Eyes Exercises Influence on Refractive Error and Reserves of Accommodation and Convergence

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Introduction. Accommodation (from Latin *accomodatio* = adaptation) is the eye's ability to adapt for clear vision at various distances. It is provided for by the coordinated operation of three elements: the ciliary muscle, the Zinn's zonule and the crystalline lens. The normal state for the eye is the accommodation, when muscles are relaxed. To look at a near item, the ciliary muscle is contracted while the Zinn's zonules are relaxed; this results in the crystalline lens increasing its circumflexion (it becomes more convex). This increases the optic power by 12-13 dioptre, the light rays are focused within retina and the image is clear. Without an accommodation stimulus the ciliary muscle becomes relaxed, the refraction power is decreased and the eye is focused to infinite distance again and this is dis-accommodation or far-accommodation [1]. Spasm of accommodation is a condition which refers to prolonged contraction of the ciliary muscle caused by insufficient opportunity to relax, which leads to a sudden increase of myopia.

The aim of our research was to determine the influence of eye exercises on visual acuity (VA), reserves of accommodation (AR) and convergence (CR).

Methods. Fifteen children aged from 9 to 18 years were included in the retrospective study that was performed in the Department of Ophthalmology at the Lithuanian University of Health Sciences. The research was approved by the Kaunas Regional Biomedical Research Ethics Committee. All the patients had myopia or pseudomyopia. All children were assigned for eye exercises for two weeks' duration (10 days).

We used the following subject inclusion criteria: (i) patients of both genders; (ii) aged 9 to 18 years; (iii) patients with myopia; (iv) patients with pseudomyopia; (v) participation consent. Subject exclusion criteria: (i) children aged less than 9 years; (ii) children aged over 18 years; (iii) patients with other refractive errors; (iv) patients with other eye disorders.

In this research, visual acuity as well as the transparency of the cornea, lens, and the fundus were investigated in all patients. Biomicroscopy was performed in order to assess the corneal and lenticular transparency. Non-corrected and best-corrected visual acuity (measured in decimals from 0.1 to 1.0) was evaluated using Landolt's rings (C optotypes) by Snellen test types at a five metre distance from the chart. Autorefractometry, monocular reserves of

accommodation and convergence were evaluated before and after eye exercises.

AR was evaluated with myopic sciascopy bars, ranging from sph (-1.00 to -19.00 D) for each eye separately from 5 metres. Refractive error before evaluating AR must be corrected. The patient looks with one eye through the first step (-1.0 D), until he/she reaches the maximum dioptric power which allows the eye to accommodate and to achieve the visual acuity 1.0. CR is determined for each eye separately from 5 metres without accommodation. CR is then determined binocularly: before one eye a red glass is placed and before the other eye a prism is placed (basis temporal). The patient notices 2 lights-one red and one white. When the images merge, the patient closes his/her eyes and opens his/her eyes again until the merge time is not equal to l.0 (immediately merge). After that, we strengthen the prism by adding 2.0-4.0 prism D until the images merge again. This process is repeated until we find the strongest prism, which overcomes the additional fusion convergence. The training of CR is carried by the same method.

Statistical analysis was performed using the computer program SPSS/W 22.0 (Social sciences statistical package program for Windows, Inc., Chicago, Illinois, USA). The χ^2 test was used for comparing frequencies of qualitative variables. A statistically significant difference was considered if $p<0.05$.

Results. A total of 15 children (30 eyes), 11 (73.3%) boys and 4 (26.7%) girls, were examined. VA before eye exercises was 0.34±0.31, after exercises – 0.39±0.36. AR before eye exercises was 6.40±3.72, after exercises – 11.43±3.60. CR before eye exercises was 20.07±8.04, after exercises – 29.77±6.23. Best optical correction before eye exercises was -1.98±1.84, after exercises it was -1.98±1.98 ($p>0.05$) (see Table 1).

Table 1. Results before and after exercises

	Before Exercises (±SD)	**After Exercises (±SD)**	**P value**
VA	0.34 (0.31)	0.39 (0.36)	p>0.05
AR	6.40 (3.72)	11.43 (3.60)	p>0.05
CR	20.07 (8.04)	29.77 (6.23)	p>0.05
Best optical correction	-1.98 (1.84)	-1.98 (1.98)	p>0.05

The VA difference before and after eye exercises was 0.05± 0.14. The AR difference before and after eye exercises was 5.03±3.54. The CR difference before and after eye exercises was 9.70±8.43. The best optical correction difference before and after eye exercises was 00.0±0.36 ($p>0.05$) (see Table 2).

Discussion. Our results revealed that visual acuity, AR and CR before eye exercises were worse compared to the results after eye exercises but the differences were not statistically significant. There are not many other studies analysing eye exercises influence on myopia development. Others studies have discussed the myopia treatment: optical correction, pharmaceutical treatment such as cycloplegic promoters, vision therapy, orthokeratology, refractive

surgeries (radial keratotomy, excimer laser photorefractive keratectomy), osteopathy, yoga therapy and aerobic exercise therapy [2].

Table 2. Differences before and after eye exercises

	Different (±SD)	**P value**
VA	0.05 (0.14)	p>0.05
AR	5.03 (3.54)	p>0.05
CR	9.70 (8.43)	p>0.05
Best optical correction	0.00 (0.36)	p>0.05

The available treatments option for myopia have many consequences, such as cosmetic problems, eye strain, asthenopic symptoms, post-LASIK infection, postoperative infection, recurrence of refractive error.. To overcome these consequences eye exercises can provide a beneficial therapeutic effect for the treatment or prevention of the development of myopia without any consequences. The limitations of this review are the lack of a systematic review and the lack of clinical trials [3]. Eye exercises can improve a large number of issues including vergence problems, ocular motility disorders, accommodative dysfunction, amblyopia, learning disabilities, dyslexia, asthenopia, myopia, motion sickness, sports performance, stereopsis, visual field defects, visual acuity, and general well-being [4].

Our results revealed that visual acuity, AR and CR were better after eye exercises.

Conlusions. Visual acuity, accommodation reserves and convergence reserves was increased after eye exercises. However, further investigations should be continued to confirm and better clarify our findings.

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Purpose. To determine the eye exercises influence on visual acuity reserves of accommodation and convergence. Methods. Fifteen children (aged from 9 to 18 years) with myopia or pseudomyopia were examined in the Department of Ophthalmology at the Lithuanian University of Health Sciences . All the children were assigned for eye exercises for two weeks' duration. Results. Visual acuity before eye exercises was 0.34±0.31, after exercises - 0.39±0.36. A reserve of accommodation before eye exercises was 6.40±3.72, after exercises - 11.43±3.60. A reserve of convergence before eye exercises was 20.07±8.04, after exercises - 29.77±6.23. Best optical correction before eye exercises was -1.98±1.84, after exercises -1.98±1.98 ($p>0.05$). The visual acuity difference before and after eye exercises was 0.05± 0.14. The reserve of accommodation difference before and after eye exercises was 5.03± 3.54. The reserve of convergence difference before and after eye exercises was 9.70± 8.43. The best optical correction difference before and after eye exercises was 00.0± 0.36 ($p>0.05$). Conlusions. Visual acuity, accommodation reserves and convergence reserves was increased after eye exercises. However, further investigations should be continued to confirm and better clarify our findings.