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Myopia progression in anisometropic amblyopia during combined treatment with orthokeratology and physiotherapy

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Abstract

Background: Myopia is labeled as one of the most common eye disorders, one of the most effective methods of its treatment being orthokeratological treatment. Anisometropic amblyopia continues to be treated by optical correction applied separately or in combination with occlusion or other therapies.
Material and methods: The study included 32 patients (64 eyes), who were divided by 8 patients (16 eyes) into 4 groups (2 primary and 2 control), depending on the presence or absence of amblyopia and the degree of myopia (small and medium). Subjects in the baseline group underwent combined treatment between orthokeratology and physiotherapy.
Results: The combined treatment resulted in the decrease of myopia according to the spherical equivalent by 60% in patients with amblyopia and mild myopia and from 90% in those without amblyopia. The values of the antero-posterior axis had a similar dynamic ($p < 0.001$). In patients with moderate myopia its evolution decreased by 95% compared to patients with amblyopia – by 60%. The degree of anisometropia decreased by 10% ($p > 0.05$). Corrected visual acuity depending on the degree of amblyopia increased by 50% in cases with mild amblyopia and 150% in cases with moderate amblyopia ($p < 0.001$). The absolute volume of accommodation increased by 70% in patients with mild amblyopia and by 300% in patients with moderate amblyopia ($p < 0.001$).
Conclusions: It is rational to apply refractive therapy in the treatment and prevention of acquired uncomplicated myopia, with an average index of quality of life of 93.1%, versus 39.3% for optical correction.
Key words: myopia, anisotropia, orthokeratology, physiotherapy, combined treatment.

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Introduction

Myopia has been labeled as one of the most common eye disorders. Progression of myopia can lead to significant irreversible changes in the eyeball resulting in loss of vision. Complicated myopia is one of the main causes of invalidation as a result of ocular pathologies [1-5]. The frequency of myopia in developed countries of the world is 19-42%, reaching in some eastern countries 70% [6, 7]. The prevalence of eye diseases and their appendages among the population of the Republic of Moldova is represented by three diseases: cataract, myopia and glaucoma. The annual average prevalence of myopia is 45.5 cases per 10 thousand inhabitants. In the period 2007-2011 the given indicator was 1.5 times higher than in the period 2003-2006. The annual average incidence of myopia is 9.1 cases per 10000 inhabitants, with extreme values mA of 6.4 cases per 10000 inhabitants in 2006 and 11.8 cases per 10000 inhabitants in 2011. In the structure of the prevalence and incidence of eye diseases in children, most cases are due to myopia. The average annual prevalence of myopia is 93.9 cases per 10000 children. The annual average incidence of myopia in children in the Republic of Moldova (2003-2011) is 23.4 cases per 10 thousand inhabitants [8]. Anisometropic amblyopia was clinically identified in 1743 by George Louis Leclerc, Count of Buffon, who proposed a treatment that is still applied today. Anisometropic amblyopia continues to be treated by optical correction applied separately or in combination with occlusion or other therapies [9]. In school-age children, the prevalence of anisometropia is 2.7% (age 7), up to 5.8% (age 9) [10]. According to the multiethnic studies of MEPEDS and Baltimore Pediatric Eye Disease (2011), the prevalence of anisometropia by grade was 20% – ≥0.50D, 3.8% – ≥1D and 0.7% – ≥2D. According to Vries' study of a group of anisometropic children (difference ≥2D), the prevalence of anisomyopics, anizohypermetropics and antimetropics was 20%, 70% and 10%, respectively [11].

The aim of the study was to assess myopia progression in patients with anisometropic amblyopia who have undergone orthokeratological treatment combined with physiotherapy.

Material and methods

The study included 32 patients (64 eyes), who were divided by 8 patients (16 eyes) into 4 groups (2 primary and 2 control), depending on the presence or absence of amblyopia and the degree of myopia (small and medium). Subjects in the baseline group underwent combined treatment between orthokeratology and physiotherapy.

Physiotherapy consisted of performing for 10 days, every day, successively, a complex of physiotherapeutic procedures with an interval of 5-10 min between them. Initially it acts for 1 min. on each acupuncture point, selected from the general biologically active points GI4, GI11, E36, TR5, with electric current with an intensity of 25-60 mA of negative polarity and on the local acupuncture points V1, E1, VB1, BT5, V2, HT1, HT2, HT3, HT9 with electric current with intensity of 15-20 mA with positive polarity. Stimulation of the ciliary muscle with low-intensity helium-neon radiation laser is then performed for 4 min. The orthokeratological treatment consisted in the application for 3 years of orthokeratological contact lenses for night wear "Paragon CRT-100", made of HDS material (paflufocon B – fluorosilicone acrylate) with high oxygen permeability (OSO-ANSI Dk-100). The lenses were selected automatically by means of the program "CRT Topography Software" in the process of assessing the topography of the cornea using the device "Keratograph 4" (Oculus, Germany).

Patients in the control group wore monofocal aerial optical correction, which was changed according to possible refractive changes during the study.

The criteria for including patients in the study were: 8 years of age; the presence of the family factor; acquired axial myopia; anisometropic amblyopia; central fixation.

Objective data were collected by the following methods: visiometry, autorefractorkeratometry, pachymetry, corneal topography, non-contact Norn test, absolute accommodation volume, non-contact tonometry, anterior pole and posterior pole biomicroscopy, biometrics, optical coherence tomography of the optic nerve and region centers of the retina.

Results and discussion

Figure 1 shows the dynamics of the annual gradient of myopia progression (AGMP) according to the spherical equivalent and AGMP according to the anterior-posterior axis in patients with low myopia.

The data obtained in the study show that in the group with mild myopia – with the presence of amblyopia, after one year of applying the combined treatment, AGMP according to the spherical equivalent decreased from 0.93±0.08 D to 0.13±0.03 D (by 0.8 D; p<0.001), and in the control group, without amblyopia, this index decreased from 0.94±0.08 D to 0.32±0.7 D (by 0 .62 D; p>0.05). After 2 years, in the main group, AGMP according to the spherical equivalent decreased compared to the initial data to 0.09±0.02 D (by

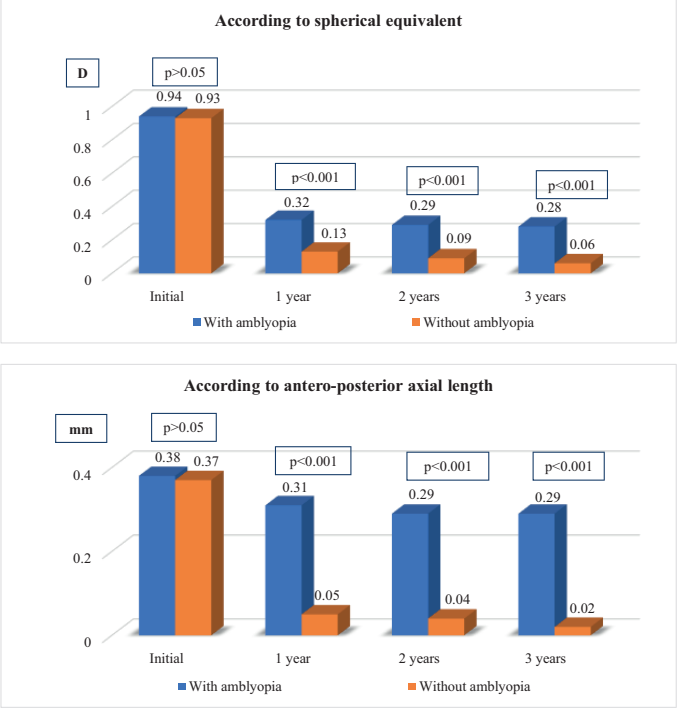

Fig. 1. Dynamics of the AGMP according to spherical equivalent and AGMP according to anterior-posterior axis in patients with mild myopia

0.84 D; p<0.001), while in the control group – to 0.29±0.07 D (with 0.65 D; p>0.05). After 3 years, in the main group, AGMP according to the spherical equivalent decreased to 0.06±0.01 D (by 0.88 D; p<0.001), compared to the control group, in which this index decreased to 0.28±0.19 D (with 0.66 D; p>0.05).

In the group with moderate myopia and the presence of amblyopia, after one year of combined treatment, AGMP according to the spherical equivalent decreased from 1.54±0.25 D to 0.19±0.03 D (by 1.35 D; p< 0.001) compared to the control group, where this index decreased from 1.38±0.29 D to 0.53±0.08 D (by 0.85 D; p>0.05). During the following year, AGMP according to the spherical equivalent decreased to 0.04±0.01 D (by 1.5 D; p<0.001) in the main group, compared to the control group – to 0.32±0.07 D (by 1.06 D; p>0.05). After 3 years, in the main group, AGMP according to the spherical equivalent decreased to 0.03±0.01 D (by 1.51 D; p<0.001), compared to the control group – to 0.32±0.07 D (by 1.1 D; p>0.05). The difference between the data obtained in the main group and in the control group at the end of the study was statistically true (p<0.001), which demonstrates a higher efficiency of the combined treatment than the optical correction.

In the main group with mild myopia and the presence of amblyopia, after one year of treatment, the value of the AGMP according to the anterior-posterior axis decreased from 0.37±0.08 mm to 0.05±0.01 mm (by 0.32 mm; p<0.001), compared to the control group – from 0.38±0.08 mm to 0.31±0.06 mm (by 0.07 mm; p>0.05).

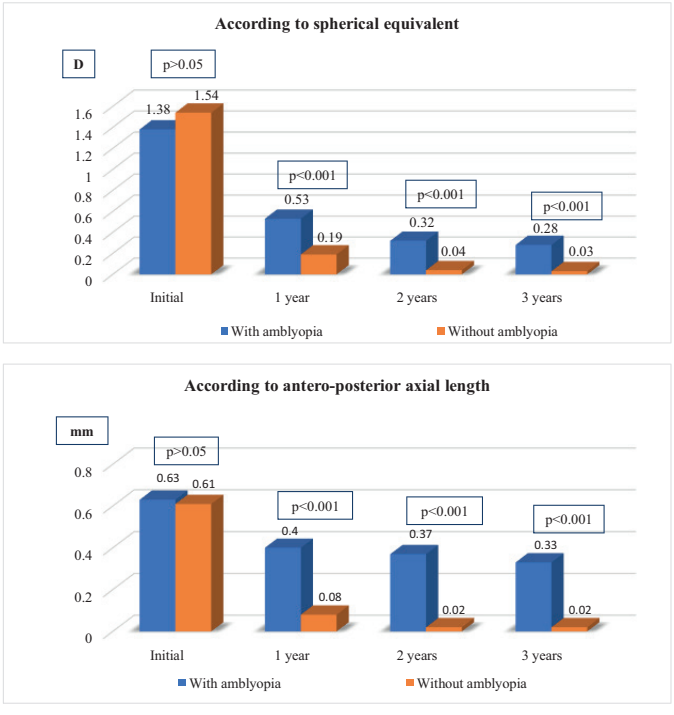

Fig. 2. Dynamics of the AGMP according to spherical equivalent and AGMP according to anterior-posterior axis in patients with moderate myopia

During the following year, the AGMP according to the anterior-posterior axis value decreased to 0.04±0.01 mm (by 0.33 mm; p<0.001) in the main group, compared to the control group – to 0.29±0.07 mm (by 0.09 mm; p>0.05). After 3 years in the main group, the AGMP according to the anterior-posterior axis value decreased to 0.02±0.01 mm (by 0.35 mm; p<0.001), compared to the control group, in which this index remained constant (p >0.05). The difference between the data obtained in both groups at the end of the study was statistically credible (p<0.001), which demonstrated a higher efficiency of the combined treatment compared to optical correction.

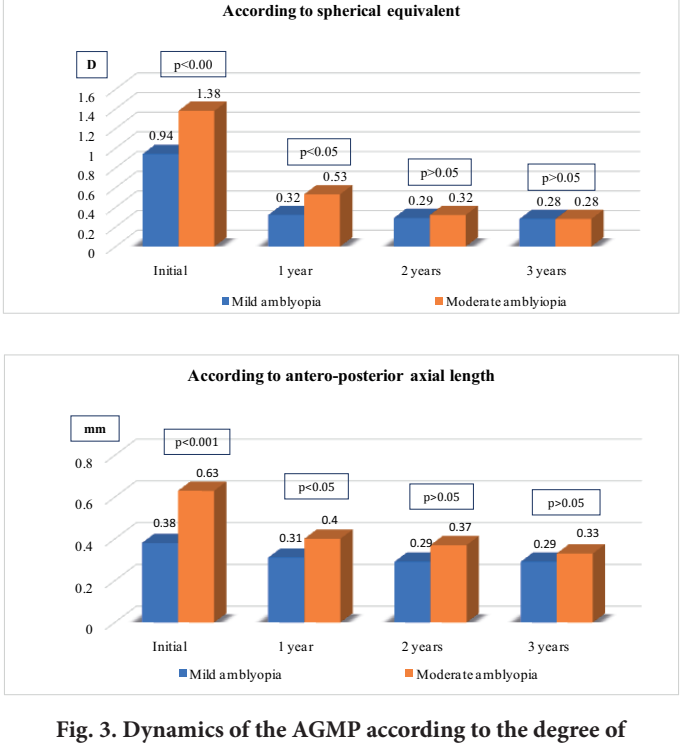

Fig. 3. Dynamics of the AGMP according to the degree of amblyopia

In the main group with moderate myopia and the presence of amblyopia, after one year of combined treatment, the AGMP according to the spherical equivalent value decreased from 0.61±0.14 mm to 0.08±0.02 mm (by 0.53 mm; p<0.001), compared to the control group – from 0.63±0.15 mm to 0.4±0.12 mm (by 0.23 mm; p>0.05).

During the following year, the AGMP according to the spherical equivalent value decreased to 0.02±0.01 mm (by 0.59 mm; p<0.001) in the main group and to 0.37±0.09 mm (by 0.25 mm; p>0.05) in the control group. After 3 years in the base group, the AGMP according to the spherical equivalent value remained the same (p<0.001), and in the control group it decreased to 0.33±0.08 mm (by 0.3 mm; p>0.05). The difference between the data obtained in the main group and in the control group at the end of the study was statistically true (p<0.001). This fact demonstrates a higher efficiency of combined treatment compared to optical correction.

Thus, in patients with mild amblyopia, AGMP according to the spherical equivalent decreased from 0.94±0.24 D to 0.32±0.08 D (by 0.58 D; p<0.001), and in those with amblyopia of moderate degree – from 1.38±0.39 D to 0.53±0.15 D (with 0.85 D; p<0.001). During the 2nd year of the study, the AGMP according to the spherical equivalent value decreased statistically insignificantly compared to the previous data in both groups: in patients with mild amblyopia – down to 0.29±0.08 D (by 0.03 D; p>0, 05); in patients with moderate amblyopia – down to 0.32±0.09 D (with 0.21 D; p>0.05). After 3 years of treatment, the AGMP according to the spherical equivalent value was 0.28±0.06 D in both groups, the difference between the groups being statistically insignificant (p>0.05).

In the same groups, with mild amblyopia, after one year of combined treatment, the AGMP according to the anterior-posterior axis value decreased from 0.38±0.11 D to 0.31±0.08 D (by 0.07 D; p<0.01), compared to patients with moderate amblyopia, where this index decreased from 0.63±0.18 D to 0.4±0.14 D (by 0.23 D; p<0.001). During the following year, the AGMP according to the anterior-posterior axis value decreased to 0.37±0.1 D in patients with low degree amblyopia (p>0.05) and to 0.29±0.08 D (p>0.05) in patients with moderate amblyopia. After 3 years, the AGMP according to the anterior-posterior axis value remained statistically unchanged compared to the previous data in both groups (p>0.05), but much more significant compared to the initial data. The difference between the data obtained at the end of the study in the two groups was statistically insignificant (p>0.05), which demonstrated a high efficiency of the combined treatment both in patients with amblyopia and in those without.

The study of the anisometropia value demonstrated a statistically significant decrease of this index under the influence of the combined treatment. Thus, initially it was 3.43±0.85 D and decreased in the first year of study to 3.22±0.64 D (p<0.001), in the second year – to 3.19±0 .34 D (p>0.05) and down to 3.18±0.28 D (p>0.05) in the third year of study.

A high direct correlation was also established between the annual gradient of myopia progression and the dynamics of the degree of anisometropia R2=0.8885.

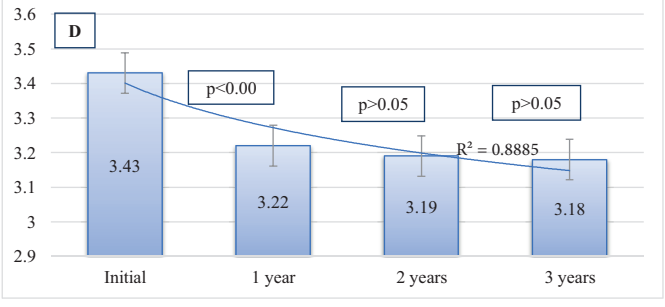

Fig. 4. Comparative dynamics of the degree of anisometropia

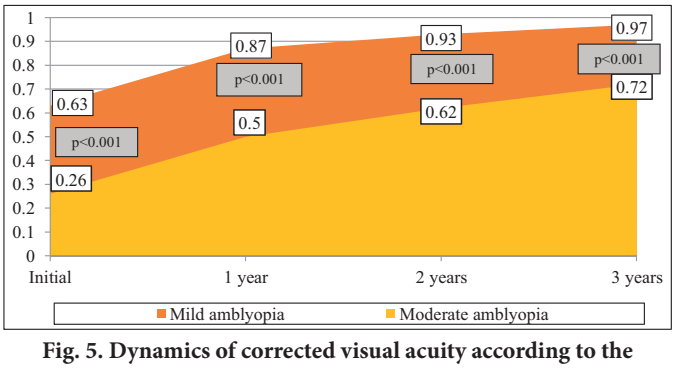

Fig. 5. Dynamics of corrected visual acuity according to the degree of amblyopia

In both study groups, the increase of corrected visual acuity (CVA) was recorded following the application of the combined treatment. Thus, in the group with mild amblyopia the CVA increased from 0.63±0.12 to 0.87±0.15 after one year of treatment, to 0.95±0.21 and to 0.97±0.22 after 2 and 3 years of treatment, respectively (p<0.001). In the group with moderate amblyopia this index increased from 0.26±0.08 to 0.5±0.1, 0.62±0.12 and 0.72±0.15 after 1, 2 and 3 years of treatment, respectively (p<0.001).

In the group with mild amblyopia, after one year of combined treatment, the absolute volume of accommodation (AVA) value increased from 7.0±0.41 D to 11.4±0.67 D (by 4.4 D) compared to the group with moderate amblyopia, where this index had a less obvious dynamic (from 2.2±0.41 D to 4.6±0.48 D – by 2.4 D), the difference between the groups being statistically significant (p<0.001). After 2 years of study, the AVA increased up to 12.0±0.73 D in the group with low-grade amblyopia and up to 6.13±0.51 D in the group with medium-grade amblyopia; after 3 years – up to 12.0±0.78 D in the group with low-grade amblyopia and up to 9.5±0.58 D in the group with

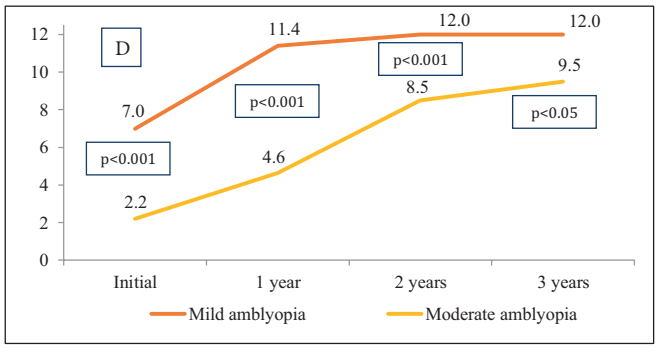

Fig. 6. Dynamics of the absolute volume of accommodation according to the degree of amblyopia

medium-grade amblyopia. The difference between the data obtained in both groups at the end of the study was statistically insignificant (p>0.05).

Conclusions

1. The study demonstrated that in patients with amblyopia the annual gradient of myopia progression was statistically significantly higher compared to patients without amblyopia, regardless of the degree of myopia (on average by 0.74 D depending on the spherical equivalent and by 0.88 mm depending on the length of the eye globe axle).

2. It was determined that in patients with moderate amblyopia the annual gradient of myopia progression had a statistically significant increase (by 0.14 D and 0.15 mm) compared to patients with low degree of amblyopia.

3. The obtained results demonstrated that the application of the combined treatment decreases the degree of anisometropia by an average of 7.3%. A high direct correlation (r=0.88) was established between the annual gradient of myopia progression and the degree of anisometropia.

4. As a result of the combined treatment, the corrected visual acuity increased from 0.63 to 0.97 in cases of mild amblyopia and from 0.26 to 0.72 in cases with moderate amblyopia.

5. The study of the absolute volume of accommodation demonstrated the increase of this index in both groups, but more significantly in cases with mild amblyopia (up to 12 D) compared to the moderate myopia (up to 9.5 D).

6. For a more effective treatment of anisomyopic amblyopia, it is recommended to control the progression of myopia, taking into account its high correlation with the evolution of amblyopia.

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Authors' contributions
RB conceptualized the project and drafted the first version of the manuscript. VC and LD interpreted the data and critically revised the manuscript, GN collected the data. All the authors revised and approved the final version of the manuscript.

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Ethics approval and consent to participate
The study was approved by the Research Ethics Committee of *Nicolae Testemitanu* State University of Medicine and Pharmacy, protocol No 01, 24.08.2022. The informed consent was received from every patient.

Conflict of interests
No competing interests were disclosed.