	214.1	35.5	408.2	-214.4	17.6	216.4	35.5	430.8	-201.1	19.0	215.1	35.2	416.2
5	-310.0	19.0	254.2	35.0	560.2	-201.3	18.0	204.5	32.0	405.8	-350.5	18.0	234.2	35.0	584.7	-214.2	18.5	211.1	32.5	425.3
6	-235.2	17.4	265.1	33.2	500.3	-271.3	18.5	200.1	32.2	471.4	-235.2	17.4	265.1	33.2	500.3	274.5	18.6	207.4	32.2	481.9
7	-247.1	18.4	198.5	32.5	445.6	221.3	17.5	172.1	33.0	393.4	-247.1	18.4	198.5	32.5	445.6	241.0	17.9	175.5	32.5	416.5
8	-301.2	17.5	201.1	31.2	502.3	-251.4	19.2	214.3	32.5	465.7	-301.2	17.5	201.1	31.2	502.3	252.5	20.0	231.4	33.0	483.9
9	-254.7	18.0	288.7	31.2	543.4	-214.4	21.5	254.1	32.0	468.5	-271.2	18.2	300.1	31.2	571.3	-215.4	20.1	260.1	32.5	475.5
10	-254.1	18.0	256.1	31.0	510.2	-212.3	22.0	322.3	32.0	534.6	-261.4	18.0	282.0	31.0	543.4	-215.0	22.0	334.3	32.0	549.3

The New Armenian Medical Journal, Vol.7 (2013), No 4, p. 82-89

Table 2.

Photopic 0 dB flash ERG

	Before treatment										After treatment									
	OD					OS					OD					OS				
	a		b		diff	a		b		diff	a		b		diff	a		b		diff
	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV	μV	ms	μV	ms	μV
I group (with positive changes)																				
1	-30.0	17.0	92.0	33.0	122.0	-15.0	14.2	73.2	30.5	88.2	-30.0	17.0	100.0	33.4	130.0	-16.0	14.5	75.0	31.0	101.0
2	-36.1	15.0	41.3	31.5	77.4	-45.0	15.0	45.0	31.5	80.0	-22.1	17.5	192.2	32.5	170.1	-8.2	16.0	164.7	30.5	172.9
3	-65.2	16.0	37.2	32.0	102.4	-73.9	15.0	30.5	32.5	106.4	-120.9	15.5	26.2	32.5	147.1	-43.6	17.0	98.4	30.5	142.0
4	-11.4	15.5	88.8	32.5	77.4	-10.3	12.5	99.3	30.0	109.6	-124.9	15.0	36.2	32.1	161.1	-43.1	16.0	108.4	30.5	151.5
5	-98.5	15.5	236.9	31.5	138.3	-60.5	11.5	227.9	32.5	167.4	-38.3	16.0	152.3	31.5	190.6	-191.1	12.0	209.5	31.0	218.4
6	-43.6	15.5	48.0	32.0	91.6	-95.6	17.0	36.5	32.5	132.0	-87.0	18.5	69.3	31.5	156.3	-80.2	15.0	65.5	32.5	145.7
7	-34.1	15.0	58.4	31.9	92.5	-99.5	15.5	78.9	32.0	178.4	-34.0	15.5	71.7	32.0	105.7	-99.1	15.5	85.5	32.2	184.6
8	-68.5	14.9	85.5	32.0	154.0	-35.5	15.0	45.0	32.2	80.5	-68.9	15.0	95.9	32.2	164.8	-38.3	15.2	59.9	32.0	98.2
9	-51.1	15.2	35.2	32.1	86.3	-35.1	15.2	58.2	32.0	93.3	-51.0	15.0	58.8	32.0	109.8	-35.0	14.9	74.2	32.0	109.8
10	-49.1	14.8	39.2	32.5	88.3	-55.0	15.1	41.1	32.1	96.1	-49.9	15.2	68.8	32.0	118.7	-60.1	15.0	69.1	32.1	129.1
11	-51.0	15.0	35.2	32.0	86.2	-32.1	15.2	35.1	32.1	67.2	-51.6	15.2	48.2	32.1	99.8	-35.7	15.6	51.0	32.0	86.7
12	-45.2	15.2	41.0	32.1	86.2	-39.2	15.0	29.5	30.9	68.7	-51.2	15.2	58.6	32.0	109.8	-45.1	15.2	51.2	31.9	96.3
I group (without positive changes)																				
1	-41.2	15.0	53.2	32.0	94.4	-41.2	15.2	64.5	32.2	105.7	-41.3	15.2	53.3	32.1	94.6	-41.5	15.0	64.5	32.0	106.0
2	-26.7	15.0	95.3	32.0	120.0	-20.0	13.0	72.6	31.5	92.6	-26.7	15.0	97.5	32.0	122.2	-20.0	13.0	74.6	31.7	94.6
3	-39.0	15.3	41.0	32.4	80.0	-35.2	15.0	35.5	32.0	70.7	-39.2	15.0	41.5	32.0	81.7	-35.0	15.1	36.0	32.1	71.0
II group (with positive changes)																				
1	-26.5	15.0	94.3	32.0	120.8	-25.0	15.0	75.6	32.5	100.6	-26.5	15.5	107.5	32.3	134.0	-20.5	13.2	89.9	31.5	110.4
2	-30.2	15.0	82.0	3.0	112.0	-25.1	15.2	63.2	30.5	88.3	-35.0	17.0	95.0	32.4	120.0	-16.7	15.5	85.1	32.0	111.8
3	-36.1	15.0	51.3	31.5	87.4	-45.2	15.0	45.5	31.5	90.7	-36.1	15.5	92.3	32.5	128.4	-38.2	15.0	69.7	31.5	107.9
4	-78.5	15.5	86.9	31.5	165.4	-60.5	11.5	77.9	32.5	138.4	-88.7	16.0	92.3	31.5	269.2	-91.1	12.0	77.5	31.0	168.6
5	-43.6	15.5	48.0	32.0	91.6	-95.6	17.0	36.5	32.5	132.0	-87.0	18.5	69.3	31.5	156.3	-80.2	15.0	65.5	32.5	145.7
II group (without positive changes)																				
1	-86.2	15.0	54.2	32.0	140.4	-53.5	15.0	130.5	32.5	184.0	-58.1	15.5	46.2	32.5	104.3	-43.6	17.0	55.3	40.5	108.9
2	-51.5	15.5	88.7	32.5	139.2	-20.3	12.5	89.3	30.0	109.6	-12.0	15.5	88.0	32.5	100.0	-43.6	17.0	38.4	30.5	82.0
3	-52.4	15.2	45.2	31.8	97.6	-61.1	15.5	38.3	32.2	99.4	-53.5	15.5	46.5	32.0	100.0	-62.2	15.5	40.1	31.0	102.3
4	-37.3	15.5	42.2	32.0	79.5	-51.3	15.5	45.4	32.0	96.7	-37.2	15.5	45.1	32.0	82.3	-50.9	15.1	46.6	32.2	97.5
5	-43.6	15.5	48.0	32.0	91.6	-95.6	17.0	36.5	32.5	132.0	-87.0	18.5	69.3	31.5	156.3	-80.2	15.0	65.5	32.5	145.7
6	-51.2	15.2	35.4	32.1	86.6	-35.1	15.2	58.1	32.0	93.2	-41.3	15.0	48.3	32.0	89.6	-35.0	14.9	54.2	32.0	89.2
7	-41.2	15.0	53.2	32.0	94.4	-41.2	15.2	64.5	32.2	105.7	-41.3	15.2	53.3	32.1	94.6	-41.5	15.0	64.5	32.0	106.0
8	-26.7	15.0	95.3	32.0	120.0	-20.0	13.0	72.6	31.5	92.6	-26.7	15.0	97.5	32.0	122.2	-20.0	13.0	74.6	31.7	94.6
9	-30.1	15.0	94.3	32.0	124.4	-24.1	15.2	94.1	31.5	118.2	-30.2	15.2	95.0	32.2	125.2	-25.1	15.2	100.1	31.5	125.3
10	-34.1	15.0	58.4	31.9	92.5	-99.5	15.5	78.9	32.0	178.4	-34.0	15.5	61.7	32.0	95.7	-99.5	15.5	79.5	32.2	179.0

were observed in children of Group 1.

It is interesting to mention that in healthy eyes of Group 2 children the changes were also observed: shifts in VEP indices were both upward and downward directed in 12 patients.

Discussion

Normal values of electrophysiological parameters in healthy eyes indicate to the absence of ophthalmopathology, as well as the monocular nature of amblyopia.

The expressed interocular asymmetry in parameters of two above-mentioned groups regarding prior to and post-treatment allowed us to consider the identified changes as pathognomonic for the specified patients: distinct electrophysiological changes were recorded on the background of the therapy.

Marked changes on the electrophysiological curves obtained for data of Group 1 children signify that treatment of amblyopia should be gradually dosed and long-lasting, because each subsequent treatment course can establish and strengthen the result of the previous one. Moreover, despite anticipations, during this study in children of Group 1 no specific increase of visiometric data was observed; however, the improvement in visual

Table 3.

Photopic 0 dB 30 H ERG

	Before treatment				After treatment			
	OD		OS		OD		OS	
	μV	*ms*	*μV*	*ms*	*μV*	*ms*	*μV*	*ms*
I group (with positive changes)								
1	98.8	29.9	79.4	29.6	100.0	29.9	95.2	30.0
2	53.6	27.9	29.5	27.0	60.0	27.9	68.0	27.8
3	42.5	31.6	43.9	31.5	44.3	29.3	71.2	30.0
4	73.7	27.0	78.3	31.1	105.2	27.9	109.8	27.1
5	59.3	30.6	74.9	28.3	93.8	29.8	88.7	27.3
6	62.9	27.8	86.5	29.3	72.5	27.8	99.0	29.3
7	68.3	27.9	54.6	30.7	100.3	29.4	69.8	31.1
8	65.4	27.4	79.9	28.0	78.8	27.1	86.3	27.4
9	38.5	31.1	78.9	29.5	51.5	28.1	81.7	27.1
10	65.2	27.8	88.0	29.0	69.8	27.1	90.0	30.4
I group (without positive changes)								
1	68.7	29.4	53.5	29.3	68.9	29.5	53.9	30.0
2	56.4	27.0	71.5	27.0	57.1	27.0	72.1	27.7
3	65.5	27.1	87.1	27.1	65.4	31.1	87.7	27.4
4	29.8	27.0	90.1	27.7	30.0	29.1	90.3	27.4
5	57.5	28.8	68.1	28.2	57.9	27.1	67.8	30.1
II group (with positive changes)								
1	54.9	28.0	58.4	28.5	59.7	28.1	69.1	29.1
2	81.2	27.2	54.4	27.4	84.0	27.5	59.9	27.0
3	48.2	27.2	79.4	27.4	58.4	27.2	89.9	27.5
4	58.0	27.5	54.4	28.5	91.1	28.4	56.5	27.9
5	61.2	30.0	79.8	27.1	76.1	28.0	84.2	33.1
6	29.8	27.4	84.5	27.4	56.1	27.0	90.0	27.4
7	55.5	270	54.4	28.1	66.8	27.1	64.4	27.1
8	54.5	27.1	68.4	27.1	68.1	27.1	88.8	27.4
9	56.7	27.0	71.4	27.5	78.5	27.1	95.5	27.4
10	51.5	27.4	64.4	27.9	94.4	28.1	78.8	27.4
11	65.1	29.1	81.1	27.1	75.8	28.4	91.4	27.5
12	44.4	28.5	24.4	27.0	48.5	27.1	55.1	29.7
13	51.1	27.0	89.7	27.9	71.1	27.0	970	31.0
II group (without positive changes)								
1	49.5	28.1	28.1	28.0	49.5	27.7	57.1	27.8
2	82.2	28.5	28.5	29.1	82.4	28.1	58.9	31.4

Table 4.

Pattern VER 64*64

	Before treatment				After treatment			
	Amp. P1		Time Label P1		Amp. P1		Time Label P1	
	OD	OS	OD	OS	OD	OS	OD	OS
I group (with positive changes)								
1.	4.2	1.9	105.5	104.5	4.5	2.9	110.0	110.0
2.	3.6	4.9	99.0	98.0	4.9	6.1	100.0	101.0
3.	11.3	16.9	76.5	77.0	20.4	25.8	78.5	77.5
4.	6.2	7.0	99.5	97.0	34.0	9.0	109.5	109.0
5.	17.9	8.5	100.5	103.5	24.0	33.0	107.5	112.5
6.	13.1	14.3	102.5	101.5	14.8	18.6	107.5	110.0
7.	7.0	6.0	97.5	98.5	16.5	8.5	100.0	100.0
8.	7.2	15.2	109.0	100.0	14.0	16.5	110.0	105.0
9.	26.8	18.0	98.5	119.0	29.4	23.1	100.0	104.5
10.	26.9	23.0	107.5	109.5	31.7	28.5	112.5	116.0
I group (without positive changes)								
1.	19.6	14.0	107.0	119.5	19.6	14.2	111.0	120.0
2.	8.5	5.9	98.5	99.5	8.6	5.9	100.0	100.0
3.	16.2	30.0	103.0	105.5	16.0	30.0	100.0	105.5
4.	18.0	8.8	105.5	105.5	17.5	9.0	105.5	105.5
5.	18.7	8.7	102.0	102.5	18.7	9.0	102.0	102.0
II group (with positive changes)								
1.	4.2	4.7	103.0	97.5	12.3	15.6	102.2	105.0
2.	3.6	4.6	119.0	100.0	7.7	13.0	116.5	102.0
3.	11.3	16.4	98.0	102.5	31.1	20.2	97.5	99.5
4.	6.2	19.0	112.5	111.0	15.2	20.8	117.2	112.0
5.	17.9	45.1	121.5	110.5	29.1	46.6	117.0	108.0
6.	13.1	3.3	100.0	97.5	11.6	8.7	102.2	100.0
II group (without positive changes)								
1.	17.5	18.1	105.5	100.0	17.6	18.2	105.5	100.5
2.	34.3	37.5	112.0	113.0	34.3	37.5	110.5	104.0
3.	16.3	6.5	106.0	121.0	16.5	6.8	106.5	120.0
4.	20.8	29.7	109.0	108.0	20.8	29.8	109.0	108.0
5.	20.4	24.8	103.0	100.5	21.0	23.5	104.0	100.8
6.	14.8	35.3	116.5	97.5	15.2	35.2	116.5	100.0
7.	10.2	11.2	100.0	102.0	10.5	11.5	100.5	105.0
8.	18.8	31.9	123.5	117.5	19.2	32.1	125.5	125.1
9.	10.7	23.0	101.5	100.5	11.2	23.2	101.8	105.1

TABLE 5.

Pattern VER 32*32

	Before treatment				After treatment			
	Amp. P1		Time Label P1		Amp. P1		Time Label P1	
	OD	OS	OD	OS	OD	OS	OD	OS
I group (with positive changes)								
1.	10.2	3.9	100.5	100.5	15.5	6.9	100.0	100.0
2.	3.6	4.9	100.0	98.0	6.9	8.1	100.0	100.0
3.	11.3	16.9	100.5	100.0	20.4	25.8	100.5	100.5
4.	26.2	7.0	100.5	97.0	34.0	9.0	109.5	109.0
5.	7.0	6.0	97.5	108.5	16.5	9.5	100.0	100.0
6.	7.2	15.2	109.0	100.0	14.0	18.5	110.0	105.0
7.	26.8	18.0	98.5	119.0	26.4	25.1	100.0	104.5
8.	26.9	23.0	107.5	109.5	31.7	28.5	112.5	116.0
9.	18.7	8.7	102.0	100.0	20.7	19.0	102.0	102.0
I group (without positive changes)								
1.	11.6	14.5	101.0	100.5	11.9	14.5	100.0	100.0
2.	17.9	8.5	100.5	103.5	18.0	9.0	101.5	101.5
3.	8.9	6.9	108.5	99.5	9.1	7.1	100.0	100.0
4.	13.1	14.3	102.5	101.5	13.8	14.6	107.5	110.0
5.	16.2	30.0	103.0	105.5	16.0	30.0	100.0	105.5
6.	18.0	8.8	105.5	105.5	17.5	9.0	105.5	105.5
II group (with positive changes)								
1.	8.7	4.7	103.0	97.5	12.3	15.6	102.2	105.0
2.	5.8	4.6	119.0	100.0	9.7	13.0	116.5	102.0
3.	29.5	16.4	98.0	102.5	34.1	20.2	97.5	99.5
4.	8.5	19.0	112.5	111.0	15.2	22.8	117.2	112.0
5.	21.0	45.1	121.5	110.5	29.1	49.6	117.0	108.0
II group (without positive changes)								
1.	14.8	35.3	116.5	97.5	15.2	35.2	116.5	100.0
2.	17.5	18.1	105.5	100.0	17.6	18.2	105.5	100.5
3.	34.3	37.5	112.0	113.0	34.3	37.5	110.5	104.0
4.	16.3	6.5	106.0	121.0	16.5	6.8	106.5	120.0
5.	20.8	29.7	109.0	108.0	20.8	29.8	109.0	108.0
6.	20.4	24.8	103.0	100.5	21.0	23.5	104.0	100.8
7.	10.2	11.2	100.0	102.0	10.5	11.5	100.5	105.0
8.	18.8	31.9	123.5	117.5	19.2	32.1	125.5	125.1
9.	10.7	23.0	101.5	100.5	11.2	23.2	101.8	105.1
10	15.1	9.2	100.1	100.5	15.5	9.9	100.1	100.5

TABLE 6.

Pattern VER 8*8

	Before treatment				After treatment			
	Amp. P1		Time Label P1		Amp. P1		Time Label P1	
	OD	OS	OD	OS	OD	OS	OD	OS
I group (with positive changes)								
1.	18.2	8.9	111.5	101.5	24.5	12.9	111.0	110.0
2.	13.6	4.9	99.2	98.9	14.9	9.1	100.0	101.0
3.	11.3	11.9	79.9	79.9	15.4	28.8	100.5	107.5
4.	9.2	8.0	109.5	97.9	14.0	11.0	109.5	109.0
5.	12.9	6.5	110.5	102.5	23.0	13.0	107.5	112.5
6.	14.1	14.3	100.5	100.5	18.8	21.6	107.5	110.0
7.	7.0	7.2	99.5	100.5	19.5	9.5	100.0	100.0
8.	7.2	15.2	100.0	102.0	14.0	18.5	100.0	105.0
9.	26.8	18.0	98.0	110.0	39.4	25.1	111.0	111.5
10.	16.9	13.0	101.9	101.5	31.7	24.5	102.5	112.0
I group (without positive changes)								
1.	10.2	20.0	103.5	101.5	10.4	20.4	110.0	111.5
2.	11.1	15.0	108.0	100.5	11.6	15.2	111.0	110.0
3.	7.5	4.9	108.5	100.5	8.0	5.1	100.0	100.0
4.	17.0	8.8	105.0	105.5	17.5	9.0	100.5	105.5
5.	18.5	8.7	102.5	102.5	18.7	9.1	101.0	102.0
II group (with positive changes)								
1.	8.7	4.7	103.0	97.5	12.3	15.6	102.0	101.0
2.	16.3	6.5	106.0	121.0	20.5	9.8	101.5	110.0
3.	5.0	5.6	119.0	100.0	8.9	15.0	100.5	100.0
4.	8.5	19.0	112.5	111.0	15.2	20.8	117.2	112.0
5.	21.0	45.1	121.5	110.5	29.1	46.6	117.0	108.0
II group (without positive changes)								
1.	11.5	11.1	105.5	100.0	12.0	11.2	105.5	100.5
2.	13.3	17.5	112.0	113.0	13.3	18.0	100.0	104.0
3.	10.8	19.5	109.0	108.0	10.9	19.7	105.0	108.0
4.	10.4	13.8	103.0	100.5	11.0	13.5	104.0	100.8
5.	29.5	16.4	98.0	102.5	30.1	16.2	107.5	109.5
6.	14.8	35.3	116.5	97.5	15.2	35.2	116.5	100.0
7.	10.2	11.2	100.0	102.0	10.5	11.5	100.5	105.0
8.	18.8	31.9	123.5	117.5	19.2	32.1	125.5	125.1
9.	10.7	23.0	101.5	100.5	11.2	23.2	101.8	105.1
10.	9.1	15.2	100.1	100.0	9.3	15.3	100.5	100.0

acuity after the previous courses of therapy was reported in all patients of the Group.

The results obtained in two specified groups might indicate a decrease in the efferent inhibition or prevalence of excitation processes in the retina itself on the background of the pleoptic treatment. However, according to some authors and our own research results the indicated excitation processes are not stable; at long-term interruption of pleoptic treatment before the age of finally formed visual fixation (12-15 years) the recovery of visual functions and thereby cure of amblyopia is not feasible. Hence, a conclusion might be drawn: if after primary pleoptic treatment there is no desired increase in visiometry data and electrophysiological parameters, as observed in children from Group 2, it is not justified to discontinue treatment. At the same time, improved electrophysiologic responses after treatment, even if non-corrected with the increase of visiometric data, can clearly testify to the positive impact of therapy repeated course, which can improve visual acuity in the amblyopic eye.

Thus, electrophysiological monitoring of pleoptic treatment of amblyopia can be considered as a clinically significant tool to increase treatment efficiency of amblyopia in children.

REFERENCES

1. *Abramov V.G.* [The main diseases of eyes in childhood and their clinical features][published in Russian]. Moscow. Mobile. 1993. 493p.
2. *Avetisov E.S.* [Concomitant strabismus][published in Russian]. Moscow. Meditsina ("Medicine" Publishers). 1977. 311p.
3. *Avetisov E.S.* [Disbinocular amblyopia and its treatment][published in Russian]. Moscow. Meditsina ("Medicine" Publishers). 1968. 207p.
4. *Bogoslovskiy A.I.* [Clinical electrophysiology of the visual system in ophthalmology practice][Article in Russian]. Vestn. oftalmol. 1982; 6: 56-63.
5. *Campbell F.W., Hess R.F., Watson P.G., Banks R.* Preliminary results of a physiologically based treatment of amblyopia. Br. J. Ophthalmol. 1978; 62: 748-755.
6. *Cherednichenko V.M.* [Method and device for amblyopia treatment][Article in Russian]. Oftalmol. zhurn. 1994; 5: 277-279.
7. *Donahue S.P.* Pediatric Strabismus. The New England Journal of Medicine. 2007; 356(10): 1040-1047.
8. *Dubovskaya L.A., Averkina L.N.* [Reflexotherapy in complex treatment of children with amblyopia and strabismus][published in Russian]. 2nd All-Union Conference on actual problems of paediatric ophthalmology. Abstracts. Moscow. 1983. P. 87-88.
9. *Fishman G.A.* The electroretinogram. In: Fishman G.A., Birch D.G., Holder G.E., Brigell M.G., eds. Electrophysiologic testing in disorders of the retina, optic nerve, and visual pathways. Foundation of the American Academy of Ophthalmology. Singapore. 2001. 155p.
10. *Ibatulin R.A.* [Visual functions in amblyopia according to data of psychophysical and electrophysiological studies][published in Russian]. Author's Thesis of Dissertation for Candidate of Med. Science. Moscow. 1998. 26p.
11. *Kashchenko T.P., Shomo P., Rabichev I.E. et al.* [A method for restoring binocular vision] [published in Russian]. Patent of the Russian Federation No. 2173119. Bulletin of Inventions (BI). 2001.
12. *Marmor M.F., Fulton A.B., Holder G.E., Miyake Y., Brigell M.* ISCEV standard for full-field clinical electroretinography (2008 update). Documenta Ophthalmologica. 2009; 118(1): 69-77.
13. *Shamshinova A.M.* [Electrophysiological methods in clinical studies of eye diseases: a review of the literature][published in Russian]. MRZH (Medical Abstracts Journal). 1986; 8(56): 1-11.
14. *Shamshinova A.M.* [Local ERG and its role in the clinic of eye diseases][published in Russian]. Rehabilitation. Collected Scientific Papers of Helmholtz Moscow Research Institute of Eye Diseases. Moscow. 1988. P. 137-148.
15. *Shamshinova A.M., Volkov V.V.* [Functional methods of investigation in ophthalmology] [published in Russian]. Moscow. Meditsina ("Medicine" Publishers). 1998. P. 415-419.
16. *Shevelev I.A.* [Neuronal mechanisms of visual images recognition: Clinical physiology of vision][published in Russian]. Moscow. Meditsina ("Medicine" Publishers). 2006. 192p.
17. *Shpak A.A.* [The study of visual evoked potentials in ophthalmology and ophthalmic surgery][published in Russian]. Moscow. Intersectoral Research and Technology Complex "Eye Microsurgery". 1993. P. 190 -191.
18. *Slyshalova N.N., Shamshinova A.M.* [Bioelectrical activity of the retina in amblyopia][Article in Russian]. Vestn. Oftalmol. 2008; 4: 32-36.
19. *Vakurina A.E.* [Treatment of amblyopia and strabismus in children by dynamic color stimuli due to the interference of polarized light] [published in Russian]. Author's Thesis of Dissertation for Candidate of Med. Science. 14.00.08. Moscow. 1996. 26p.