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Research Article

Various Surgical Modalities of Pterygium

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Abstract

Primary open-angle glaucoma (POAG) is a chronic progressive optic neuropathy. The expected prevalence of glaucoma in the world in 2020 is about 80 million people, and in 2040 - about 112 million. There are about 1.3 million patients with glaucoma officially registered in the Russian Federation, which is a couple of times less than the permissible calculated indicators. High myopia is relevant in the pathogenesis of glaucoma, especially POAG, although increased IOP remains the main risk factor for this condition.

The goal of the work is to identify risk factors for the development of POAG, early changes in functional tests in students and assess the dynamics of indicators when using fractal photostimulation (FPS) in comparison with patients with POAG.

The study contained searching for references between newly significant risk factors according to ICO and initial changes in functional tests - standard automated perimetry (SAP), assigning FPS according to questionnaire data and degree of refraction violation and estimating the dynamics of these indicators against the background before the treatment of FPS.

The study was conducted in 3 clinical groups: 1 - students with myopia - 24; 2 - 29 patients with POAG; 3 - control of 66 students with myopia. Risk factors for developing glaucoma were studied by questioning. Intraocular pressure (IOP) was evaluated in patients with myopia who were homogeneous by age and gender (ICare TA01i, Eyecare OY tonometer). SAP (SITA-Standard, Humphrey, CarlZeissMeditec, 24-2 and Threshold Center1 AP-5000C Kowa) was performed. The dynamics of the perimety indices Mean Deviation (MD) and Pattern Standard Deviation (PSD) was evaluated before and after the course of ten 10-minute sessions of FPS. Results: risk factors for the development of eye diseases were identified. Participants noted a decrease in subjective eye discomfort after FPS sessions. The level of IOP in students with myopia decreased after mydriasis, which can be explained by the combined effect of the drug phenylephrine hydrochloride and tropicamide. In group 1 IOP was measured before and after ten FPS sessions: in participants with mild myopia IOP of the right eye decreased by an average of 0.42 mm Hg and the left eye by 0.63 mm Hg; with moderate myopia the IOP of the right eye did not change, and the left eye decreased by 0.54 mm Hg. In patients with POAG, a decrease in IOP comprised: in Ia stage 0.75 and 1.00 mm Hg for the right and left eyes accordingly; for IIa stage patients the decline was 1.30 mm Hg gor both eyes; in POAG IIIa pations it was 2.28 and 1.28 mm Hg accordingly. When comparing the perimetric indices before and after treatment with FPS in cases of mild degree myopia, MD increased, on average, by 0.96 dB for both eyes, moderate myopia showed a increase in MD by 0.94 and 1.29 dB for right and left eyes accordingly. In patients with POAG the decline of MD was accounted: in Ia stage 0.11 dB for right eye and 0.25 for left eye; in stage IIa, MD decreased by an average of 1.17 dB for OD and 1.13 dB for OS. The greatest effect was found in the eyes with POAG IIIa, where the average defect in the field of view decreased by 6.39 dB.

Keywords: Fractal Optical Stimulation; Open-angle Glaucoma; Myopia; Perimetric Indices; Risk Factors; ICare Tonometry

Introduction

Primary open-angle glaucoma is a chronic progressive optic neuropathy. The expected prevalence of glaucoma in the world in 2020 is approximately 80 million people, and in 2040 - about 112 million [1-5,33]. In Russian Federation the official accounting consists of about 1.3 million patients with glaucoma. Of the 72 thousand people with vision disabilities registered in Russia, 27% are patients with glaucoma [7]. For a possible decrease of progression and extension of this condition the establishment of glaucoma's risk factors is becoming very actual starting from a young age.

The development and progression of glaucoma in the presence of axial myopia is investigated by scientists for many years. The prevalence of myopia is growing every year. It is assumed that by 2050 the number of near-sighted people in the world will be 5 billion, and about half of the world population will become myopic with 10% complicated myopia among them [45]. Supposedly, the prevalence of myopia is rising with urbanization expansion, changes in the environment, lessening the time outdoors in children, high educational requirements.

High myopia is relevant in the pathogenesis of glaucoma, especially POAG, although the increased IOP remains the main risk factor for this condition. Patients with axial myopia often have specific morphological and functional changes, which can cause difficulties in differential diagnosis with glaucoma during diagnostic manipulations. These include structural changes in optic nerve head, specific zone of peripapillary atrophy, various changes in vision fields on SAP, variation of the IOP above or below the average indexes [10].

High level of IOP in myopia development mentioned in three-factor theory of myopia pathogenesis described by Dashevsky A.I. and Avetisov E.S.: a weakened accommodation does not cope with the near work along with hereditary predisposition and stretchable sclera with IOP pulling it [14,50]. Ophthalmohypertension in persons with myopia is explained by the presence of goniodisgenesis (in 18.7% of patients), associated with a deterioration in the outflow of intraocular fluid and with relative hypersecretion of chamber moisture (in 46.7% of patients), as well as errors in measuring IOP [38].

Most likely, in some children, myopia is a manifestation of sub- or compensated congenital glaucoma. The effect of ophthalmohypertension on the negative progression of myopia in children with an established diagnosis was noted [14].

There is a statistically significant correlation ($p < 0.05$) between IOP and myopia in the groups of moderate and high myopia, where IOP was higher than in emmetropia and mild myopia, which increased the risk of glaucoma in these patients [15].

Accurate tonometry results are relevant for patients with myopia. For example, the risk of developing glaucoma increases 10-fold with an increase in IOP by 1 mmHg [36]. The most common and accurate method of studying IOP in Russia is Maklakov tonometry, but this technique is difficult to perform in screening conditions. The ICare tonometer is an induction method in which accurate IOP measurements can be performed quickly and without the use of anesthesia. After six measurements the average value is determined, minimizing the calculation error [40]. The ICare is currently the only tonometer operating in two positions (vertical and horizontal) and can be used as an alternative Goldmann perimetry screening method [51].

In 2016, the assessment of risk factors for the development of POAG [19], which make their debut at a young age, changed, and therefore it is necessary to prevent their development as early as possible and to offer preventive treatment [46]. Considering that, it is advisable to compare the dynamics of glaucoma's stability or progression indicators in young patients with a group of patients with an already established diagnosis of glaucoma and evaluate the effectiveness of treatment according to the method proposed by us using the "Cognito" photostimulator.

The "Cognito" photostimulator contains an LED emitter, an Arduino V3 controller, and a plexiglass light distribution plate. In this sample device, the emitter is mounted in a holder in the form of virtual reality glasses, but any other holder design can be used. The firmware for the controller provides control of the LEDs in accordance with the loaded signal. The software allows to upload signals to the controller in the form of an application for Windows 7 and higher. The emitter contains WS2812b LEDs that form safe low-intensity light signals according to existing regulatory documents. The presented version of the device contains a built-in signal, the parameters of which provide maximum illumination of 10-12 Lux at the corneal level. With other stimulation modes, the maximum illumination can be 50 lux. This is many times lower than the il-

lumination standards regulated [20]. The lighting standards are designed for many hours of exposure, while the duration of the fractal photostimulation procedure (FPS) is from 10 to 20 minutes per day (the course is from 1 to 4 weeks).

The uniqueness of the technology in comparison with existing analogues consists in the use of original algorithms for generating complex-structured optical signals with chaotically deterministic dynamics based on the Weierstrass function with a fractal dimension from 1.2 to 1.8.

The device and the FPS technology are based on the results of theoretical and experimental studies, it is physiologically justified and registrated with our patents (No. 2017137147/14 (064774) of 05.11.2018 and No. 2017137151/14 (064780) of 14.11.2018, priority 23.10.2017).

The purpose of the study: to identify risk factors for the development of POAG, early changes in functional tests in students of Voronezh and to assess changes in indicators when using FPS compared with patients with an established diagnosis of POAG.

Materials and Methods

Clinical bases of the study: VSMU named after N. N. Burdenko", BUZ VGKP No. 1, BUZ VO "VOCOB". The analysis of the research results was carried out in students who underwent a preventive examination for the timely identification of risk factors for ophthalmological diseases and patients with the diagnosis of POAG who applied to the BUZ VO "VGKP No. 1". The period of research is from October 2018 to September 2021. The study was conducted in three clinical groups: group 1 - students with myopia - 24 people: subgroup 1A mild myopia, 1B moderate myopia. The average age in the first group was 21.3 ± 0.7 years, including 16 women (66.7%), 8 men (33.3%). The second group consisted of 29 patients (58 eyes) with a diagnosis of POAG: subgroup 2A POAG Ia (9 eyes), 2B - POAG IIa (30 eyes) and 2C - POAG IIIa (19 eyes). The average age of patients was 58 ± 18 years, 17 women (58.6%), 12 men (41.4%). The third group included 66 students with mild (68%), medium (27%) and high (5%) degrees of myopia. The average age in the group was 21.2 ± 1.3 years, of which 44 were women (66.7%), 22 were men (33.3%). IOP was evaluated in age- and gender-homogeneous clinical groups of students with myopia (Figure 1).

The patients' anamnesis and specific complaints were evaluated by the questionnaire method. The questionnaire was formed by the authors of the article for the most complete determination of risk factors in the examined patients.

The standard examination procedure included determining the visual acuity of patients with the selection of the ametropia correction, biomicroscopy and ophthalmoscopy.

Patients of the group 1 underwent a standard examination, as well as tonometry using an ICare TA01i, Eyecare OY tonometer [21]. The patients underwent SAP on the AP-5000C Kowa perimeter, Threshold 1 testing, and the perimeter indices MD and PSD were determined before and after the course of treatment with the «Cognito» device according to the method we proposed.

Ophthalmological examination of patients of group 2 was carried out according to the standard method. In this group, the SAP was performed on the Humphrey device (Carl Zeiss Meditec) according to the threshold program 30-2 with the SITA Standard algorithm. The MD and PSD indices were evaluated before and after treatment with the "Cognito" device.

Patients from the control group 3 underwent a standard examination before and after cycloplegia using a short-acting cycloplegic (Phenylephrine+Tropicamide).

In groups 1 and 2, the effects of low-intensity photostimulation with a complex structured optical signal for the prevention and treatment of functional disorders were evaluated. A stimulation program and fractal phototherapy technology were used. The FPS method is carried out using generators of specified fractal optical signals through devices capable of generating light signals. The form of the optical pulses has a fractal structure and was calculated based on the Weierstrass functions (Figure 2).

The duration of the cycle was 10 days, the duration of each session was 10 minutes. To conduct light stimulation sessions, a device consisting of a projector plate, diodes and a controller mounted in the case of virtual reality glasses was used. The processor generated optical pulses with a programmed fractal shape D=1,4 [22]. The duration of stimulation was determined using a personal computer.

On day 10, the effectiveness of FFS was evaluated - a comprehensive ophthalmological examination was performed with IOP measurement and computer static perimetry [22].

Figure 1: Comparison of clinical groups by gender and age

Figure 2: Fractal pulse based on the Weiers trass function.

The Microsoft Excel 2016 package ("Microsoft", USA) was used for statistical processing of the obtained data. The discrepancy was significant at the significance level (p) $p < 0.05$.

All patients underwent visometry. The average visual acuity (AVA) in group 1 of students with mild myopia (subgroup 1A) without correction was 0.49 ± 0.22, with correction 1.0. In subgroup 1B with an average degree of myopia, AVA was 0.08 ± 0.025, with correction 0.89 ± 0.11.

In group 2 patients with glaucoma AVA by subgroups was as follows: 2A subgroup - 0,34 ± 0,12, with correction 0,78 ± 0,43; for 2B subgroup is 0.16 ± 0.24, with correction 0,46 ± 0,27; 2C subgroup - 0,03 ± 0,021 with correction 0.04 ± 0,048.

In group 3 of students with mild myopia AVA was 0.49 ± 0,64, with the usual correction is 1.0. With moderate myopia in students, the AVA without correction is 0.24 ± 0.03, with the usual correction - 0.76 ± 0.23. The AVA in students with high myopia is 0.06 ± 0.042, with correction - 0.85 ± 0.78.

As a result of the questionnaire of all the participants the following risk factors for the development of glaucoma were established: the presence of glaucoma in relatives, episodes of vasospasm, hypo- or hypertension, periodic migraine-like pain, established cerebrovascular pathology (Table 1). The above risk factors remained unchanged throughout the study, due to the lack of effectiveness of the influence of FPS.

Risk factor	Group 1 (students with myopia)	Group 2 (patients with glaucoma)	Group 3 (students with myopia)
Glaucoma in relatives	6(25,1%)	6(20,2%)	3(4,51%)
Episodes of vasospasm	5(20,9%)	15(51,8%)	5(7,5%)
Hypotension/ hypertension	3(12,6%)	29(100%)	3(4,6%)
Migraine	2(8,4%)	16(55,3%)	5(7,7%)
Cerebrovascular pathology	3(12,6%)	7(24,5%)	1(1,6%)

Table 1: Risk factors that are not subject to changes in the treatment of FFS.

Risk factor	Group 1 (students with myopia)		Group 2 (patients with glaucoma)	
	Before FPS	After FPS	Before FPS	After FPS
Visual fatigue when working with digital devices	20(83,4%)	18(75,1%)	14(48,3%)	13(44,8%)
Dry eye syndrome	11(45,8%)	10(41,7%)	25(86,2%)	23(79,3%)
Eye redness	16(66,7%)	15(62,5%)	24(82,8%)	24(82,8%)
Reduced vision in the dark	12(50,0%)	6(25,0%)	16(55,2%)	13(44,8%)
Distortion of letters when reading	6(25,0%)	2(8,3%)	14(48,3%)	12(41,4%)
Increased lacrimation	10(41,7%)	8(33,3%)	26(90,0%)	25(86,2%)

Table 2: Risk factors subject to changes in the treatment of FFS.

Table 2 shows the risk factors in group 1 and group 2, the changes of which were determined as a result of the FPS course. These include the following symptoms of asthenopia: visual fatigue when working with digital devices, dry and red eyes, decreased vision in the dark, distortion of letters when reading and lacrimation.

Asthenopia is characterized by discomfort that quickly occurs during visual work. Within the framework of modern understanding, this phenomenon is regarded as a disorder that precedes visual impairment.

The screening examination of the control group students revealed the most significant risk factors for the development of socially significant diseases: retinal dystrophy in relatives (12.5%), glaucoma in relatives (25.0%), as well as episodes of vasospasm (20.8%), migraine (8.3%). The most frequent complaints of the subjects are complaints of visual fatigue when working with digital devices (83.3% in the first group, 48.3% in the second group of subjects) decreased vision in the dark (50.0% in the first group, 55.2% in the second group of subjects).

Table 3 shows the average values of IOP in the examined groups 1 and 2 before and after passing the FPS course for 10 days.

In the group of students with mild myopia (subgroup 1A), the decrease in IOP for OD was 0.42 ± 1.99 mmHg, for OS - 0.63 ± 2.73 mmHg. For students with moderate myopia (subgroup 1B) IOP for OD did not significantly decrease, for OS - slightly decreased.

Group	OD		OS	
	Before FPS	After FPS	Before FPS	After FPS
Mild myopia (1A subgroup)	15,37 ± 2,23	14,95 ± 1,75	15,26 ± 1,80	14,63 ± 1,50
Moderate myopia (1B subgroup)	14,75 ± 0,75	14,75 ± 2,25	15,74 ± 2,50	15,20 ± 2,96
POAG Ia (2A subgroup)	19,75 ± 0,90	19,00	19,60 ± 0,80	18,60 ± 0,60
POAG IIa (2B subgroup)	20,62 ± 0,87	19,31 ± 0,59	20,65 ± 0,58	19,35 ± 0,54
POAG IIIa (2C subgroup)	21,55 ± 0,81	19,27 ± 0,38	20,57 ± 0,87	19,29 ± 0,67

Table 3: Average IOP values (mmHg) in patients before and after the course of FPS.

In the group of patients with the established diagnosis of POAG Ia (2A subgroup), the indicators of IOP reduction for OD were 0.75 ± 0.46 mmHg, for OS - 1.00 ± 0.71 mmHg. In subgroup 2B in patients with POAG IIa IOP decreased for OD by 1.31 ± 0.74 mmHg, for OS - 1.30 ± 0.55 mmHg. In the last group of examined patients with POAG IIIa (2C subgroup), the average IOP decrease values for OD by 2.28 ± 0.61 mmHg, for OS - 1.28 ± 0.78 mmHg.

The results obtained show that after the FPS course, IOP indicators in students with mild and moderate myopia do not change significantly. This group of subjects often noted the effect of FPS expressed in the form of a decrease in complaints of visual fatigue when working with digital devices, dryness and redness of the eyes, decreased vision in the dark, distortion of letters when reading and lacrimation, while no significant changes in the hydrodynamics of the eye were observed.

In group 2 (patients with an established diagnosis of POAG), the examined patients noted a decrease in asthenopic complaints to a lesser extent. More often, the respondents noticed a decrease in dry eyes, distortion of letters when reading and an improvement in dark adaptation, while the sensations of visual fatigue when working with digital devices, redness of the eyes and lacrimation did not significantly decrease. IOP indicators in patients with an established diagnosis of POAG changed to a greater extent compared to myopic students, which indicates the influence of FPS on the stabilization of IOP in patients with already existing morpho-functional glaucoma changes and the presence of such background pathology as vasospasm episodes, blood pressure drops and migraine headaches.

For further examination, the patients underwent SAP with an assessment of the MD and PSD indices (Tables 4 and 5).

Refraction	N	MD OD before FPS	MD OD after FPS	PSD OD before FPS	PSD OD after FPS	MD OS before FPS	MD OS after FPS	PSD OS before FPS	PSD OS after FPS
Mild myopia (1A subgroup)	39	1,20 ± 0,86	0,96 ± 0,78	2,01 ± 0,95	2,14 ± 0,28	1,20 ± 0,95	0,96 ± 0,86	2,06 ± 0,48	2,09 ± 0,28
Moderate myopia (1B subgroup)	9	-1,49 ± 0,75	-0,94 ± 0,71	1,87 ± 0,15	1,90 ± 0,21	-1,29 ± 1,10	-0,72 ± 0,77	1,94 ± 0,13	1,95 ± 0,38

Table 4: Perimeter indices of MD and PSD (dB) in students with myopia.

N - number of examined eyes.

The following average SAP indicators were determined for students of subgroup 1A before the FPS course: MD OD - 1.20 ± 0.86 dB, PSD OD - 2.01 ± 0.95 dB; MD OS - 1.20 ± 0.95 dB, PSD OS - 2.06 ± 0.48 dB. In 1B subgroup students have the following average indicators MD OD - 1.49 ± 0.75 dB, PSD OD - 1.87 ± 0.15 dB, MD OS - 1.29 ± 1.10 dB, PSD OS - 1.94 ± 0.13 dB.

After passing the FPS course, the following changes were noted in the students of subgroup 1A: MD OD - 0.96 ± 0.78 dB, PSD OD - 2.14 ± 0.28 dB, MD OS - 0.96 ± 0.86 dB, PSD OS - 2.09 ± 0.28 dB. Students of subgroup 1B have: MD OD - 0.94 ± 0.71 dB, PSD OD - 1.90 ± 0.21 dB, MD OS - 1.29 ± 1.10 dB, PSD OS - 1.95 ± 0.38 dB. The stability of the PSD was explained by a significant correlation of structural changes in the optic nerve head itself, which are more stable against the background of stimulation.

In the 2A subgroup of the examined patients with POAG, the following SAP indicators were obtained before FPS sessions: MD OD - -0.49 ± 0.76 dB, PSD OD - 1.82 ± 0.29 dB; MD OS - -1.67 ± 0.72 dB, PSD OS - 1.87 ± 0.56 dB.

Degree of glaucoma	N	MD OD before FPS	MD OD after FPS	PSD OD before FPS	PSD OD after FPS	MD OS before FPS	MD OS after FPS	PSD OS before FPS	PSD OS after FPS
POAG Ia (2A subgroup)	9	-0,49 ± 0,76	-0,38 ± 0,55	1,82 ± 0,29	1,73 ± 0,27	-1,67 ± 0,72	-1,42 ± 0,64	1,87 ± 0,56	1,80 ± 0,60
POAG IIa (2B subgroup)	30	-9,80 ± 8,55	-8,63 ± 8,71	5,01 ± 2,38	4,78 ± 2,37	-8,27 ± 7,53	-7,14 ± 7,63	4,28 ± 2,68	4,06 ± 2,64
POAG IIIa (2C subgroup)	19	-15,12 ± 8,20	-9,81 ± 4,54	6,23 ± 1,90	5,73 7 ± 1,86	-17,21 ± 5,82	-10,82 ± 4,65	7,79 ± 1,85	7,33 ± 1,96

Table 5: Perimeter indices of MD and PSD (dB) in students with POAG.

N - number of examined eyes.

In subgroup 2B, the perimetry indicators are defined as follows: MD OD - -9.80 ± 8.55 dB, PSD OD - 5.01 ± 2.38 dB; MD OS - -8.27 ± 7.53 dB, PSD OS - 4.28 ± 2.68 dB.

In subgroup 2C, the SAP indicators of the initial study test: MD OD - -15.12 ± 8.20 dB, PSD OD - 6.23 ± 1.90 dB; MD OS - -17.21 ± 5.82 dB, PSD OS - 7.79 ± 1.85 dB.

In the examined subgroups of patients with POAG there was a correlation between the violation of general photosensitivity in SAP, the degree of which is interrelated with the stage of the glaucoma process and the effectiveness of its treatment. After the course of FPS, there was a decrease in MD in patients of each subgroup.

In the 2A subgroup, the dynamics of MD was, on average, 0.11 dB for OD and 0.25 dB for OS. In subgroup 2B, the dynamics was more distinct: MD decreased, on average, by 1.17 dB for OD and 1.13 dB for OS. The effectiveness was established in the eyes with POAG IIIa, where the defect in the field of vision decreased by 6.39 dB. Changes in PSD values after FPS sessions are statistically insignificant in all subgroups.

Results

Early detection of risk factors for the development of POAG with the background of refractive disorders is designed for a more thorough examination of persons who later make up the most disadvantaged group of the progredient course of the glaucomatous process. In the case of myopia due to the extensibility of the sclera the increasing IOP isn't the leading diagnostical factor, and in the absence of morphostructural analysis the diagnosis is not established for a long time. There is a term "preperimetric glaucoma" - glaucoma without specific changes in functional and morphostructural protocols. It first appeared in foreign literature at the very end of the 20th century (C. Y. Martin, F. K. Horn, J. B. Jones., *et al.*) [23].

However, when comparing the risk factors of IOP indicators and perimetric indices in three groups of patients: two groups of students with myopia of varying degrees, homogeneous in age and gender, and a group of patients with POAG I-IIIa degrees, we identified not preperimetric changes, but certain functional objective disorders, such as risk factors for the development of diseases of the visual organ: cerebrovascular pathology (12.5%, 24.1% and 1.5% in groups 1, 2 and 3, respectively), glaucoma in relatives (25.0%, 20.1% and 4.5%), as well as episodes of vasospasm (20.8%, 51.7% and 7.6%), migraine (8.3%, 55,2% and 7.6%) and hypotension/hypertension (12.5%, 100% and 4.5%) (Table 1).

According to the results of the questionnaire, the most frequent complaints among the surveyed are complaints of visual fatigue when working with digital devices (83.3%, 48.3% and 86.4% in groups 1, 2 and 3, respectively), decreased vision in the dark (50.0%, 55.2% and 34.8%), dry eyes (45.8%, 86.2% and 15.2%), periodic redness of the eyes (66.7%, 82.8% and 13.6%), distortion of letters when reading (25.0%, 48.3% and 4.5%) and lacrimation (41.7% and 90.0% in groups 1 and 2).

After FPS treatment sessions on the "Cognito" device, the subjects from group 1 noted positive dynamics in the state of the visual analyzer. The number of students with complaints of decreased visual acuity in the dark decreased by half (25.0%), and the number of complaints about the distortion of letters when reading decreased by three (8.3%), as well as complaints of visual fatigue when working with digital devices (75.0%), feeling of dryness and redness of the eyes (41.7% and 62.5%), lacrimation (33.3%), which is an indicator of an improvement in the state of the visual organ after FPS sessions. There were no significant changes in subjective sensations among patients with POAG from group 2 of the examined subjects.

For the first time, we analyzed the average IOP values in the examined groups 1 and 2 before and after passing the FFS course for 10 days. In the group of students with mild myopia (subgroup 1A), the maximum decrease in IOP after the course of treatment was 0.63 ± 2.73 mmHg. In students with moderate myopia (subgroup 1B), IOP decreased insignificantly.

In the group of patients with the established diagnosis of POAG Ia (subgroup 2A), the maximum IOP reduction rates were 1.00 ± 0.70 mmHg. In subgroup 2B, in patients with POAG IIa, IOP decreased, on average, by 1.31 ± 0.73 mmHg. In patients with POAG IIIa (subgroup 2C), the average IOP values decreased to 2.28 ± 0.60 mmHg.

Students from group 3 were measured IOP before and after mydriasis with the combined drug Phenylephrine+Tropkamid. As a result of repeated measurements, the IOP level decreased in all clinical groups, most significantly in the group of students with high-grade myopia - by 2.33 mm Hg.

When comparing the perimeter indices before and after FPS treatment in groups 1 and 2, it can be concluded that the therapy of patients with moderate myopia became effective, since the MD of retinal photosensitivity increased, on average, by 0.56 dB. In the case of students with mild myopia, there is, on average, a decrease in MD by 0.24 dB. The PSD shifts are insignificant in both subgroups, which indicates a minimal effect of FPS on the dispersion of photosensitivity loss in the group and during the examination as a whole.

For patients with glaucoma, there was a decrease in the average deviation of photosensitivity at all stages of the glaucoma process. At the Ia degree, the decrease in MD was 0.11 dB for OD and 0.25 dB for OS. In POAG IIa: MD decreased by 1.17 dB for OD and 1.13 dB for OS. The obtained data certify that the FPS sessions have proved to be effective in increasing the photosensitivity of retinal nerve cells in patients with glaucoma. A positive reaction to therapy is due to the existence of ganglion cells in the plastic stage of functional changes, even in the late stages of this disease.

The use of stimulating signals with intensity fluctuations corresponding to the physiological biorhythm of healthy brain activity

increased the effectiveness of neurorehabilitation, positively affecting the plasticity of nerve tissue cells in patients with moderate and high myopia [28]. The connection of the neuroprotective effect of FSS, which is involved in the activation of neural and dendritic plasticity, which decreases with moderate and high myopia, has been established.

The course of FPS has proved to be effective for reducing the subjective discomfort of patients with eye diseases. It should be assumed that this effect can be associated with the effect of FPS on the activation of biochemical processes in the retina, increased metabolism in the retinal pigment epithelium, improved blood circulation in the internal structures of the eye on the feedback principle.

Clinical case № 1 (subgroup 1A)

Student S., 23 years old. Anamnesis of the disease: due to frequent work "near", she began to notice a gradual decrease in distant vision from the age of 18.Did not receive any treatment. She has been using spectracles since the age of 19. Current correction used: OD sph -0.75 dpt; OD sph -1.25 dpt.

At the time of the initial examination, visual acuity was Vis OD = 0.4 with a corresponding sph -1.5 dpt. = 1.0; Vis OS = 0.4 with a corresponding sph -1.75 dpt. = 1.0.

Before taking the course of the FPS, student S. noted distortion of objects and faces when looking into the distance, redness, fatigue of the eyes after long mental work and in the evening, a decrease in the brightness of surrounding objects. After treatment with FPS, complaints are limited only to the distortion of objects and faces when looking into the distance.

The obtained IOP indicators before the FPS were for OD - 16 mmHg, for OS - 17 mmHg, the IOP values after the FPS course changed as follows: OD - 16 mmHg, for OS - 15 mmHg.

The SAP indicators in the first test were MD OD - -0.82; PSD OD - 2.25; MD OS - -1.06; PSD OS - 2.39. Repeated passage of the SAP registered the following parameters: MD OD - -0,02; PSD OD - 1,86; MD OS - -0,13; PSD OS - 1,84.

Clinical case № 2 (subgroup 1B)

Student B., 24 years old. Anamnesis of the disease: distant vision decreased gradually from the age of 14-15. She was under sur-

Figure 3

veillance of the ophthalmologist since then. The student has been using eyeglass correction since the age of 15, contact correction since the age of 17. At the time of admission to the university, the usual correction was -1.75 dpt. (Vis OU 0.4). Over the course of 3.5 years, her vision deteriorated significantly. Currently, she uses glass correction and soft contact lenses OD sph -3.75 dpt., OS sph -3.75 dpt.

At the time of the initial examination, visual acuity was Vis OD - 0.03 cor. sph -4.00 dpt. - 1.0; Vis OS - 0.03 cor. sph -4.00 dpt. - 1.0. Before completing the course of the FPS, student B. noted low vision in both eyes, distortion of letters when reading, decreased vision in the dark, fatigue and dry eyes in the evening. After the treatment complaints were: low vision in both eyes, periodic dryness of the eyes.

The IOP indicators before the FPS session were for OD - 15 mmHg, for OS - 15 mmHg. After the FPS course, the IOP values changed as follows: OD - 12 mmHg, for OS - 11 mmHg.

The SAP parameters at the beginning of the study were: MD OD - -2.78; PSD OD - 1.57; MD OS - -4.04; PSD OS - 1.90. Results when passing the SAP again: MD OD - -0,41; PSD OD - 1,48; MD OS - -0,10; PSD OS - 1,43.

Figure 4

Conclusions

At this time, early detection of risk factors for the development of POAG remains an urgent problem, due to the imperfection of diagnosis, which has a significant impact in its successful therapy.

We analyzed questionnairies of participants and identified the following risk factors for glaucoma: the presence of glaucoma in relatives, episodes of vasospasm, hypo - or hypertension, periodic migraine-like pain, established cerebrovascular pathology.

After FPS treatment sessions on the "Cognito" device, patients noted positive dynamics. The results obtained by us reflect the positive effect of the FPS effect in the form of reducing complaints of visual fatigue when working with digital devices, dry and red eyes, decreased vision in the dark, distortion of letters when reading and lacrimation. However, no significant changes in the hydrodynamics of the eye were observed.

In our opinion, new trends in the early diagnosis of glaucoma risk factors, an individual approach and anamnesis collection will allow us to correctly assess the patient's condition, which is a fundamental link in the personalized determination of the causes of POAG and further management tactics, taking into account all concomitant diseases, thereby reducing the risks of complications and further vision loss.

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