UOT: 617.735-007.681-07:612.017

Zaynutdinov N.N., Kamilov X.M.*

MİOPİYADA BUYNUZ QİŞANIN BİOMEXANİKİ İNDEKSLƏRİNİN KLİNİK ƏHƏMİYYƏTİ

Respublika İxtisaslaşdırılmış Elmi-praktik Göz Mikrocərrahiyyəsi Tibb Mərkəzi, Daşkənd, Özbəkistan Respublikası

Korrespondensiya üçün:
Zaynutdinov Nozim Nadirxodcayeviç, t.ü.f.d., Respublika İxtisaslaşdırılmış Elmi-Praktik Göz Mikrocərrahiyyəsi Mərkəzinin doktorantı, Daşkənd, Özbəkistan
E-mail: znazim@yandex.ru
https://orcid.org/0000-0003-3380-522X

İstinad üçün:
Zaynutdinov N.N., Kamilov X.M. Miopiyada buynuz qişanin biomexaniki indekslərinin klinik əhəmiyyəti. Azərbaycan Oftalmologiya Jurnalı, 2026, 18; 1 (56): 89-95. (İngilis dilində).

Müəlliflərin iştirakı:
Tədqiqatın anlayışı və dizaynı: Kamilov X.M.
Materialın toplanması və işlənməsi: Zaynutdinov N.N.
Statistik məlumatların işlənməsi: Zaynutdinov N.N.
Mətnin yazılması: Zaynutdinov N.N.
Redaktə: Kamilov X.M.

Müəlliflər münaqişələrin (maliyyə, şəxsi, peşəkar və digər maraqları) olmamasını təsdiqləyirlər.

Daxil olmuşdur 02.02.2026
Çapa qəbul olunmuşdur 16.03.2026

https://www.doi.org/10.71110/ajo791020261801568995

XÜLASƏ

Dünya üzrə miopiyanın yayılması artır və 2050-ci ilədək əhalinin 45-50%-ni əhatə edəcəyi proqnozlaşdırılır. Refraktiv cərrahiyyədə nəticələri və ağırlaşmaları, məsələn keratektaziya, keratokonus və qlaukoma kimi halları proqnozlaşdırmaq üçün buynuz qişa biomexanikasının dəqiq qiymətləndirilməsi çox önəmlidir. Corvis ST cihazı buynuz qişanın biomexanik parametrlərinin, o cümlədən Corvis Biomexanik İndeks və Tomoqrafik Biomexanik İndeksin ətraflı qiymətləndirilməsini təmin edərək, klinik qərarvermə və əməliyyatdan sonrakı müşahidə zamanı faydalıdır.

Məqsəd – Corvis ST cihazı vasitəsilə müxtəlif dərəcəli miopiya olan xəstələrdə Corvis Biomexanik İndeks və Tomoqrafik Biomexanik İndeksin klinik əhəmiyyətini və buynuz qişa biomexanik xüsusiyyətlərini qiymətləndirmək.

Material və metodlar
Bu perspektiv tədqiqat 2025-ci ildə "NAZAR Eye Center" klinikasında aparılmış və yüngül, orta və yüksək dərəcəli miopiyası olan 56 xəstəni (103 göz) əhatə etmişdir. Bütün xəstələrdə tam oftalmoloji müayinə, Pentacam tomoqrafiyası və Corvis ST cihazı ilə biomexanik ölçmələr aparılmışdır. Öncədən mövcud göz xəstəlikləri və ya cərrahi müdaxilə keçirmiş xəstələr tədqiqatdan çıxarılmışdır. Məlumatlar SPSS və MedCalc proqramları ilə təhlil edilmişdir ($p < 0,05$).

Nəticələr
Yüksək miopiyası olan xəstələrdə gözün ox uzunluğu artır, buynuz qişanın mərkəzi qalınlığı azalır və Corvis Biomexanik İndeks və Tomoqrafik Biomexanik İndeks dəyərləri yüksək olur. Digər biomexanik parametrlər də miopiyanın artması ilə əhəmiyyətli tendensiya göstərmişdir. Bu nəticələr refraktiv cərrahiyyə və uzunmüddətli stabil vəziyyətinin proqnozlaşdırılması üçün mühüm əhəmiyyət kəsb edir.

Yekun
Corvis ST cihazı vasitəsilə buynuz qişanın biomexanik xüsusiyyətlərinin qiymətləndirməsi refraktiv cərrahiyyədən sonra yarana biləcək mümkün fəsadların yaranma riskini müəyyən edərək, əməliyyatın daha dəqiq planlaşdırılmasına geniş imkanlar yaradır. Yüksək miopiyası olan xəstələrdə biomexanik parametrlərdə müşahidə edilən dəyişikliklər əməliyyatönü kompleks qiymətləndirmənin xüsusi əhəmiyyətini bir daha vurğulayır.

Açar sözlər: *miopiya, buynuz qişanın biomexanikası, refraktiv cərrahiyyə, buynuz qişanın sabitliyi, ox uzunluğu, buynuz qişanın mərkəzi qalınlığı*

**Özbəkistan Respublikası Səhiyyə Nazirliyi yanında Tibb İşçilərinin Peşəkar İnkişafı Mərkəzi, Daşkənd şəhəri, Mirzo Ulugbek rayonu, 51 Parkentskaya küç., Daşkənd, 100159, Özbəkistan*

UDC: 617.735-007.681-07:612.017

Zaynutdinov N.N., Kamilov Kh.M.*

CLINICAL SIGNIFICANCE OF CORNEAL BIOMECHANICAL INDICES IN MYOPIA

Republican Specialized Scientific and Practical Medical Center for Eye Microsurgery, Tashkent, Republic of Uzbekistan

For correspondence:
Zaynutdinov Nozim Nadirkhodjayevich, PhD, doctoral student at Republican Specialized Scientific and Practical Medical Center for Eye Microsurgery, Tashkent, Uzbekistan
E-mail: znazim@yandex.ru
https://orcid.org/0000-0003-3380-522X

For citation:
Zaynutdinov N.N., Kamilov Kh.M. Clinical significance of corneal biomechanical indices in myopia. Azerbaijan Journal of Ophthalmology, 2026, 18; 1 (56): 89-95.

Authors participation:
Concept and design of investigation: Kamilov Kh.M.
Material collection and processing: Zaynutdinov N.N.
Statistical data processing: Zaynutdinov N.N.
Spelling text: Zaynutdinov N.N.
Editing: Kamilov Kh.M.

The authors confirm that there are no conflicts (financial, personal, professional and other interests).

Received 02.02.2026
Accepted 16.03.2026

https://www.doi.org/10.71110/ajo791020261801568995

SUMMARY

The prevalence of myopia is rising globally, projected to affect 45-50% of the population by 2050. Accurate assessment of corneal biomechanics is critical in refractive surgery to predict outcomes and complications such as keratectasia, keratoconus, and glaucoma. The Corvis ST device provides detailed evaluation of corneal biomechanical parameters, including the Corvis Biomechanical Index (CBI) and Tomographic Biomechanical Index (TBI), which aid clinical decision-making and postoperative monitoring.

Purpose – to evaluate corneal biomechanical properties and the clinical significance of CBI and TBI in patients with varying degrees of myopia using the Corvis ST device.

Material and methods

This prospective study included 56 patients (103 eyes) with mild, moderate, or high myopia, examined at "NAZAR Eye Center" in 2025. All patients underwent full ophthalmologic assessment, Pentacam tomography, and Corvis ST biomechanical measurements. Exclusion criteria included pre-existing ocular disease or prior surgery. Data were analysed using SPSS and MedCalc ($p < 0.05$).

Results

High myopia was associated with increased axial length, thinner central corneal thickness (CCT), and higher CBI and TBI values. Other biomechanical parameters also showed significant trends with increasing myopia. These findings provide important predictive information for refractive surgery and long-term ocular health.

Conclusion

Corvis ST biomechanical assessment reliably identifies high-risk eyes and guides surgical planning. Patients with high myopia exhibit increased biomechanical parameters, emphasizing the importance of preoperative evaluation.

Key words: *myopia, corneal biomechanics, refractive surgery, corneal stability, axial length, central corneal thickness*

**Center for the Development of Professional Qualifications of Medical Workers under the Ministry of Health of the Republic of Uzbekistan, Tashkent city, Mirzo Ulugbek district, 51 Parkentskaya st. Tashkent, 100159, Uzbekistan.*

Currently, the number of patients with refractive errors, including myopia, is increasing every year worldwide. According to the 2024 report of the World Health Organization, myopia, the most common type of refractive error, will account for about 45-50% of the population by 2050. The increase in the incidence of refractive errors among the working-age population is causing a number of social and medical problems [1]. As a solution to this problem, public awareness campaigns, disease prevention measures, and modern correction methods are being developed [2].

These types of correction are divided into procedures based on corneal ablation (LASIK) or lenticular refractive surgery (SMILE), as well as procedures such as removal of the natural clear lens (lensectomy) and implantation of phakic intraocular lenses [3].

As is well known, before performing planned refractive surgery, the doctor carefully analyzes and monitors the results of a number of parameters over a long period. Of course, for patients with refractive errors and candidates for surgical intervention, the stability of manifest and cycloplegic refraction, sufficient CCT, anterior chamber depth, endothelial cell density, and intraocular pressure are important [4].

As modern ophthalmology advances, the capabilities for preliminary analysis of the eyes of patients who are candidates for surgical intervention and the widespread use of new devices in clinical practice are expanding daily. In particular, the relationship between CCT and intraocular pressure, which is of great importance in refractive surgery, allows for scientifically valid and accurate prediction of the likelihood of developing keratectasia, keratoconus, and glaucoma in a patient's eye based on the biomechanical parameters of the cornea (strength and elasticity). The most advanced diagnostic device used to determine corneal biomechanical parameters is the Corvis ST (Oculus GbH, Germany) [5]. The Corvis ST can perform a series of horizontal Scheimpflug images using a high-speed camera that collects 4330 frames per second for a period of 100 milliseconds (ms) [6, 7]. There are currently several reports of the normal distribution of Corvis ST Dimensions [3, 6]. Since it is a well-defined factor that determines the biomechanical properties of the cornea, regardless of ethnic origin, a normative database of different populations is very useful and can help in scientific research to identify abnormal conditions.

One of the biomechanical indices is the CBI. The CBI was developed to detect biomechanical changes in early keratoectasia and post-operatively by analyzing the deformed weak zones of the cornea. This index is based on a logistic regression formula that includes various corneal response measures, stiffness state, and corneal thickness profile of horizontal cross-section. This index represents the biomechanical stability of the cornea after laser correction, expressed as CBI – LVC. This information is important for making clinical decisions such as post-LASIK retreatment or corneal cross-linking in ectasia. Various pre-operative screening methods are available to analyze the risk of developing ectasia after laser correction of visual acuity. However, the possibility of evaluating the risk of ectasia in the postoperative period based on objective criteria is still limited. This software allows automatic assessment of post-operative biomechanical stability [5].

Another important indicator of the cornea is the combined biomechanical index TBI, which combines the results of tomography from the device (Pentacam, Oculus, Germany) and biomechanical from the device (Corvis ST, Oculus, Germany) using a statistical analysis algorithm. Brazilian professor Renato Ambrosio developed an index that combines tomographic and biomechanical measurements to achieve maximum accuracy. This index, which works according to a modern integrated system, provides an overall risk score for assessing the susceptibility to ectasia, based on a random selection analysis algorithm. The tomographic and

biomechanical data obtained from the two devices, Pentacam and Corvis ST, are analyzed using an artificial intelligence program to identify patients at high risk of developing ectasia after refractive surgery [6].

Purpose – to evaluate of corneal biomechanical properties and clinical significance of corneal biomechanical parameters CBI and TBI using the Corvis ST device in patients with varying degrees of myopia.

Material and methods

In this study, conducted from January 2025 to December 2025 at the private eye clinic "NAZAR Eye Center", 56 patients (103 eyes) with varying degrees of myopia were studied using the Corvis ST device. These patients were divided into 3 groups according to the degree of myopia detected. The first group had mild myopia (0.5 D - 3.0 D), the second group had moderate myopia (3.25 D - 6.0 D), and the third group had high myopia (6.25 D and ≤ D).

A complete ophthalmologic examination of each eye, including visual acuity, slit-lamp biomicroscopy, and fundus examination using 90 D non-contact aspheric lenses was performed. Patients with a history (or objective signs) of eye diseases (e.g., glaucoma, uveitis, corneal ectasia, Fuchs' corneal dystrophy, and diabetic retinopathy), chronic use of topical eye drops, previous ocular surgery, corneal scarring or opacification, etc. were excluded from the study. Written informed consent was obtained from each patient participating in the study, in accordance with the principles of the Declaration of Helsinki, and an explanation was provided.

Refraction was measured using an autorefractometer (KR-1 Topcon, Japan) and keratotopographic measurements were performed using a Pentacam AXL (Oculus GmbH, Wetzlar, Germany). Corneal biomechanical parameters, biomechanically-corrected intraocular pressure (bIOP) and CCT, were determined using Corvis ST.

Data were analyzed using IBM SPSS Statistics software (SPSS Inc., Chicago, IL) and MedCalc version 12.2.1 (MedCalc Software, Mariakerke, Belgium). Descriptive statistics are reported as M ± m, standard

Table 1. *Demographic and statistical data of patients with varying types of myopia (M ± m)*

Characteristics	*Mild grade of myopia*	*Moderate grade of myopia*	*High grade of myopia*	*Total and Mean*
Age	23.12±2.4*	24.34±2.8***	25.84±3.9*	24.35±3.2
Gender				
Male	12 (40%)	10 (33.3%)	8 (26.7%)	30 (53.6%)
Female	11 (42.3%)	8 (30.8%)	7 (26.9%)	26 (46.4%)
Eyes	44	31	28	103 (100%)
Right	24 (40%)	18 (30%)	18 (30%)	60 (58.3%)
Left	20 (46.5%)	13 (30.2%)	10 (23.3%)	43 (41.7%)
Visual Acuity by Snellen		**M ± m (Mean ± SD) (95% CI)**		
UCVA	0.15±0.04**	0.12±0.05***	0.07±0.03*	0.12±0.04
BCVA	0.75±013*	0.70±0.12**	0.55±0.12*	0.65±0.12
SE (D)	2.85±0.76*	4.32±0.81*	7.23±0.85*	3.67±0.80
AXL (mm)	24.16±0,85*	24.87±0.92***	25.7±0.88*	24.6±0,87
CCT (µm)	530±29*	521±26***	513±28*	521±29
bIOP (mmHg)	15.34±1.2**	15.45±1.3***	16.11±1.2*	15.5±1.2

Note: *SD, standard deviation; CI, confidence interval; SE, Spherical equivalent; AXL, axial length; CCT, central corneal thickness; bIOP, biomechanical corrected intraocular pressure; UCVA, uncorrected visual aciuty; BCVA, best corrected visual acuity. P – Probability, (p ≤ 0.001*, p ≤ 0.05**, p > 0.05***)*

deviation (SD). Corvis ST Data are presented as mean and normal range. P < 0.05 and p < 0.001 were considered statistically significant.

Results

Analyzing the results of our study

The mean age of 56 patients was 24.35 ± 3.2 years, of which 30 (53.6%) were male and 26 (46.4%) were female. 103 (100%) eyes, 60 (58.3%) were right eyes and 43 (41.7%) were left eyes. The mean visual acuity of the patients was 0.12 ± 0.04 UCVA and 0.65 ± 0.12 BCVA by Snellen. The mean spherical equivalent was 3.67±0.8 D, the mean axial length of the eye was 24.6 ± 0,87 mm, the mean CCT was 521±29 μm, and the mean bIOP pressure was 15.5 ± 1.2 mmHg (**Table 1**).

A case with refractive error but normal corneal biomechanical indices is shown in Figure 1. In addition, changes in parameters such as CBI, TBI, BAD-D, and bIOP in the case of corneal ectasia are illustrated in **Figure 2.**

During the 1-year analysis of this study, the following results were recorded in each group regarding corneal biomechanical parameters (**Table 2**).

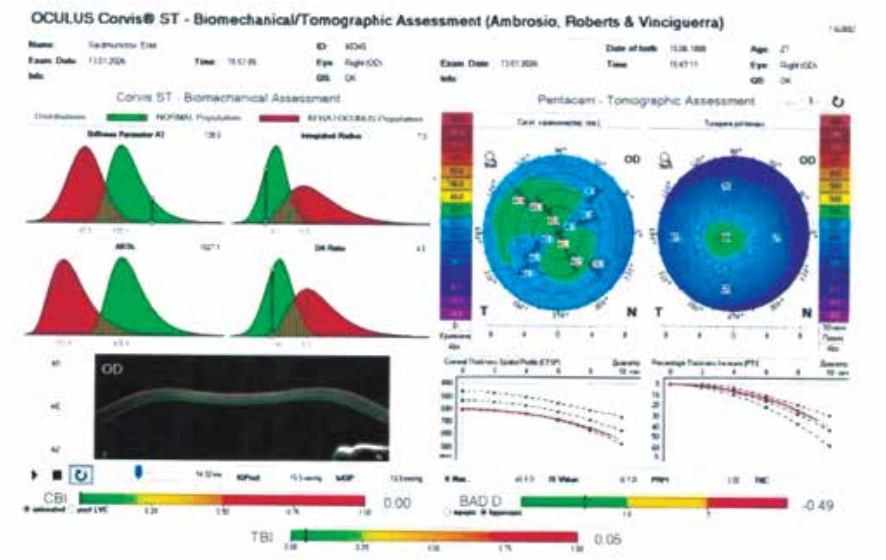

Figure 1. *A refractive case with normal biomechanical indices.*

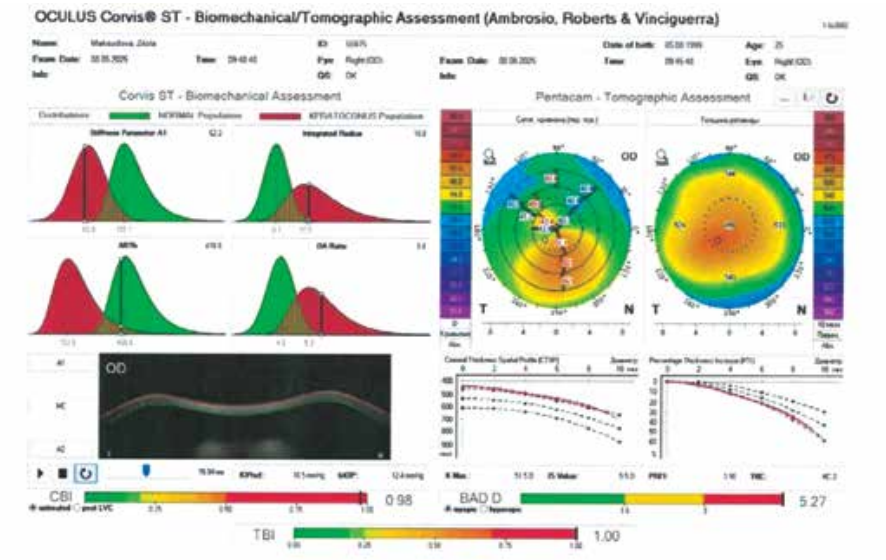

Figure 2. *A corneal ectasia case with biomechanical indices changes*

Table 2. *Corneal biomechanical parameters determined using the Corvis ST device in patients with myopia (M ± m)*

Characteristics	*Mild grade of myopia (n=44)*	*Moderated grade of myopia (n=31)*	*High grade of myopia (n=28)*	*Total (mean) (n=103)*
AL1 (mm)	2.23±0.51***	2.18±0.53***	2.16±0.54***	2.21±0.52
AL2 (mm)	1.75±0.71***	1.62±0.72***	1.53±0.70***	1.71±0.70
AV1 (m/s)	0.15±0.02***	0.15±0.02***	0.16±0.02***	0.15±0.02
AV2 (m/s)	-0.28±0.03***	-0.27±0.03***	-0.28±0.03***	-0.28±0.03
HCR (mm)	7.75±0.58*	7.56±0.63*	7.32±0.65*	7.65±0.69
DA (mm)	1.05±0.12**	1.06±0.13***	1.10±0.15*	1.06±0.13
PD (mm)	**5.23±0.45***	**5.34±0.52****	**5.45±0.56***	**5.30±0.48**
IR (mm)	7.45±1.16**	7.62±1.18**	7.89±1.24*	7.53±1.19
CBI	0.04±0,02***	0.06±0.03***	0.11±0,03*	0.06±0.03
TBI	0.07±0,03***	0.08±0.02***	0.15±0.03*	0.09±0.03

Note: *AL1, applanation length-1; AL2, applanation length-2; AV1, applanation velocity 1; AV2, applanation velocity-2; HCR, high concave radius; DA, deformation amplitude; PD, pick distance; IR, integrated radius; CBI, Corvis biomechanical index; TBI, tomographic biomechanical index. P – Probability, ($p \leq 0.001$*, $p \leq 0.05$**, $p > 0.05$***.)*

According to the analysis of the above-mentioned biomechanical parameters, the mean applanation length AL1, AL2 in the group of patients with mild myopia was 2.23 ± 0.51 and 1.75 ± 0.71 mm. This indicator was higher than in the group of patients with moderate and high myopia (AL1; 2.18 ± 0.53 and 2.16 ± 0.54 mm, AL2; 1.62 ± 0.72 and 1.53 ± 0.70 mm). However, the result of the AL1 indicator in all groups was found to be statistically insignificant ($p > 0.05$). The applanation velocity indicators AV1 and AV2 remained unchanged in all groups and were not statistically significant ($p > 0.05$). The mean HCR – high concave radius – was 7.75 ± 0.58 mm in the group of patients with mild myopia, 7.56 ± 0.63 mm in the group of patients with moderate myopia, and 7.32 ± 0.65 mm in the group of patients with high myopia, showing a decreasing trend. These indicators were statistically significant ($p < 0.001$).

The mean DA-curvature amplitude in the group of patients with mild myopia was 1.05 ± 0.12 mm, in the group of patients with moderate myopia it was 1.06 ± 0.13 mm, and in the group of patients with high myopia it was 1.10 ± 0.15 mm, and was statistically significant ($p < 0.001$). In these results, it is possible to observe the dynamics of the increase in indicators with increasing myopia.

Curvature amplitude - DA - can also be explained by an increase in corneal diameter and elongation of the axial axis in high myopia. In mild myopia, these indicators are somewhat smaller. PD - peak distance indicator was on average 5.23 ± 0.45 mm in the group with mild myopia. It was the mean 5.34 ± 0.52 mm in the group with moderate myopia, and the mean 5.45 ± 0.56 mm was in the group with high myopia. These results are statistically significant ($p < 0.05$).

Biomechanical indices – CBI and TBI – are not significantly changed among mild and moderate myopia groups ($p > 0.05$). However, there were dramatically changes between moderate (the mean 0.04 ± 0.02 and 0.07 ± 0.03) and high myopia (the mean 0.11 ± 0.03 and 0.15 ± 0.03) groups ($p < 0.001$).

Discussion

These above-mentioned parameters have a great importance in myopic eyes. This measurement represents CCT and resistance to the corneal surface to the action of intraocular pressure and external air blowing. It is clinically important and allows predicting the long-term results (keratoectasia and keratoconus) after LASIK refractive surgery and the development of glaucoma.

In all three groups DA, PD, IR, CBI and TBI parameters showed a tendency to increase proportionally with the increase of myopia. These parameters are also statistically significant ($p < 0.05$).

Corvis ST biomechanical parameters are some geometric measurements that result from the inward and outward movement of the cornea after a single air puff. This is mainly determined as the product of three factors: the air puff pressure, the IOP, and the biomechanical properties of the cornea. In all cases, the air puff pressure is the same and constant. As a result, analyzing the biomechanical properties of the cornea can show changes in some eye diseases such as keratoconus and glaucoma [6].

Therefore, an accurate method for assessing corneal biomechanics in vivo is of great importance for predicting corneal surgical outcomes and planning the optimal type of surgery [4].

The results obtained in our study, including HCR, PD, DA, CBI and TBI are close to the results of Huseynova T. et al. [6]. In a study by Valibon B.F. et al. [8] in healthy eyes, the results of corneal biomechanical parameters were comparable to those obtained in a group of patients with myopia and the differences between them and the results in healthy human eyes were determined.

Conclusion

It should be noted that the above-mentioned corneal biomechanical parameters allow us to analyze and predict the course of eye diseases and long-term results of refractive surgery. According to the results, a tendency was observed to increase in the main parameters of corneal biomechanical dimensions in patients with high myopia, who had a larger axial length of the eyeball and a thinner CCT, compared to patients with mild myopia.

ƏDƏBİYYAT

REFERENCE

1. Atowa, U.C. Vision problems: A review of prevalence studies on refractive errors in school-age children / U.C.Atowa, R.Hansraj, S.O.Wajuihian // Afr. Vision Eye Health, – 2019. 78(1), – p. 461. https://doi.org/10.4102/aveh.v78i1.461
2. Zhang, J. Epidemiology and Burden of Astigmatism: A Systematic Literature Review / J.Zhang, Y.Wu, B.Sharma [et al.] // Optometry and Vision Science, – 2023. 100(3), – p. 218-231 https://doi.org/10.1097/OPX.0000000000001998
3. Tian, L. Corneal biomechanical assessment using corneal visualization scheimpflug technology in keratoconic and normal eyes / L.Tian, Y.F.Huang, L.Q.Wang [et al.] // J. Ophthalmol., – 2014. 2014, – p. 147516. https://doi.org/10.1155/2014/147516
4. Pinero, D.P. In vivo characterization of corneal biomechanics / D.P.Pinero, N.Alcon // J. Cataract. Refractive Surg., – 2014. 40, – p. 870-887. https://doi.org/10.1016/j.jcrs.2014.03.021
5. Hassan, Z. Examination of ocular biomechanics with a new Scheimpflug technology after corneal refractive surgery / Z.Hassan, L.Modis Jr., E.Szalai [et al.] // Cont. Lens Anterior. Eye, – 2014. 37, – p. 337-341. https://doi.org/10.1016/j.clae.2014.05.001
6. Huseynova, T. Corneal biomechanics as a function of intraocular pressure and pachymetry by dynamic infrared signal and Scheimpflug imaging analysis in normal eyes / T.Huseynova, G.O.Waring, C.Roberts [et al.] // Am. J. Ophthalmol., – 2014. 157, – p. 885-893. https://doi.org/10.1016/j.ajo.2013.12.024
7. Hong, J. A new tonometer-the Corvis ST tonometer: clinical comparison with noncontact and Goldmann applanation tonometers / J.Hong, J.Xu, A.Wei [et al.] // Invest Ophthalmol. Vis. Sci., – 2013. 54, – p. 659-665. https://doi.org/10.1167/iovs.12-10984
8. Valibon, B.F. Ocular biomechanical metrics by Corvis ST in healthy Brazillian patients / B.F.Valibon, R.Ambrosio Jr., B.M.Fontes [et al.] // J. Refractive Surg., – 2014. 30, – p. 468-473. https://doi.org/10.3928/1081597X-20140521-01