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Interconnection between several eye biomechanical and biometric parameters in children with axial and refractive mild myopia

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Key words: *Diagnostics, Children, Myopia.*

Aim – to study the relationship of biometric and biomechanical indicators of corneoscleral capsule of the eye in children with axial and refractive mild myopia.

Materials and methods. Axial myopia was diagnosed in 32 children (64 eyes), refractive myopia – 18 (36 eyes). The control group – 16 children without ophthalmic diseases (32 eyes). Eye examination: visometry, automated refractometry, biomicroscopy, ophthalmoscopy, determination of the axial length of the eyeball and corneal hysteresis.

Results. Significant differences were determined in the indicators of dioptric power of the cornea: 42.2 dpt in patients with axial and 44.7 dpt with refractive myopia (p<0.05), and also difference between patients with refractive myopia and the control group, in which the diopter power of cornea was 42.6 (p<0.05). There are also significant differences in the indicators of the axial length of eyes between axial and refractive myopia – 24.5±0.64 mm and 23.1±0.43 mm (p<0.05). Significant difference with the control group in the axial length marked only in eyes with axial myopia 22.7±0.33 mm and 24.5±0.64 mm, respectively (p<0.05). Corneal hysteresis determined significantly reduced on eyes with both the axial and refractive myopia, which was significantly lower than in the indicators of emmetropic eyes of the control group 13.7 (p<0.05). Corneal hysteresis is inversely related to the axial length of the eyeball: in patients with axial myopia r -0.32, p<0.05; with refractive myopia r -0.36, p<0.05. Correlation between diopter power of cornea and axial length of the eyeball: r -0.53, p<0.05 in eyes with axial myopia and r -0.42, p<0.05 refractive myopia. Comparative analysis showed no significant differences between the corneal hysteresis, the axial length of the eye and the spherical component of myopia.

Conclusions. In patients with axial and refractive mild myopia corneal hysteresis is reduced on average in 1.2 and 1.1 times, in comparison with emmetropic eyes. Corneal hysteresis is independent of spherical component of myopia, decreases with increasing of axial length of the eye in 82 % of cases with axial myopia and in 76 % of cases with refractive myopia.

Взаємозв’язок деяких біомеханічних і біометричних показників ока в дітей з осьовою та рефракційною міопією слабкого ступеня

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Мета роботи – вивчити взаємозв’язок біометричних і біомеханічних показників корнеосклеральної капсули ока в дітей з осьовою та рефракційною міопією слабкого ступеня.

Матеріали та методи. Осьова міопія діагностована у 32 дітей (64 ока), рефракційна міопія – у 18 дітей (36 очей). Група контролю – 16 дітей без офтальмологічної патології (32 ока). Офтальмологічне обстеження: візометрія, авторефрактокератометрія, біомікроскопія, офтальмоскопія, визначення аксіальної довжини ока та кореального гістерезису.

Результати. Вірогідні відмінності визначені в показниках діоптрійності рогівки: 42,2 діоптрії в пацієнтів з осьовою, 44,7 діоптрії з рефракційною міопією (p<0,05), а також між пацієнтами з рефракційною міопією та групою контролю: діоптрійність рогівки становила 42,6 діоптрії (p<0,05). Відзначили вірогідні відмінності в аксіальній довжині ока між осьовою та рефракційною міопією – 24,5±0,64 мм та 23,1±0,43 мм (p<0,05). Вірогідні відмінності з контрольною групою в аксіальній довжині відзначені тільки на очах з осьовою міопією 22,7±0,33 мм і 24,5±0,64 мм відповідно (p<0,05). Корнеальний гістерезис вірогідно знижений на очах з осьовою до 11,7 і з рефракційною міопією до 12,2, що є нижчим за показники еметропічних очей контрольної групи 13,7 (p<0,05). Корнеальний гістерезис має зворотну кореляцію з аксіальною довжиною ока: в пацієнтів з осьовою міопією – r -0,32, p<0,05; з рефракційною міопією – r -0,36, p <0,05. Кореляція між діоптрійністю рогівки та аксіальною довжиною ока: r -0,53 (p<0,05) на очах з осьової міопією та r -0,42 (p<0,05) на очах із рефракційною міопією. Порівняльний аналіз не показав відмінностей між кореальним гістерезисом, аксіальною довжиною ока та сферичним компонентом міопії.

Висновки. У пацієнтів з осьовою та рефракційною міопією слабкого ступеня кореальний гістерезис знижений у середньому в 1,2 та 1,1 раза порівняно з еметропічними очима. Корнеальний гістерезис не залежить від сферичного компонента короткозорості, знижується зі збільшенням аксіальної довжини ока у 82 % випадків при осьовій та в 76 % випадків при рефракційній міопії.

Ключові слова: *діагностика, діти, міопія.*

Запорізький медичний журнал. – 2016. – № 4 (97). – С. 55–58

Взаимосвязь некоторых биомеханических и биометрических показателей глаза у детей с осевой и рефракционной миопией слабой степени

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Цель работы – изучить взаимосвязь биометрических и биомеханических показателей корнеосклеральной капсулы глаза у детей с осевой и рефракционной миопией слабой степени.

Материалы и методы. Осевая миопия диагностирована у 32 детей (64 глаза), рефракционная миопия – у 18 (36 глаз). Группу контроля составили 16 детей без офтальмологической патологии (32 глаза). Офтальмологическое обследование: визометрия, авторефрактокератометрия, биомикроскопия, офтальмоскопия, определение аксиальной длины глаза и корнеального гистерезиса.

Результаты. Достоверные различия определяются в показателях диоптрийности роговицы: 42,2 диоптрии у пациентов с осевой и 44,7 диоптрии с рефракционной миопией (p<0,05), а также между пациентами с рефракционной миопией и группой контроля, в которой диоптрийность роговицы составила 42,6 диоптрии (p<0,05). Отмечаются достоверные различия в аксиальной длине глаза между осевой и рефракционной миопией – 24,5±0,64 мм и 23,1±0,43 мм (p<0,05). Достоверные различия с контрольной группой в аксиальной длине отмечены только на глазах с осевой миопией 22,7±0,33 мм и 24,5±0,64 мм соответственно (p<0,05). Корнеальный гистерезис достоверно снижен на глазах с осевой до 11,5 и с рефракционной миопией 12,2, что ниже показателей эмметропических глаз контрольной группы 13,7 (p<0,05). Корнеальный гистерезис имеет обратную корреляцию от аксиальной длины глаза: у пациентов с осевой миопией – r -0,32, p<0,05; с рефракционной миопией – r -0,36, p<0,05. Корреляция между диоптрийностью роговицы и аксиальной длиной глаза: r -0,53, p<0,05 на глазах с осевой миопией и r -0,42, p<0,05 на глазах с рефракционной миопией. Сравнительный анализ не показал различий между корнеальным гистерезисом, аксиальной длиной глаза и сферическим компонентом миопии.

Выводы. У пациентов с осевой и рефракционной миопией слабой степени корнеальный гистерезис снижен в среднем в 1,2 и 1,1 раза в сравнении с эмметропическими глазами. Корнеальный гистерезис не зависит от сферического компонента близорукости, снижается с увеличением аксиальной длины глаза в 82 % случаев при осевой и в 76 % случаев при рефракционной миопии.

Ключевые слова: *диагностика, дети, миопия.*

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Relevance. Among the factors influencing the occurrence and development of myopia, violation of the strength properties of the fibrous capsule is the leading one as well as biometric features of postnatal development of the eyeball [1,2]. In this regard, interconnection of biomechanical and biometric parameters of the eye has clinical significance for the diagnostics and forecasting the development of myopic process. Evaluation of these indicators in children and adolescents acquires special significance, when refractogenesis is incomplete and there is a necessity to differentiate its natural course against pathological changes, peculiar to progression of myopia and development of myopic complications in the eye fundus.

The literature describes various indicators and methods of investigation of biomechanical properties of the eyeball. Thus, we know the method of determining of biomechanical properties of corneoscleral capsule of the eye in terms of acoustic density of the sclera, which corresponds to the amplitude attenuation of the echo signal reflected from the eye sclera. However, the results of this technique are influenced by a number of factors: rigidity, thickness and radius of cornea curvature, the volume of the eyeball. Another technique that allows receiving uninterrupted dependence of the "stress-strain" in the local dosage load on the analyzed portion of corneascleral capsule is uncomfortable and difficult in pediatric practice [1].

Opportunities of investigation corneoscleral layer of the eye in clinical diagnostic practice on the device of the analyzer of biomechanical properties of the eye (Ocular Response Analyzer, ORA, Reichert) are described in the literature [3,7]. This device allows a contactless measure of corneal-compensated intraocular pressure and the pressure according to Goldman, and also to evaluate some biomechanical characteristics that reflect the visco-elastic properties of the corneal tissue: corneal hysteresis and factor of resistance. At the same time, it is proved that the data of ORA reflect biomechanical response to the impact of air pulse not only of the cornea, but of the corneoscleral capsule in general [3]. It was noted a diagnostic value of biomechanical parameters of the cornea and sclera, investigated on ORA during the excimer laser correction, for the diagnostics of keratoconus and glaucoma [3,5,7]. Messages of researchers about the biomechanical properties of the corneoscleral layer in patients with various refractive errors, investigated on ORA, show a decrease in corneal hysteresis and factor of resistance on myopic eyes compared to hyperopic [4]. Data from other researchers show that in myopic refraction of high degree there is a reduction of corneal hysteresis [4,6,7].

Many studies have shown that myopia is associated with changes in biometric parameters of the eye, among which changing in axial length of the eyeball in children is one of the reliable indicators of the progression of this disease and their assessment is included into the algorithm of investigation [1,2].

Therefore, evaluation of the relationship between biomechanical and biometric parameters of the eye in these categories of patients requires an additional study. Evaluation of these indicators in children with mild myopia acquires special significance, when the probability of amplification of refraction is especially high and ophthalmologists should be aimed at early detection of risk groups of progression of myopia.

Aim of the research – to study the relationship of biometric and biomechanical indicators of corneo-scleral capsule of the eye in children with axial and refractive mild myopia.

Materials and methods

We examined 50 children (100 eyes) with mild myopia. Axial myopia was diagnosed in 32 children (64 eyes), refractive myopia – 18 (36 eyes). The control group included 16 children without ophthalmic diseases (32 eyes). Visual acuity in children with myopia was 1.0 with a correction. We performed a standard eye examination, including visometry, automated refractometry on the device "HUVITZ MRK-3100 Premium" before and after the instillation of a solution of 1 % Cyclomedi, biomicroscopy and ophthalmoscopy. In order to determine the axial length of the eyeball we used biometric device IOL Master (Carl Zeiss, Germany). Biomechanical index of corneo-scleral capsule of the eyeball – the corneal hysteresis – CH (Mm Hg) was determined on the analyzer of biomechanical properties of the cornea (Ocular Response Analyzer, ORA, Reichert, USA).

Statistical data processing has been done using the Statistica for Windows 6.0 with a preliminary evaluation of the normality of the distribution in a number of variations. At normal distribution data were presented in the format M±δ, where M – the average value, δ – standard quadratic deviation. In the absence of normal distribution the data were described as a median and 50 % inter percentile range in the form of Me (X25; X75), where Me – median, X25 – 25 th percentile, X75 – 75 th percentile. To evaluate the differences in the two groups, obeying the normal distribution of a number of variations, we used Student's t-test. In the absence of a normal distribution of the variables in the test samples we used the nonparametric Mann-Whitney test. Differences were considered significant at p<0.05.

To evaluate the differences in the two groups we used the

Student's t-test with a preliminary evaluation of the normality of the distribution in a number of variations. In the absence of a normal distribution of the values in the test samples we used the nonparametric Mann-Whitney criterion. Differences were considered significant at p <0.05.

Results

Indicators of visual acuity without optical correction and spherical component are shown in *Table 1*. It is evident that these figures do not differ significantly between patients with an axial and refractive myopia. Significant differences were determined in the indicators of dioptric power of the cornea: 42.2 dpt in patients with axial and 44.7 dpt with refractive myopia (p<0.05). This indicator also has a significant difference between patients with refractive myopia and the control group, in which the diopter power of cornea was 42.6 dpt (p<0.05). There are also significant differences in the indicators of the axial length of eyes between axial and refractive myopia – 24.5±0.64 mm and 23.1±0.43 mm (p<0.05). Significant difference with the control group in the axial length marked only in eyes with axial myopia 22.7±0.33 mm and 24.5±0.64 mm, respectively (p<0.05). CH indicator determined significantly reduced on eyes with both the axial and refractive myopia. but in varying degrees: with axial myopia up to 11.5 and 12.2 in eyes with refractive myopia. which was significantly lower than in the indicators of emmetropic eyes of the control group 13.7 (p<0.05).

Table 1

Indicators of the state of the visual analyzer in children with axial and refractive mild myopia

Indicator	Axial myopia (n=64)	Refractive myopia (n=36)	Control group (n=32)
Visual acuity without correction	0.22±0.15*	0.26±0.15*	0.99±0.01*
Spherical component of refraction, dpt	-1.62±0.85*	-1.55±0.76*	+0.28±0.24*
Diopter power of cornea, dpt	42.2 (42.0; 42.5) •	44.7 (44.0; 46.2)*•	42.6 (42.2; 43.2)*
Corneal hysteresis	11.5 (10.8; 12.3)*	12.2 (11.2; 13.9)*	13.7 (12.8; 14.1)*
Axial length of the eye, mm	24.5±0.64*•	23.1±0.43*•	22.7±0.33*

Notes: * – statistically significant difference with control group (p<0.05); • – statistically significant differences between axial and refractive myopia (p <0.05).

Further evaluation of the relationship between the studied indicators in patients with axial and refractive myopia showed that CH is inversely related to the axial length of the eyeball: in patients with axial myopia: the correlation coefficient was: r -0.32, p<0.05; with refractive myopia r -0.36, p<0.05. In addition, we revealed correlation between diopter power of cornea and axial length of the eyeball, which was: r -0.53, p<0.05 in eyes with axial myopia and r -0.42, p<0.05 in eyes with refractive myopia. Comparative analysis showed no significant differences between the CH and the axial length of the eye and the spherical component of myopia. Reducing of corneal hysteresis in children with mild myopia, compared with the control group of healthy children, and also revealed correlation of this parameter with the axial length of the eyeball in myopia in pediatric practice may indicate a change in the strength properties of the fibrous capsule of the eye as a whole. This is consistent with the data of other researchers who have established the decrease of corneal hysteresis in myopic eyes compared with hypermetropic eyes and also in the eyes of patients with high myopia [4]. And also with the data obtained by Z. Jiang and coauthors, who have established a positive correlation between corneal hysteresis and refraction in myopia [6].

From our results it is evident that the decrease of strength properties of corneoscleral capsule of the eye doesn't depend on the type of myopia and occurs both in the eyes with axial and refractive myopia, i.e. it does not depend on the type of myopia. Significant differences between the average values of corneal hysteresis in patients with myopia of different types from the children with emmetropia have practical value for early prediction of progressive course of myopia in children.

Conclusions

1. In patients with axial and refractive mild myopia we determined reduction of corneal hysteresis compared to the emmetropic eyes on average in 1.2 and 1.1 times, respectively.
2. Corneal hysteresis is independent of spherical component of myopia and decreases with increasing of axial length of the eye in 82 % of cases with axial myopia and in 76 % of cases with refractive myopia.
3. The relationship between biomechanical and biometric indicators is informative evaluation in predicting the course of myopic process in children with mild myopia regardless of the type of myopia.

Prospects for further research. It is advisable to conduct the dynamic control on changes of biometric and biomechanical parameters during the observation of patients with mild myopia and the formation of the risk groups of progression of myopia.

Conflicts of Interest: authors have no conflict of interest to declare.

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