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Research Article

A Combined Approach to Treating Progressive Myopia in Children

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Abstract

The results of treatment for 120 children (233 eyes) with progressive myopia were analyzed. In the control group, 72 children (137 eyes) underwent scleral buckle surgeries, while in the main group, 48 children (96 eyes) had scleral buckle surgeries and were fitted with orthokeratology lenses one month after the surgery. The average age of the patients was 13.4 ± 2.2 (from 9 to 17) years. Follow-up periods were at 1, 2 and 3 years. The best results on annual gradient of myopia progression decrease were registered after 3 years in the main group judging by the change of the anteroposterior eye size and the refractive index ($p = 0.001$). The use of scleroplasty and of orthokeratological lenses was the most effective tactic for the treatment of progressive myopia in children.

Keywords: *Myopia; Scleroplasty; Orthokeratological Correction; Annual Gradient of Myopia Progression*

Introduction

Modern society is facing a growing issue with the increase of myopia among its population, particularly among children and young people. According to the World Health Organization, 2.6 billion people worldwide have been diagnosed with myopia, including 312 million young individuals under the age of 19 [1]. In Russia, approximately 15 million people suffer from myopia, with at least 70% of patients being of working age [2]. High-degree myopia is associated with the development of myopic maculopathy, subretinal neovascular membranes, rhegmatogenous retinal detachment and glaucoma, which contribute to a decline in the quality of life, work capacity, and potential disability among working-age individuals [3,4]. The average prevalence of disability due to myopia in Russia is estimated at 0.4 to 1.5 per 10,000 population [5]. Timely diagnosis of myopia and the application of the most effective treatments are of particular importance. In the vast majority of cases, myopia manifests during childhood, with initial detection typically occurring in children aged 7 to 12 years, often with a mild refractive error ranging from -1.25 to -3.0 diopters [3]. The progression of the condition is influenced by several factors, the most significant of which is genetic predisposition. Myopia is inherited as a complex polygenic trait, with high-degree myopia often following autosomal dominant, autosomal recessive, or X-linked inheritance patterns [6].

Environmental factors also play a significant role: increased visual workload during educational periods and changes in its nature significantly impact the manifestation of myopia in schoolchildren. A direct correlation has been noted between the risk of developing myopia in children and the amount of time spent outdoors in natural light [7]. One of the main factors contributing to the progression of myopia includes accommodation disorders, as well as a decrease in the rigidity of the corneoscleral coat [8,9].

Myopia is classified into stable, slowly progressive (less than 1 diopter per year), and rapidly progressive (more than 1 diopter per year) [10]. Currently, orthokeratology and scleral reinforcement have been recognized as effective methods for slowing the progression of rapidly progressing myopia [11-17].

Aim of the Study

To analyze the effectiveness of combined treatment of progressive myopia in children before and after scleral reinforcement surgeries and the application of orthokeratological correction.

Materials and Methods

A retrospective analysis was conducted on the clinical and functional outcomes of 120 children (233 eyes) treated at the pediatric ophthalmological department of the Volgograd branch of the Federal State Autonomous Institution "National Medical Research Center "Intersectoral Scientific and Technical Complex "Eye Microsurgery" n. a. acad. S.N. Fyodorov" for progressive myopia. The average age of the patients was 13.4 ± 2.2 years (ranging from 9 to 17 years). The patients were divided into two groups: Group I (control) consisted of 72 patients (137 eyes) who underwent collagen scleral reinforcement, while Group II (main) included 48 children (96 eye) who received both collagen scleral reinforcement and orthokeratological lenses. All patients underwent a comprehensive ophthalmological examination, including the measurement of axial length (AL) of the eyeball using optical biometry with the OA-2000 device (TOMEY Corporation, Japan). Optical biometry differs from contact biometric methods by its higher accuracy (± 0.01 mm compared to ± 0.1 mm). The axial length (AL) is the distance from the corneal surface to an interference peak corresponding to the retinal pigment epithelium/ Bruch's membrane [18-20].

Refractometry was also performed using the RK-F1 device (Canon, Japan). Follow-up assessments were conducted at 1, 2, and 3 years. The rate of myopia progression in the groups prior to treatment was over 1.0 diopter per year.

The technology of the procedure: incisions were made in the conjunctiva and Tenon's capsule 8-10 mm from the limbus in the supero-temporal, supero-nasal, infero-temporal, and infero-nasal meridians, parallel to the limbus with a width of 2 mm, exposing the episclera. Tunnels were formed using a spatula. Scleral grafts were placed into the formed tunnels and directed to the posterior pole of the eye using a scleral plastic spatula. After completing the procedure, a sub-conjunctival injection of Dexamethasone 2 mg and Ceftazidime 50 mg was administered. Aseptic dressing was applied.

Data processing was based upon methods of variation statistics, determining the mean value and standard deviation (M ± σ). The Mann-Whitney U-test was used for comparison of independent samples. Differences were considered statistically significant at a significance level of $p<0.05$. Calculations were performed using STATISTICA 10.0 (StatSoft, USA) for Windows (Microsoft Corporation, USA).

Results

The clinical and functional results for the studied groups before and after treatment were presented in table 1.

Groups Indicators	Before Treatment		After 1 Year		After 2 Years		After 3 Years	
	1st Group	2nd Group	1st Group	2nd Group	1st Group	2nd Group	1st Group	2nd Group
UCVA	0.07 ± 0.03	0.08 ± 0.35	0.06 ± 0.03	0.09 ± 0.38	0.06 ± 0.1	0.08 ± 0.25	0.06 ± 0.14	0.084 ± 0.27
BCVA	0.78 ± 0.2	0.89 ± 0.1	0.8 ± 0.2	0.9 ± 0.12	0.8 ± 0.2	0.8 ± 0.13	0.84 ± 0.2	0.86 ± 0.16
AL, mm	25.7 ± 1.21	25.66 ± 0.82	25.9 ± 1.3	25.76 ± 0.84	26.15 ± 1.39	25.9 ± 0.9	26.45 ± 1.4	26.01 ± 1.09
Rf, diopters	-5.5 ± 1.7	-5.4 ± 1.58	-6.07 ± 2.5	-5.65 ± 1.26	-6.7 ± 2.9	-5.9 ± 1.44	-7.5 ± 2.2	-6.11 ± 1.42

Table 1: *Mean values of clinical and functional indicators in patients with progressive myopia after 1, 2, and 3 years of observation, M ± σ.*

In the control group, the average axial length of the eye (AL) before treatment was 25.7 ± 1.21 mm, and the mean value of refraction was -5.5 ± 1.7 diopters. In the main group, the average axial length of the eye (AL) before treatment was 25.63 ± 0.82 mm, and the mean value of the spherical equivalent of refraction was -5.4 ± 1.58 diopters. The groups were comparable in age, AL, and spherical equivalent of refraction ($p > 0.05$). During dynamic observation at 1, 2, and 3 years, both groups showed an increase in the average values of AL and Rf, with the maximum difference between the groups observed at the 3-year follow-up.

When conducting a comparative analysis of the clinical-functional indicators between the two groups, it was important to note that the main parameter was the annual gradient of myopia progression based on the growth dynamics of the axial length (AL) of the eye over 12 months.

The average values of changes in AL and the spherical equivalent of refraction (Rf) for the control and main groups were presented in table 2. The table comprised a statistical analysis between the groups using the Mann-Whitney U test, chosen due to the deviation from normal distribution of the studied characteristics.

Groups Indicators	After 1 Year		After 2 Years		After 3 Years	
	Δ AL, mm	ΔRf, diopters	Δ AL, mm	ΔRf, diopters	Δ AL, mm	ΔRf, diopters
1st Group	0.2 ± 0.2	-0.55 ± 0.7	0.24 ± 0.23	-0,6 ± 0,7	0.3 ± 0.53	-0.8 ± 0.74
2nd Group	0.1 ± 0.21	-0.25 ± 0.35	0.13 ± 0.26	-0.3 ± 0.5	0.11 ± 0.2	-0.21 ± 0.31
Z	3.7	2.86	3.3	3.8	3.9	8.3
P	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001

Table 2: *Average values of changes in clinical-functional indicators in patients with progressive myopia after 1, 2, and 3 years of observation, M ± σ.*

After one year of observation in both the control and main groups, the changes in Δ AL were 0.2 ± 0.2 mm and 0.1 ± 0.21 mm, respectively. In the control group, a greater increase in ΔAL was observed at the third year of observation (0.3 ± 0.53 mm) compared to the second year (0.24 ± 0.23 mm). That may be explained by a decrease in the effectiveness of the scleroplasty procedure. In the main group of patients, the third year of observation showed minimal changes in Δ AL (0.11 ± 0.2 mm) as well as ΔRf (-0.21 ± 0.31) diopters. Statistically significant differences between the groups for the above-mentioned indicators were noted at the third year of observation.

The results indicate that the combined treatment is more effective for patients in the main group: scleroplasty in conjunction with the use of orthokeratological lenses in reducing the progression of myopia.

Conclusion

Combined treatment of progressive myopia: scleral reinforcement and the use of orthokeratological correction provide the lowest annual progression gradient in axial eye length changes. The application of scleral reinforcement and orthokeratological lenses was the most effective treatment strategy for progressive myopia in children.

Disclosure

None of authors has a financial or proprietary interest in any material or method.

Conflict of Interest

There is no conflict of interest.

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