Ultrasonic biometry of slightly myopic children eyes

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Abstract

The aim of our work has been to determinate changes of optical-anatomical elements of 1^0 myopic eyes during accommodation using precise ultrasonic biometry.

The first group 6-10 years old children (n=23) and the second group 11-15 years old children (n=75) eyes were investigated. There was no changes in anterior chamber depth, lens thickness and vitreous length during accommodation. After medicamental threatment (spasmolitic solution) accommodation of the eyes was restored and lens changes reached to 0.31mm ($p<0.001$) in the first group and to 0.32mm ($p<0.001$) in the second group.

Ultrasonic biometry is one of objective methods to investigate possibilities of eyes accommodation and to evaluate the effectiveness of the chosen method of treatment to restore accommodation function.

Keywords: myopia, ultrasonic biometry, accommodation

Introduction

Ultrasonic biometry as one of the objective research methods for evaluating refractogenesis process is widely used in children ophthalmology. The pathophysiology and pathogenesis of myopia are still a matter of controversy. Exaggerated longitudinal eye growth is assumed to play an important role in the development of myopia [1].

By measuring the thickness of the cornea, the depth of anterior chamber, the thickness of the lens, the length of eye axis and optico-anatomical elements interrelation it is possible to observe the speed of myopia progression and effectiveness of treatment measures in stopping this process. [2].

In 1970 D. J. Coleman was the first to use the ultrasonic biometry method to investigate the eye accommodation and evaluate the changes in the size of optico-anatomical elements during accommodation. He didn't notice marked changes in the length of eye axis while investigating this phenomenon. J. K. Storey [3] indicates an increase in the length of eye axis during accommodation to objects at near distance. L. F. Garner, G. Smith [4] point out that during accommodation the depth of anterior chamber decreases while the lens thickness increases, but the length of eye axis does not undergo any changes. H. Bayramear, C. O. Cehi et al. determined marked increase in the length of eye axis during accommodation [3]. D. O. Mutti, K. Zadink, R. E. Fusaro investigated parameters of children eye lens by ultrasonic biometry method and determined that in children of 6-10 the thickness of lens decreased by 0.2 mm, i.e. the lens became thinner [5]. The authors indicate that after such "growth" of lens of these children later on the first signs of myopia occur after the age of 10.

Ostein L., Kasthurirangen S., et al. [6, 9 and 10] proposed that anterior chamber depth , the lens thickness, and the anterior segment length change linearly with refraction during accommodation. Mallen E., Kaskyap P., Hampson K. [7] showed that during short periods of accommodative stimulation the axial length increases in both emetropic and myopic young adults. At higher levels of accommodative stimulation a significantly greater transient increase in the axial length is observed in myopic subjects then in their emmetropic counterparts. Some authors noticed that growth of the axial length of the emmetropic eyes is finished at the age of 12, in hyperopic eyes in the age of 11, and in myopic eyes growth is propotional until the age of 14, and then significantly accelerates. Growth of the axial length is mainly caused by increasing the axial length of vitreous cavity. A little role in human eye growth is also played by increasing depth of the anterior chamber [8].

According to the literary data different authors point out rather different changes in size of optical-anatomical elements during accommodation. Different authors studied different age groups of children whose eyes were of different refraction size. That is why we see that refraction process has not been fully studied and requires further investigation both in the age of children and adults.

The aim of our work has been to determine changes in optico-anatomical elements of eyes during accommodation using precise ultrasonic biometry in children of 6-15 having 1^0 myopia and differences of these meanings after medicamental treatment by spasmolitic solution.

Methods and materials

Research has been done on 95 children with 1^0 myopia. Their age being 6-15 years: 29 boys and 66 girls.

Children of 6-10 years old were assigned to the first group (n=23), children of 11-15 years old were assigned to the second group (n=72).

In our work we have evaluated the following data: vision acuity to the distance, accommodation reserves to the distance, eye refraction during cycloplegia (using Cyclogyli 0.1%).

In the case of myopia refraction fluctuated from -1.0 D to -3.0 D.

The precise ultrasonic biometry was done by ultrasonic measuring system which included:

a) coordinative equipment on which ultrasonic transducer of 15 MHz was fixed.

b) ultrasonic biometric apparatus working in A-regime. This equipment was constructed in Biomedical Ultrasonic Engineering Laboratory of Kaunas University of Technology. By using ultrasonic transducer fixing equipment it was possible to carry out precise ultrasonic biometry more exactly as this enabled to avoid researcher's hand micro-movements.

During the examination the eye was anesthesed by 0.25% of tetracain solution. Having put ultrasonic transducer to the eye, the glance of another eye was directed to the object located at 5 m distance. Both eyes accommodate equally at the same time because of the effect of accommodation hysteresis.

In the ultrasonic curve on the A- scanner's screen the length of eye axis, the depth of anterior chamber, the thickness of the lens, the length of the vitreons were measured .

Analogous measurements were carried out for the eye accommodating to the object located at the 33 cm distance. After examining one eye because of slow accommodation hysteresis the examination of another one was done after 60 minutes.

We used medicamental (spasmolitic solution) treatment for 1° myopic children eyes.

Results and discussions

The results are presented in the paper as the mean and standard deviation (M±SD), p values less than 0.05 were considered to be statistically significant.

In the first group, i.e. the children of 6-10 years old, vision acuity was 0,3 according to the Landtolt ring opto-types table (Table 1). Because of a poor function of accommodation muscle its accommodation reserves to the distance reached 0 - 3 diopters. By means of ultrasonic biometry we wanted to evaluate changes in the size of optico-anatomical elements taking place during accommodation. The average of the thickness of the main accommodation element, the lens, was 2.88 mm and during accommodation process the difference of its thickness wasn't observed. The changes in the axial length, the depth of anterior chamber and in the size of vitreous length were not observed too and their averages were 23,75 mm, 3,28 mm and 17,59 mm respectively. Similar results were obtained in the second group, i.e. in children of 11-15 years (Tab. 2) Their vision acuity average reached 0,28 according to the Landtolt ring table. Accommodation reserves to the distance fluctuated from 0 to 3 diopters. The average of the length of eye axis in these children was 24,19 mm and it was a little longer than in the first group because the eyeball increases in the growing organism and its axis becomes longer. The thickness of the lens in this children group reached 3,29 mm. This has confirmed the proposition: during the process of accommodation no difference in the lens thickness has been noticed too, what confirms low working-capacity of accommodation muscle. Averages of the depth of anterior chamber and the length of the vitreous were 2,89 mm and 17,99 mm respectively. The length of the vitreous in this group was longer because of the increase in the eye length. This is the result of a natural eye growth process.

In order to restore the working possibility of accommodation muscle we used medicamental treatment.

Vision acuity in children of 6-10 years after procedures reached 0.4 according to the Landtolt ring table (Table 3), accommodation reserves to the distance restored up to 10,6 diopters. If there were no differences in lens thickness before treatment during accommodation process, after treatment its difference reached to 0,31 mm. These observations showed that the lens took an active part in accommodation process because of improvement in accommodation muscle. Differences in the depth of anterior chamber during accommodation were 0,12 mm and the difference in vitreous length was 0,19 mm.

Differences in the size of eye optico-anatomical elements in children of 11-15 years on accommodation after treatment by spasmolitical solution were noticed. Their vision acuity after the treatment reached 0,33 according to the Landtdolt ring table and the reserves of accommodation to the distance were restored up to 11,5 diopters. (Table 4)

The lens was found to be thinner in desaccommodation condition after treatment than it was before treatment, due to that during accommodation the difference of lens thickness reached to 0,32 mm .That showed a good working-capacity of accommodation muscle. Differences in the depth of anterior chamber were found to be 0,11 mm and the difference in the length of the vitreous was 0,20 mm, respectively.

Conclusions

1. No changes in the size of eye optical anatomical elements were found in accommodation process for children with 1° myopia diagnosed by data of precise ultrasonic biometry.

2. After the treatment by spasmolitic solution for the children of 6-10 years old accommodation reserves were restored and the difference in lens thickness in accommodation process was 0,31±0,07 mm and in the children of 11-15 years old it was 0,32±0,08 mm ($p<0,001$).

3. Ultrasonic biometry is an effective method in evaluating the activity of the eye accommodation apparatus, the possibilities of the eye accommodation and the effectiveness of the chosen method of treatment to restore accommodation function.

References

1. **Drexler W., Findl O.** Eye elongation during accommodation in humans: differences between emmetropes and myopes. Invest Ophtalmol Vis Sci. Oct 1998.Vol.39(11). P.:2140-2147.
2. **Arasvenor T., Gass D. A.** Role of the cornea in emmetropia and myopia. Optom.Vis. Sci. 1998. Vol. 75. P.132-145.
3. **Storey J. K., Rabie E. D.** Ultrasound – a research tool in the study of accommodation. Ophthalmol. Physiol. Opt. 1983. Vol. 3. P. 315-320.
4. **Garner L. F., Smith G.** Changes of ocular dimensions and refraction with accommodation. Ophthalmol. Physiol.Opt. 1997. Vol.7. P.12-17.
5. **Zadnik K., Muth D. O., Fusaro R. E. et al.** Longitudinal evidence of crystalline lens thinning in children. Invest. Ophthalmol. Vis. Sci. 1995. Vol. 36. P. 1581- 1587.
6. **Ostrin L, Kasthurirangan S**. Simultaneous measurements of refraction and A-scan biometry during accommodation in humans. Optom Vis Sci. Sep 2006. Vol.83(9). P.657-665.

Table 1. **Parameters of 1^0 myopic eyes of children 6-10 y.o.**

Parameter	Average	±95 proc. PI	Mediana	Min. Mean	Max.Mean
Visual acuity	0,33	0,27-0,39	0,30	0,1	0,8
Accommodation reserves to distance (D)	0,41	0,12-0,69	0	0	3
Axial length to the distance (mm)	23,75	23,57-23,93	23,70	22,8	25,2
Axial length to the nearness (mm)	23,75	23,57-23,93	23,70	22,8	25,2
Anterior chamber depth to the distance (mm)	2,88	2,82-2,94	2,90	2,6	3,5
Anterior chamber depth to the nearness(mm)	2,88	2,82-2,94	2,90	2,6	3,5
Difference of anterior chamber depth	0	0	0	0	0
Vitreous length to the distance (mm)	17,59	17,41-17,78	17,50	16	18,9
Vitreous length to the nearness(mm)	17,59	17,41-17,78	17,50	16	18,9
Difference of vitreous length	0	0	0	0	0
Lens thickness to the distance(mm)	3,28	3,23-3,33	3,30	2,9	3,6
Lens thickness to nearness(mm)	3,28	3,23-3,33	3,30	2,9	3,6
Difference of lens thickness	0	0	0	0	0

Table 2. **Parameters of 1^0 myopic eyes of children 11-15 y.o.**

Parameter	Average	±95 proc. PI	Mediana	Min. Mean	Max.Mean
Visual acuity	0,28	0,25-0,31	0,20	0,1	0,9
Accommodation reserves to distance (D)	0,68	0,54-0,80	0	0	3
Axial length to the distance (mm)	24,19	24,09-24,28	24,20	23	26,2
Axial length to the nearness (mm)	24,19	24,09-24,28	24,20	23	26,2
Anterior chamber depth to the distance (mm)	2,89	2,88-2,92	2,90	2,7	3,2
Anterior chamber depth to the nearness(mm)	2,89	2,88-2,92	2,90	2,7	3,2
Difference of anterior chamber depth	0	0	0	0	0
Vitreous length to the distance (mm)	17,99	17,89-18,09	18	16,9	20,1
Vitreous length to the nearness(mm)	17,99	17,89-18,09	18	16,9	20,1
Difference of vitreous length	0	0	0	0	0
Lens thickness to the distance(mm)	3,29	3,27-3,32	3,30	3	3,7
Lens thickness to nearness(mm)	3,29	3,27-3,32	3,30	3	3,7
Difference of lens thickness	0	0	0	0	0

Table 3. **Parameters of 1^0 myopic eyes before and after the treatment (6-10 years old)**

Parameter	Average	SD	Difference	p mean
Visual acuity before treatment	0,377	0,223		
Visual acuity after treatment	0,400	0,312	-0,023	NS
Accommodation reserves to distance before treatment (D)	0,692	1,159		
Accommodation reserves to distance after treatment (D)	10,692	1,761	-10	<0,0001
Anterior chamber depth to distance before treatment (mm)	2,877	0,212		
Anterior chamber depth to distance after treatment (mm)	2,992	0,209	-0,115	<0,0001
Anterior chamber depth to near before treatment (mm)	2,877	0,212		
Anterior chamber depth to near after treatment (mm)	2,869	0,189	0	NS
Differences of anterior chamber depth before treatment	0	0		
Differences of anterior chamber depth after treatment (mm)	0,123	0,043	-0,115	<0,0001
Lens thickness to distance before treatment (mm)	3,239	0,136		
Lens thickness to distance after treatment (mm)	2,923	0,161	0,315	<0,0001
Lens thickness to near before treatment (mm)	3,239	0,136		
Lens thickness to near after treatment (mm)	3,239	0,136	0	-
Differences of lens thickness before treatment (mm)	0	0		
Differences of lens thickness after treatment (mm)	0,316	0,079	-0,315	<0,0001
Vitreous length to distance before treatment (mm)	17,669	0,465		
Vitreous length to distance after treatment (mm)	17,869	0,471	-0,2	<0,0001
Vitreous length to near before treatment (mm)	17,669	0,465		
Vitreous length to near after treatment (mm)	17,676	0,462	-0,008	NS
Difference of vitreous before treatment (mm)	0	0		
Difference of vitreous after treatment (mm)	0,192	0,085	-0,2	<0,0001

Table. 4. Parameters of 1^0 myopic eyes before and after the treatment (11-15 years old)

Parameter	Average	SD	Difference	p mean
Visual acuity before treatment	0,289	0,207		
Visual acuity after treatment	0,333	0,229	-0,044	<0,0002
Accommodation reserves to distance before treatment (D)	0,944	0,820		
Accommodation reserves to distance after treatment (D)	11,056	2,325	-10,111	<0,0001
Anterior chamber depth to distance before treatment (mm)	2,875	0,122		
Anterior chamber depth to distance after treatment (mm)	2,992	0,133	-0,127	<0,0001
Anterior chamber depth to near before treatment (mm)	2,875	0,122		
Anterior chamber depth to near after treatment (mm)	2,872	0,120	0	NS
Differences of anterior chamber depth before treatment	0	0		
Differences of anterior chamber depth after treatment (mm)	0,119	0,052	-0,127	<0,0001
Lens thickness to distance before treatment (mm)	3,250	0,133		
Lens thickness to distance after treatment (mm)	2,925	0,129	0,325	<0,0001
Lens thickness to near before treatment (mm)	3,253	0,129		
Lens thickness to near after treatment (mm)	3,253	0,129	0	-
Differences of lens thickness before treatment (mm)	0	0		
Differences of lens thickness after treatment (mm)	0,328	0,084	-0,325	<0,0001
Vitreous length to distance before treatment (mm)	18,083	0,647		
Vitreous length to distance after treatment (mm)	18,292	0,668	-0,208	<0,0001
Vitreous length to near before treatment (mm)	18,081	0,647		
Vitreous length to near after treatment (mm)	18,083	0,648	0	NS
Difference of vitreous before treatment (mm)	0	0		
Difference of vitreous after treatment (mm)	0,208	0,099	-0,208	<0,0001

7. **Mallen E. A, Kashyap P.** Transielt axial length change during the accommodation response in young adults. Invest Ophthalmol. Vis. Sci. Mar. 2006. Vol.47(3). P.1251-1254.
8. **Katuzny B. J., Koszewska-Kolodziejczak A.** Changes of axial dimensions of eye during growth in emmetropia, myopia and hyperopia. Klin Oczna. 2005. Vol.107(4-6). P.292-296.
9. **Kaluzny B. J.** Anterior movement of crystalline lens in the process of accommodation in children. Eur. J. Ophtalmol. Jul-Aug. 2007. Vol.17(4). P.515-520.
10. **Bolz M., Prinz A.** Linear relationship of refractive and biometric lenticular changes during accommodation in emmetropic and myopic eyes. Br. J. Ophtalmol. Mar. 2007. Vol.91(3). P.360-365.

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Ultragarsinės biometrijos naudojimas pradinei I° trumparegystei įvertinti

Reziumė

Aptariami 6-15 metų vaikų (n=95), kuriems nustatyta I° trumparegystė, akių optinių-anatominių elementų dydžiai ir jų pokyčiai akomodacijų metu. Pirmojoje vaikų grupėje (amžius nuo 6 iki 10 metų, n=23) ir antrojoje vaikų grupėje (amžius nuo 11 iki 15 metų, n=72) priekinės kameros gylio, lęšiuko storio ir stiklakūnio ilgio skirtumo akomoduojant nenustatyta.

Po medikamentinio poveikio (spazmolitiniu mišiniu) akių akomodacinės galimybės vėl atsirado ir lęšiuko storio skirtumas buvo 0,31 mm (p<0,001) pirmojoje grupėje ir 0,32 mm antrojoje grupėje (p<0,001). Ultragarsinė biometrija gali išaiškinti akies akomodacines galimybes ir padeda įvertinti pasirinkto gydymo metodo efektyvumą.

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