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The evaluation of the changes of ultrasonic accommodation in the treatment of myopia

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Introduction

The term accommodation in the ophthalmology is understood as adaptation of an eye to see the views of things, which are in different distances clearly. When the distance is changing from the thing to the eye almost exceptionally, correspondingly changes the distance of the optical system of the eye.

The possibilities of the accommodation characterize their nearest and farthest seeing points. The important role is given to the accommodation in the mechanism of myopia [1, 2, 5]. The assumption, that the weakness of the accommodation to the nearness can stimulate the refractogenesis towards the myopia, the clinical and experimental information confirm it [3, 7]. Myopia begins with the spasm of the accommodation. One of the methods used in treatment of the accommodation spasm is a low frequency electromagnetic field therapy [4, 6]. Ultrasonic biometry is one of a few research methods that improves evaluation of the accommodation process objectively. The aim of our work was to evaluate myopia with the spasm of the accommodation, the changes of the accommodation before and after the treatment with a low frequency electromagnetic field.

Material and methods

90 myopic eyes with the accommodation spasm before the treatment and after it were investigated. The age of the investigated children fluctuated between 6 and 15. The size of the refraction was from – 1,0 to – 3,0 dioptria. The visual acuity to the nearness and to the distance, the reserves of accommodation and the refraction in cycloplegia (using sol. cyclogyli 1%) were investigated.

The ultrasonic biometry was performed using coordination equipment with a fixed transducer (frequency 15 MHz) constructed in the Biomedical Ultrasonic engineering laboratory of Kaunas University of Technology. The uncertainty of the measurements was ± 0,025 mm. The following parameters were measured: the anterior camber depth, thickness of crystalline lens, vitreous body length. The object being fixed by one eye, while investigated by the other. First of all the right eye biometric investigations were performed, when the patient fixes his look to the distance of 5 m, corresponding to 100% visual acuity. After that the investigation of the same eye, fixing the Landolt optotype (corresponding to 100% vision from near) at the distance of 33 cm by the left eye is performed. Investigations of the left eye, fixing the look to the distance and to the near by the right eye were performed by us after 60 min., as the accommodation hysteresis disappears very slowly.

560 ultrasonic measurements were carried out before the treatment by a low frequency electromagnetic field and 560 after it. The instrument of a low frequency electromagnetic field consist of two electromagnetical coils forming the electromagnetic field of a low frequency. The depth of the influence 10 - 12 mm, the strength 1,2 mT. The procedures are performed in impulsive mode. 15 procedures were performed for every myopic child.

Results are presented in the paper as the mean and standard deviation (M±SD). Linear regression and correlation coefficients (*r*) according to Pearson were used to analyse correlation between variables. The *p* values less than 0,005 was considered as statistically significant.

Results and discussion

Children, whose refraction fluctuated between – 1,0 D and –3,0 D, made the first group. Their age was from 6 to 10. The second group was made by children whose age was from 11 to 15. In Table 1 we present the results of optical – anatomical size of the eye elements, their changes in the process of accommodation after the treatment with a low frequency electromagnetic field.

The reserves of accommodation to the distance was 0,33 ± 0,73 D before the treatment and it rose to 6,37 ± 4,73 D after the treatment. In the process of accommodation, when accommodation reserves were low, anterior chamber depth, lens crystalline thickness, length of the vitreous were not different before the treatment.

After the influence of the low frequency electromagnetic field the difference of the anterior chamber depth was 0,09 mm, lens crystalline thickness 0,173 mm, length of the vitreous 0,096 mm ($p < 0,001$).

In Table 2 we can see the optical – anatomical changes of the children eyes from 6 to 10 years old after the treatment by a low frequency electromagnetic field.

The reserves of the accommodation were not noticed before the treatment and they rose till 5,33 ± 4,05 D after the treatment.

When accommodation reserves were bad the optical – anatomical elements interrelation in the eye were not noticed. The reserves of accommodation have risen the difference of the anterior chamber depth increased to 0,078 ± 0,065 mm, of the lens crystalline thickness increased to 0,178 ± 0,167mm, length of the vitreous body increased to 0,122 ± 0,117 mm ($p < 0,001$).

Table. 1 **Parameters of myopic eyes before and after the treatment by a low frequency electromagnetic field (LFEMF)**

Parameter	Average	SD	Difference	*p* mean
Visual acuity before treatment	0,271	0,143		
Visual acuity after treatment	0,311	0,192	- 0,040	<0,003
Accommodation reserves to distance before treatment (D)	0,33	0,734		
Accommodation reserves to distance after treatment (D)	6,378	4,732	- 6,044	<0,0001
Anterior chamber depth before treatment (mm)	2,911	0,120		
Anterior chamber depth after treatment (mm)	2,976	0,131	0,064	<0,0001
Anterior chamber depth to near before treatment (mm)	2,911	0,120		
Anterior chamber depth to near after treatment (mm)	2,898	0,132	0,013	<0,007
Differences of anterior chamber depth before treatment (mm)	0	0		
Differences of anterior chamber depth after treatment (mm)	0,091	0,087	- 0,091	<0,0001
Lens thickness to distance before treatment (mm)	3,331	0,172		
Lens thickness to distance after treatment (mm)	3,164	0,279	0,167	<0,0001
Lens thickness to near before treatment (mm)	3,331	0,172		
Lens thickness to near after treatment (mm)	3,338	0,156	- 0,007	NS
Differences of lens thickness before treatment (mm)	0	0		
Differences of lens thickness after treatment (mm)	0,173	0,152	- 0,173	<0,0001
Vitreous length to distance before treatment (mm)	17,827	0,618		
Vitreous length to distance after treatment (mm)	17,929	0,650	- 0,102	<0,0001
Vitreous length to near before treatment (mm)	17,827	0,618		
Vitreous length to near after treatment (mm)	17,833	0,614	- 0,007	NS
Differences of vitreous length before treatment (mm)	0	0		
Differences of vitreous length after treatment (mm)	0,096	0,116	- 0,096	<0,0001

In Table 3 we can see changes of the optical – anatomical elements of the children eyes from 11 to 15 years old, after the treatment with the low frequency electromagnetic field.

The reserves of accommodation after the treatment rose to 6,63 ± 4,87 D. Difference of the anterior chamber depth was 0,094 ± 0,092 mm, of lens crystalline thickness was 0,172 ± 0,149 mm, of vitreous body length was 0,089 ± 0,116 mm ($p < 0,001$).

The information of our investigations showed statistically important results during accommodation in difference of the anterior chamber depth, of the crystalline lens thickness and vitreous body length after the treatment myopic children by low frequency electromagnetic field.

Conclusions

1. According to the data of ultrasonic biometry anterior chamber depth, lens crystalline thickness and vitreous body length does not change during accommodation in myopic eyes before the treatment.
2. The evaluation of the accommodation can help to diagnose the spasm of the accommodation.
3. Low frequency electromagnetic field improve the accommodation possibilities of the myopic children.

Table 2. **Parameters of the children myopic eyes from 6 to 10 years old before and after the treatment by the LFEMF**

Parameter	Average	SD	Difference	*p* mean
Visual acuity before treatment	0,267	0,097		
Visual acuity after treatment	0,389	0,268	- 0,122	<0,05
Accommodation reserves to distance before treatment (D)	0	0		
Accommodation reserves to distance after treatment (D)	5,333	4,058	- 5,333	<0,0001
Anterior chamber depth before treatment (mm)	2,878	0,167		
Anterior chamber depth after treatment (mm)	2,933	0,182	- 0,056	<0,02
Anterior chamber depth to near before treatment (mm)	2,878	0,167		
Anterior chamber depth to near after treatment (mm)	2,878	0,167	0,042	_
Differences of anterior chamber depth before treatment (mm)	0	0		
Differences of anterior chamber depth after treatment (mm)	0,078	0,065	- 0,078	<0,0001
Lens thickness to distance before treatment (mm)	3,333	0,194		
Lens thickness to distance after treatment (mm)	3,178	0,282	0,152	<0,0008
Lens thickness to near before treatment (mm)	3,333	0,194		
Lens thickness to near after treatment (mm)	3,356	0,146	- 0,022	NS
Differences of lens thickness before treatment (mm)	0	0		
Differences of lens thickness after treatment (mm)	0,178	0,167	- 0,178	<0,0003
Vitreous length to distance before treatment (mm)	17,478	0,767		
Vitreous length to distance after treatment (mm)	17,578	0,801	- 0,100	<0,003
Vitreous length to near before treatment (mm)	17,478	0,767		
Vitreous length to near after treatment (mm)	17,456	0,756	0,022	NS
Differences of vitreous length before treatment (mm)	0	0		
Differences of vitreous length after treatment (mm)	0,122	0,117	- 0,122	<0,0004

Table 3. **Parameters of the children myopic eyes from 11 to 15years old before and after the treatment by the LFEMF**

Parameter	Average	SD	Difference	*p* mean
Visual acuity before treatment	0,272	0,153		
Visual acuity after treatment	0,292	0,165	- 0,019	<0,003
Accommodation reserves to distance before treatment (D)	0,417	0,801		
Accommodation reserves to distance after treatment (D)	6,639	4,877	- 6,222	<0,0001
Anterior chamber depth before treatment (mm)	2,919	0,106		
Anterior chamber depth after treatment (mm)	2,986	0,114	- 0,067	<0,0001
Anterior chamber depth to near before treatment (mm)	2,919	0,106		
Anterior chamber depth to near after treatment (mm)	2,903	0,122	0,017	<0,007
Differences of anterior chamber depth before treatment (mm)	0	0		
Differences of anterior chamber depth after treatment (mm)	0,094	0,092	- 0,094	<0,0001
Lens thickness to distance before treatment (mm)	3,331	0,168		
Lens thickness to distance after treatment (mm)	3,161	0,280	0,169	<0,0001
Lens thickness to near before treatment (mm)	3,331	0,168		
Lens thickness to near after treatment (mm)	3,333	0,159	- 0,003	NS
Differences of lens thickness before treatment (mm)	0	0		
Differences of lens thickness after treatment (mm)	0,172	0,149	- 0,172	<0,0001
Vitreous length to distance before treatment (mm)	17,914	0,547		
Vitreous length to distance after treatment (mm)	18,017	0,581	- 0,103	<0,0001
Vitreous length to near before treatment (mm)	17,914	0,547		
Vitreous length to near after treatment (mm)	17,928	0,539	- 0,014	<0,03
Differences of vitreous length before treatment (mm)	0	0		
Differences of vitreous length after treatment (mm)	0,089	0,116	- 0,089	<0,0001

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Ultragarsinis akomodacijos pokyčių įvertinimas gydant trumparegius

Reziumė

Straipsnyje pateikiami vaikų nuo 6 iki 15 metų amžiaus, turinčių nuo –1,0 iki 3,0 dioptrijų miopinę refrakciją precizinės ultragarsinės biometrijos duomenys ir aptariami pokyčiai akomodacijos metu, kai gydyti naudojamas žemojo dažnio elektromagnetinis laukas. Pirmąją grupę sudarė vaikai nuo 6 iki 10, antrąją - nuo 11 iki 15 metų amžiaus. Abiejose grupėse prieš gydymą esant mažiems akomodacijos rezervams (pirmojoje gr. 0,33±0,73 D, antrojoje gr. 0,41±0,80 D), optinių–anatominių elementų pokyčių akomoduojant (perkeliant žvilgsnį iš 5 m į 33 cm atstumą) nebuvo pastebėta. Po poveikio žemojo dažnio elektromagnetiniu lauku pirmojoje grupėje lęšiuko storio skirtumas buvo 0,178±0,167 mm, antrojoje - 0,172±0,149 mm (p<0,001). Statistiškai reikšmingai akomodacijos procese keitėsi ir priekinės kameros gylis, ir stiklakūnio storis. Ultragarsinė biometrija įrodė teigiamą aktyvinamąjį žemojo dažnio elektromagnetinio lauko poveikį akomodaciniam procesui.

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