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Evaluation of the Anatomical and Optical Characteristics of the Eye in the Clinical Course of Congenital Myopia

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Annotation: Evaluation of morphofunctional parameters of the visual analyzer with an increase in the length of the anterior-posterior axis (APA) of the eye in patients with myopia.

Materials and methods: The study included 36 patients (71 eyes). All patients in the study were divided into 4 groups according to the size of the anterior-posterior axis of the eyeball. The first group consisted of patients with mild myopia and an axial length of 23.81 to 25.0 mm; the second - patients with moderate myopia and an axial length of 25.01 to 26.5 mm; the third - patients with high myopia, an axial length value of more than 26.51 mm; the fourth group - patients with refraction close to emmetropic and an axial length of 22.2 to 23.8 mm. In addition to a standard ophthalmological examination, the following diagnostic complex was performed on the patients: echobiometry, determination of the optical density of the macular pigment (ODMP), digital photography of the fundus, optical coherence tomography of the anterior and posterior segments of the eyeball.

Results: The average age of the patients was 47.3±13.9 years. During the statistical processing of the obtained results of the studied parameters, a decrease was noted in some of them with an increase in axial length: maximum corrected visual acuity ($p=0.01$), sensitivity in the infraorbital region ($p=0.008$), average retinal thickness in the infraorbital region (p=0.01), average in the choroidal and nasal sectors p=0.05. 03). In addition, a significant statistically reliable inverse correlation was found between PZO and (BCVA) -0.4 in all groups of subjects; also, the thickness of the infraorbital region was 0.6; choroidal thickness in the infraorbital region -0.5 and sensitivity -0.6; ($p<0.05$).

Conclusion: A detailed analysis of the obtained average values of the studied parameters revealed a general tendency to decrease in the morphofunctional indicators of the eyeball with increasing AOV in the groups. Correlation data obtained from the clinical test indicate a close relationship between the morphometric and functional parameters of the visual analyzer.

Keywords: myopia, emmetropia, macular pigment optical density, superior posterior axis of the eye, morphometric parameters, carotenoids, heterochromatic flicker photometry, optical coherence tomography of the retina.

Introduction: Morphometric characteristics of the eyeball in patients with myopia and their impact on visual function In the structure of diseases of the visual organs, the frequency of myopia in different regions of the Russian Federation varies from 20 to 60.7%. It is known that 22% of people with visual impairment are young people, in whom the main cause of disability is high myopia [10].

Both in our country and abroad, high myopia in adolescents and "young people" is often combined with pathology of the retina and optic nerve, thereby complicating the prognosis and course of the pathological process [10]. The medical and social significance of the problem is further enhanced by the fact that complex myopia affects people of working age. The development of myopia can lead to serious irreversible changes in the eye and significant loss of vision [7]. According to the results of the All-Russian medical examination, the incidence of myopia in children and adolescents has increased 1.5 times over the past 10 years. Among adults with impaired vision due to myopia, 56% have congenital myopia, the rest, including those who have myopia during school years.

The results of complex epidemiological and clinical-genetic studies have shown that myopia is a multifactorial disease. Understanding the pathogenetic mechanisms of visual impairment in myopia remains one of the pressing issues of ophthalmology. Pathogenesis links in myopic disease interact with each other in complex ways [6]. Morphological features of the sclera play an important role in the course of myopia. It is they who are of particular importance in the pathogenesis of eyeball elongation. Dystrophic and structural changes occur in the sclera of myopic people [6]. It has been found that the elasticity and deformation of the sclera of the eye in adults with high myopia are significantly higher than in emmetropia, especially in the posterior pole [20]. An increase in the length of the eye in myopia is currently considered a consequence of metabolic disorders in the sclera, as well as changes in regional hemodynamics [6]. The elastic properties of the sclera and changes in the length of the anteroposterior axis (APA) have long interested scientists. The evolution of the study of the anatomical parameters of the eyeball is reflected in the works of many authors.

According to EJ. Throne, the axial length of the emmetropic eye varies from 22.42 to 27.30 mm. As for the variability of the axial length in myopia from 0.5 to 22.0D, E.Zh. Throne provides the following data: for myopia of 0.5-6.0D, the axial length is from 22.19 to 28.11 mm; for myopia of 6.0-22.0D - from 28.11 to 38.18 mm. According to TI. Eroshevsky and AA Bochkareva, the biometric parameters of the sagittal axis of the normal eyeball are on average 24.00 mm [4]. According to ES. Avetisova, with emmetropia, the axial length of the eye is 23.68±0.910 mm, with myopia 0.5-3.0D - 24.77±0.851 mm; with myopia 3.5-6.0D - 26.27 ± 0.725 mm; with myopia 6.5-10.0D - 28.55±0.854 mm [1]. The exact parameters of emmetropic eyes are given in the National Ophthalmology Manual: the axial length of the emmetropic eye is on average 23.92 ± 1.62 mm [8]. In 2007, IA Remesnikov created a new anatomical-optical and, accordingly, reduced optical scheme of the emmetropic eye with a clinical refraction of 0.0D and AOV of 23.1 mm [9].

As mentioned above, myopia is characterized by dystrophic changes in the retina, which are often associated with impaired blood flow in the choroidal and peripapillary arteries, as well as its mechanical stretching [2]. It has been shown that in people with high axial myopia, the average thickness of the retina and choroid in the subfovea is less than in emmetropes [16]. This means that the greater the axial length, the greater the “overstretching” of the membranes of the eyeball and the lower the density of tissues: sclera, choroid, retina. As a result of these changes, the number of tissue cells and cellular substances also decreases: for example, the layer of the retinal pigment epithelium thins, and the concentration of active compounds, possibly carotenoids, decreases in the macular area.

It is known that the total concentration of carotenoids: lutein, zeaxanthin and mesoxanthin in the central part of the retina forms the optical density of the macular pigment (ODMP). Macular pigments (MP) absorb the blue part of the spectrum and provide powerful antioxidant protection against free radicals and lipid peroxidation [3, 13, 14]. According to a number of authors, a decrease in the MPOD index is associated with the risk of developing maculopathy and a decrease in central vision.

Moreover, many authors agree that MPOP decreases with age [15]. Studies of MPOD levels in healthy populations of different ages and ethnicities in many countries of the world present a very contradictory picture. For example, in a Chinese population of healthy volunteers aged 3 to 81 years, the average MPOD value was 0.303±0.097. In addition, an inverse correlation with age was found [21]. In healthy Australian volunteers aged 21 to 84 years, the average MPOD value was 0.41±0.20 [12]. For the UK population aged 11 to 87 years, the overall average MPOD in the group was 0.40±0.165. A correlation with age and iris color has been noted [19].

Eskina et al. This study involved 75 healthy volunteers aged 20 to 66 years. The mean value of MPOD in different age groups varied from 0.30 to 0.33, and the Pearson correlation coefficient showed that there was no correlation between the value of MPOD and age in normal age-related processes in the organ of vision [5].

At the same time, the results of a clinical study conducted by foreign authors confirm that MPOD values in healthy volunteers are positively correlated with central retinal thickness (r = 0.30) measured using heterochromatic flicker photometry and optical coherence tomography (OCT), respectively [17].

Therefore, in our opinion, the study of OPMP is of particular interest not only in a healthy population of patients of different ages and all types of ethnic groups, but also in dystrophic ophthalmopathy and refractive anomalies, in particular myopia. In addition, the fact of the influence of an increase in the axial length on the topographic-anatomical and functional indicators of the visual analyzer (in particular, OPMP, retinal thickness, choroid, etc.) remains interesting.

The relevance of the above fundamental issues determined the goals and objectives of this study.

Purpose of the study: to assess the morphofunctional parameters of the visual analyzer with an increase in the axial length of the eye in patients with myopia.

Materials and methods

A total of 36 patients (72 eyes) were examined. All patients in the study were divided into groups only according to the size of the axial length of the eyeball (according to the classification of ES Avetisov) [1]. Group 1 consisted of patients with mild myopia and an axial length of 23.81 to 25.0 mm; Group 2 consisted of moderate myopia and an axial length of 25.01 to 26.5 mm; Group 3 consisted of patients with high myopia and an axial visual field of more than 26.51 mm; Group 4 consisted of patients with refraction close to emmetropic and an axial length of 22.2 to 23.8 mm (Table 1).

The patients were not taking any carotenoid-containing medications or following a special diet enriched with lutein and zeaxanthin. All subjects underwent a standard ophthalmological examination to rule out macular pathology, which could potentially affect the results of the examination.

The examination includes the following diagnostic complex: autorefractometry, visometry with determination of maximum corrected visual acuity (MCVA), non-contact computer pneumotonometry, biomicroscopy of the anterior segment using a slit lamp, static automatic perimetry with correction of ametropia (as well as sensitivity MD, PSD, indirect sensitivity). cular region and optic disc using a 78 diopter lens. In addition, all patients underwent echobiometry using a Quantel Medical device (France), determination of OPMP using the Mpod MPS 1000 device, digital photography of the fundus using a Tinsley Precision Instruments Ltd., Croydon, Essex (Great Britain) and a Carl Zeiss Medical Technology fundus camera (Germany); OCT of the anterior segment of the eyeball using the OCT-VISANTE device from Carl Zeiss Medical Technology (Germany) (central corneal thickness was assessed based on the OCTA-VISANTE study); OCT of the retina using the Cirrus HD 1000 Carl Zeiss Medical Technology (Germany). Based on the OCT data, the average retinal thickness in the foveal area was calculated automatically by the device using the Macular Cube 512x128 protocol, as well as the average choroidal thickness calculated manually using the hyperreflective border corresponding to the RPE, using the choroid-scleral boundary, using the scanned center High-resolution images: HD Line Raster protocol. Choroidal thickness measurements were performed at the same time of day from 9:00 to 12:00, at the foveal center, as well as from a depth of 3 mm in the nasal and temporal directions [11, 18].

Statistical processing of clinical study data was performed using standard statistical algorithms using the Statistica program, version 7.0. A difference in values of $P<0.05$ (significance level 95%) was considered significant. Mean values and standard deviations were determined, and correlation analysis was performed by calculating the Spearman rank correlation coefficient. Hypothesis testing was performed using the Kruskal-Wallis ANOVA test to determine the level of statistical significance when comparing 4 unrelated groups.

Results

The mean age of the patients was 47.3±13.9 years. The gender distribution was as follows: 10 males (28%), 26 females (72%).

The average values of the studied parameters are presented in Tables 2, 3, and 4.

When conducting a correlation analysis, a statistically significant inverse relationship was found between PZO and some parameters (Table 5).

In our opinion, the data from the correlation study in the group of patients diagnosed with high myopia are of particular interest. The results of the analysis are presented in Table 6.

Conclusion

A detailed examination of the obtained average values of the studied parameters reveals a general tendency to a decrease in the functional indicators of the eye with increasing AOV in the groups, while the data obtained from the correlation analysis indicate a close relationship between the morphometric and functional parameters of the visual analyzer. It is possible that these changes are also associated with the "mechanical overstretching" of the membranes in patients with myopia due to an increase in axial length.

I would like to separately note, although unreliable, a small trend towards a decrease in OPMP in groups and a negative correlation between OPMP and PZO. As the number of subjects in the group increases, a stronger and more reliable correlation between these indicators can be observed.

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