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Original Article

Changes in corneal biomechanics after phacoemulsification

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Abstract: Background: The aim of this study was to explore changes in corneal biomechanics in patients with longer axial lengths after phacoemulsification. Methods: A total of 58 patients (68 eyes) undergoing phacoemulsification were divided into longer axial length and normal axial length groups (each group with 34 eyes). Corneal visualization Scheimpflug technology (Corvis ST) was used to measure biomechanical corneal parameters, preoperatively, in the first postoperative week and in the first postoperative month. Results: Comparing preoperative values with those in the first postoperative week and first postoperative month, statistically significant differences were found between the two groups in peak distance (P=0.002), central corneal thickness (P<0.001), corrected intraocular pressure (P<0.001), and intraocular pressure (P<0.001). Moreover, second applanation time (*P*=0.042) and deformation amplitude were significantly different in the longer axial length group (P=0.005). In the longer axial length group, changes in central corneal thickness (*P*=0.014), corrected intraocular pressure (*P*=0.04), and deformation amplitude (*P*=0.005) were positively correlated with axial length in the first postoperative week. However, in the normal axial length group, changes in related parameters did not correlate with axial length. Conclusion: Phacoemulsification can affect corneal biomechanical properties in patients with longer axial lengths.

Keywords: Biomechanics, cornea, corneal visualization Scheimpflug technology, high myopia, phacoemulsification

Introduction

Cataracts are a disease occurring commonly in elderly populations. However, age-related cataracts can develop in the fourth and fifth decades of life. Most cataracts that occur during middle age are small and do not affect vision. Most cataracts that impair vision occur after the age of age 60. Worldwide, cataracts are the leading cause of blindness [1]. At present, the main treatment method for cataracts is phacoemulsification (Phaco). Corneal biomechanical characteristics are complex and flexible. Moreover, they change with microstructural corneal changes in clinical ophthalmology. Phacoemulsification can lead to corneal endothelial cell injury and corneal edema. Valbon et al. [2] found that phacoemulsification increased corneal thickness and weakened corneal biomechanical properties. Corneal biomechanical changes following cataract surgery may cause poor wound healing, leading to persistent infections. Compared with normal eyes, eyes with high myopia show decreased corneal endothelial cell density, increased average cell area, and decline in the "pump" function of endothelial cells. Therefore, they were more susceptible to corneal edema, decompensation, and other diseases following intraocular surgery [3]. Axial elongation is an important factor in occurrence and development of myopia [4]. There are few studies regarding changes in corneal biomechanical properties and differences between patients with longer and normal axial lengths following cataract surgery.

Recently, a new instrument for corneal visualization, Scheimpflug technology (Corvis ST; Wetzlar, Germany), was developed to detect corneal biomechanical properties *in vivo*. Scheimpflug technology can record dynamic corneal compressive deformation in real time and analyze biomechanical changes that occur

during this process. Deformation parameters measured by this instrument are unaffected by corneal morphology and are preferable for describing corneal biomechanical properties in study populations [5, 6]. Corvis ST also has been used in clinical intraocular pressure measurement [7], differential diagnosis of keratoconus [8], and assessment of corneal biomechanical changes after corneal cross-linking and refractive surgery [9, 10]. Bruno et al. [1] first used Corvis ST to measure biomechanical parameters and compare changes after femtosecond laser-assisted phacoemulsification and standard phacoemulsification. They found that the majority of corneal biomechanical parameters changed during the first postoperative day in patients undergoing both types of surgeries.

This study aimed to observe changes in corneal biomechanical parameters in patients with longer axial lengths, before and after phacoemulsification.

Materials and methods

Research design and patients

A total of 58 patients (68 eyes) undergoing phacoemulsification and intraocular lens implantation in the Department of Cataract of Tianjin Eye Hospital, between June 2017 and January 2018, were selected for this prospective cohort study. Inclusion criteria included an axial length of 22-24 mm or greater than 26 mm and level II-III lens nucleus graded, in accordance with Emery and Little standards [11]. Exclusion criteria included patients with history of other eye diseases, such as keratoconus, suspected keratoconus, corneal scarring, glaucoma, and active eye diseases as well as eye trauma or a history of ophthalmic surgery, systemic diseases that affect the eyes, and an unstructured corneal surface, poor transmittance, and difficulties in autofocusing. Patients were divided into longer axial length (> 26 mm) and normal axial length groups (22-24 mm). This study followed Declaration of Helsinki guidelines and was approved by the Ethics Committee of Tianjin Eye Hospital. All participants signed informed consent (Ethical approval number: TJYYKK-2015-13).

Routine preoperative examination

All subjects underwent ophthalmologic examinations 1 day before the operation, including uncorrected and corrected visual acuity, monocular uncorrected visual acuity (UCVA), best-corrected visual acuity (BCVA), intraocular pressure, slit-lamp microscopy, and indirect ophthalmoscopy. IOLMaster was used to measure curvature and axial length and Corvis ST was used to measure corneal biomechanical parameters and intraocular pressure.

Corneal biomechanical parameter measurement using Corvis ST

Corvis ST uses ultrahigh-speed Scheimpflug technology (a maximum acquisition rate of 4,330 frames/second with an acquisition diameter of 8.5 mm and image resolution of 640 × 480 pixels) to obtain dynamic recordings of the entire deformation process in the central horizontal section of the cornea in real time [11-13]. After analysis using professional software, slow-motion frames can be obtained and displayed on the control panel. During intraocular pressure and corneal viscoelasticity measurements, airflow was used to depress the cornea inward and when the corneal vertex reached its maximum depth, attenuation or disappearance of airflow caused the cornea to return to its initial state. During this procedure, the cornea underwent applanation twice. Corvis ST recorded corneal deformation parameters that reflected corneal biomechanical properties throughout the deformation process. All examinations were performed by the same physician. During examination, the gaze of the affected eye was strictly monitored to ensure accurate and reliable results. Corneal biomechanical parameters were measured, preoperatively, in the first postoperative week and in the first postoperative month. Examinations were completed before 2 p.m.-4 p.m. Each eye was measured three times during the examination. Average values were used as the final result.

Surgical methods

Before surgery, the conjunctival sac was washed with normal saline. Next, the skin surrounding the eye was disinfected using 5% iodophor. Two drops of 0.5% proxymetacaine were instilled in the eye for surface anesthesia and a sterile towel (eye mask) and eye speculum were placed. The main incision was made in the transparent corneal margin (incision length, 2.8 mm) in the 11 o'clock direction and an auxiliary incision was made in the corneal margin in the 2 o'clock direction. The anterior

Table 1. Basic information of enrolled patients

Basic characteristics	Longer-axial length group	Normal-axial length group	*P* value
Age (year)	54.85 ± 4.78	56.41 ± 5.29	0.215
Gender (M/F)	18/16	15/19	0.476
Axial length (mm)	29.04 ± 1.72	23.04 ± 0.37	<0.001
Corneal curvature (D)	45.34 ± 1.31	44.48 ± 1.42	0.015
Lens nucleus hardness	II level core 16 cases, III level core 18 cases	II level core 15 cases, III level core 19 cases	0.261

chamber was filled with a viscoelastic agent. The lens nuclei and cortex were removed using phacoemulsification and an artificial lens was implanted into the sac, followed by incision closure using a hydraulic seal. No complications were observed intraoperatively. Postoperatively, levofloxacin eye drops and tobramycin cream were applied to the conjunctival sac. All operations were performed by the same experienced chief physician.

Postoperative treatment and follow up

Patients were discharged from the hospital after conventional visual acuity and slit-lamp examinations. Postoperative medications were prescribed, including pranoprofen eye drops, levofloxacin hydrochloride eye drops, and fluorometholone eye drops. Each were applied four times per day, with the dose was decreased once weekly. All eye drops were discontinued 1 month after the ophthalmic operation. Patients in both groups visited the hospital for routine examinations (visual acuity, slit-lamp examination, and Corvis ST corneal biomechanical measurement) in the first postoperative week and first postoperative month.

Statistical analysis

Statistical analyses were performed using SPSS v. 18.0 software (SPSS, Chicago, IL, USA). Data are expressed as mean ± the standard deviation. Data in each group were assessed using Kolmogorov-Smirnov normality test. Differences in preoperative parameters between the two groups were analyzed using independent-samples *t*-test. Sex ratio and lens nucleus hardness were analyzed using Chi-squared test. Overall differences in corneal biomechanical parameters, at different time points, between the two groups, pre- and postoperatively, were analyzed using one-way analysis of variance. Bonferroni's test was used for multiple comparisons between different time points. Correlation analyses were performed using Pearson's correlation analysis. *P*-values less than 0.05 were considered statistically significant.

Results

General information

Characteristics of the enrolled patients are shown in **Table 1**. Age was not statistically different between longer and normal axial length groups (t=-1.28; P=0.215). Moreover, no statistically significant differences were observed in sex ratio (χ^2=0.53, P=0.476) or lens nucleus hardness (χ^2=4.00, P=0.261) between the two groups.

Pre- and postoperative corneal biomechanical analyses

Changes in corneal biomechanical parameters in the longer axial length group, at different time points before and after phacoemulsification, are shown in **Table 2**. Significant differences were found in peak distance, central corneal thickness, corrected intraocular pressure, intraocular pressure, second applanation time, and deformation amplitude, preoperatively, in the first postoperative week and the first postoperative month (P<0.05). Of these, peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure were statistically significantly higher in the first postoperative week than preoperatively (P=0.018, <0.001, <0.001, and <0.001, respectively). Deformation amplitude was reduced significantly compared with the preoperative value (P<0.001). Deformation amplitude in the first postoperative month was significantly lower than that preoperatively (P<0.001). Central-corneal thickness, corrected intraocular pressure, and intraocular pressure values were significantly higher than preoperative values (P<0.001, 0.023, and 0.010, respectively), while peak distance and second applanation time returned to preoperative levels (P=0.072 and 0.076, respectively). Additionally, peak dis-

Table 2. Changes in corneal biomechanical parameters in the longer-axial length group at different time points before and after Phaco operation (x ± s)

Time	Eye number	Central corneal thickness (μm)	First applanation time (ms)	Second applanation time (ms)	Highest concavity Time (ms)	Intraocular pressure (mm Hg)	Corrected intraocular pressure (mm Hg)
Before operation	34	520.09 ± 26.04	7.16 ± 1.07	21.62 ± 0.59	16.96 ± 0.66	12.56 ± 2.72	12.27 ± 2.80
In the first postoperative week	34	543.30 ± 32.16[a]	7.30 ± 0.30	21.61 ± 0.48[b]	17.09 ± 0.64	14.36 ± 3.20[a,b]	13.68 ± 2.39[a,b]
In the first postoperative month	34	540.71 ± 30.57[a]	7.10 ± 1.09	21.81 ± 0.45	17.02 ± 0.75	13.42 ± 2.73[a]	12.95 ± 2.59[a]
F		32.00	1.25	3.33	0.354	13.42	36.78
P		<0.001	0.299	0.042	0.703	<0.001	<0.001

Note: compared with corresponding preoperative values ([a]*P*<0.05), comparison between values in the first postoperative week and those in the first postoperative month ([b]*P*<0.05) (analysis of variance and Bonferroni's test).

Table 3. Changes in corneal biomechanical parameters in the normal-axial length group at different time points before and after Phaco operation (x ± s)

Time	Eye number	First applanation length (mm)	Second applanation length (mm)	First applanation velocity (m/s)	Second applanation velocity (m/s)	Peak distance (mm)	Radius (mm)	Deformation amplitude (mm)
Before operation	34	1.79 ± 0.05	1.81 ± 0.29	0.15 ± 0.02	-0.34 ± 0.07	3.67 ± 0.22	7.20 ± 0.83	1.14 ± 0.14
In the first postoperative week	34	1.81 ± 0.04	1.75 ± 0.27	0.15 ± 0.02	-0.37 ± 0.09	4.49 ± 0.17[a,b]	7.36 ± 1.05	1.13 ± 0.10
In the first postoperative month	34	1.80 ± 0.03	1.70 ± 0.26	0.15 ± 0.02	-0.37 ± 0.08	3.73 ± 0.24	7.18 ± 0.99	1.14 ± 0.13
F		2.28	2.90	0.83	2.28	6.60	0.73	0.12
P		0.110	0.062	0.442	0.110	0.002	0.486	0.89

Note: compared with corresponding preoperative values ([a]*P*<0.05), comparison between values in the first postoperative week and those in the first postoperative month ([b]*P*<0.05 (analysis of variance and Bonferroni's test).

tance, corrected intraocular pressure, and intraocular pressure showed decreasing trends in the first postoperative month compared with values in the first postoperative week (*P*<0.001, 0.001, and <0.001, respectively). Central-corneal thickness differences did not show statistical significance (*P*=1.000).

Changes in corneal biomechanical parameters in the normal axial length group at different time points before and after phacoemulsification

Changes in corneal biomechanical parameters in the normal axial length group at different time points are shown in **Table 3**. Significant differences were found in peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure, preoperatively, in the first postoperative week and the first postoperative month (*P*<0.05). Peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure values were increased significantly in the first postoperative week compared with preoperative values (*P*=0.004, 0.046, <0.001, and <0.001, respectively). However, peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure in the first postoperative month returned to preoperative levels (*P*=1.000, 0.221, 0.548, and 1.000, respectively). Moreover, peak distance, corrected intraocular pressure, and intraocular pressure showed a significant decreasing trend in the first postoperative month compared with values in the first postoperative week (*P*=0.013, <0.001, and <0.001, respectively).

Comparison of changes in biomechanical parameters between the longer axial length and normal axial length groups in the first week after phacoemulsification

Comparisons of changes in corneal biomechanical parameters between the longer axial length and normal axial length groups in the first week after phacoemulsification are shown in **Table 4**. Significant differences were found in central corneal thickness, deformation amplitude, corrected intraocular pressure, and peak distance at 1 week after phacoemulsification between longer and normal axial length groups (*P*<0.05). Changes in biomechanical parameters were larger in the longer axial length group than normal axial length group.

Table 4. Comparison of changes in biomechanical parameters between the longer-axial length and normal-axial length groups in the first week after Phaco operation

Groups	ΔCentral corneal thickness (μm)	ΔDeformation amplitude (mm)	ΔCorrected intraocular pressure (mm Hg)	ΔPeak distance (mm)
Longer-axial length group	23.21 ± 22.61	-0.07 ± 0.05	1.40 ± 1.09	0.93 ± 0.67
Normal-axial length group	10.68 ± 17.89	-0.007 ± 0.12	0.92 ± 0.80	0.06 ± 1.57
t	2.53	-2.78	2.09	2.98
P	0.014	0.005	0.04	0.004

Note: Δ, Changes between values in the first postoperative week and those before operation, $P<0.05$.

Table 5. Comparison of changes in biomechanical parameters between the longer-axial length and normal-axial length groups in the first month after Phaco operation

Groups	ΔCentral corneal thickness (μm)	ΔDeformation amplitude (mm)	ΔCorrected intraocular pressure (mm Hg)	ΔPeak distance (mm)
Longer-axial length group	20.62 ± 12.77	-0.05 ± 0.06	0.67 ± 1.24	0.32 ± 0.78
Normal-axial length group	7.41 ± 23.39	-0.003 ± 0.14	0.26 ± 1.12	0.81 ± 1.35
t	2.89	-2.04	3.26	-1.86
P	0.005	0.045	0.002	0.06

Note: Δ, Changes between values in the first postoperative month and those before operation, $P<0.05$.

Comparison of changes in biomechanical parameters between the longer axial length and normal axial length groups in the first month after phacoemulsification

Comparisons of changes between the groups in corneal biomechanical parameters in the first month after phacoemulsification are shown in **Table 5**. Significant differences were found in central corneal thickness, deformation amplitude, and corrected intraocular pressure between the two groups in the first month after phacoemulsification ($P<0.05$). Changes in biomechanical parameters were greater in the longer axial length group than normal axial length group. Changes in corneal biomechanical parameters between the two groups at different time points are shown in **Figure 1A-D**.

Postoperative correlation analysis of corneal biomechanical parameters

Changes in central corneal thickness, corrected intraocular pressure, and deformation amplitude were positively correlated with axial length in the longer axial length group in the first postoperative week ($r=0.493$, $P=0.003$; $r=0.575$, $P<0.001$; $r=0.587$, $P<0.001$, respectively). However, changes in central corneal thickness, corrected intraocular pressure, and deformation amplitude were not correlated with axial length in the normal axial length group in the first postoperative week ($r=0.125$, $P=0.482$; $r=-0.083$, $P=0.639$; $r=-0.129$, $P=0.468$, respectively). Moreover, changes in peak separation were not correlated with axial length in either group in the first postoperative week ($r=-0.250$, $P=0.154$; $r=-0.199$, $P=0.259$), as shown in **Figure 2A-C**.

Discussion

The cornea is a transparent membrane barrier that isolates the eye from the environment. Collagen fibers in the corneal stroma are important factors related to corneal tensile strength. When the arrangement of stromal collagen fibers is changed by trauma or disease, the biomechanical properties of the cornea are affected. Studies have found that the density of corneal cells in the corneal stroma increase significantly after phacoemulsification [14]. Phacoemulsification and intraocular lens implantation may have impact on corneal biomechanical properties due to surgical incision, intraoperative damage from ultrasound energy, mechanical damage from emulsified particles, and mechanical injury during intraocular lens implantation. Studies have found that the cornea becomes thinner with increases in axial length and eye dilation [9]. The microstructure may change in patients with a longer axial

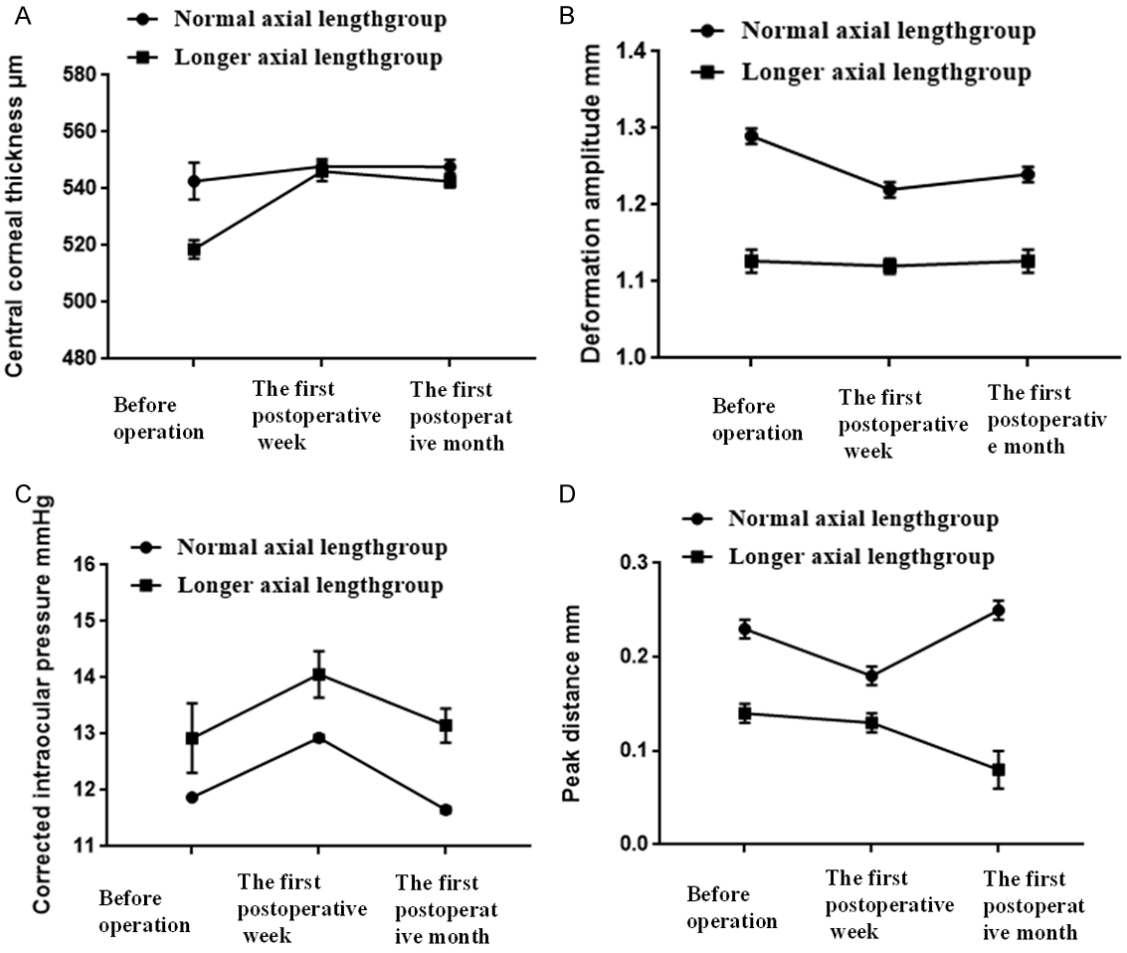

Figure 1. A-D. Changes in corneal biomechanical parameters at different time points between longer axial length and normal axial length groups.

length due to the ocular axis itself and intraoperative injuries after phacoemulsification. Corneal biomechanics may also change. At present, ocular response analyzers (ORA) are widely used to measure biomechanical properties of the cornea. ORAs have been used in many studies to evaluate relationships between corneal biomechanical changes and cataract surgery. Zhangzhe et al. [15] used an ORA to compare corneal biomechanical parameters between patients undergoing phacoemulsification with a 2.2-mm microincision and a 3.0-mm standard incision. They found that corneal biomechanical parameters in the two groups were reduced, whereas the IOPg and IOPcc were increased on the first postoperative day. Moreover, compared with patients in the 3.0-mm incision group, patients in the 2.2-mm incision group recovered more quickly, with aforementioned parameters returning to preoperative levels. Alió et al. [16] performed a similar study and found that corneal biomechanics were more stable in patients with a 1.8-mm incision compared with patients with a 2.75-mm incision. Simsek et al. [17] studied corneal biomechanics, following congenital cataract surgery, and found that although corneal thickness increased, biomechanical parameters were not affected by the operation. However, the quantitative relationship between parameters measured by ORA and classical biomechanical parameters of corneal materials, such as the elastic modulus, stress, and strain, has not yet been established. To some extent, these are affected by corneal morphology [18]. Freitas et al. [1] first used the Corvis ST to measure and compare changes in corneal biomechanical parameters in patients undergoing femtosecond laser-assisted phacoemulsification and standard cataract surgery. They found

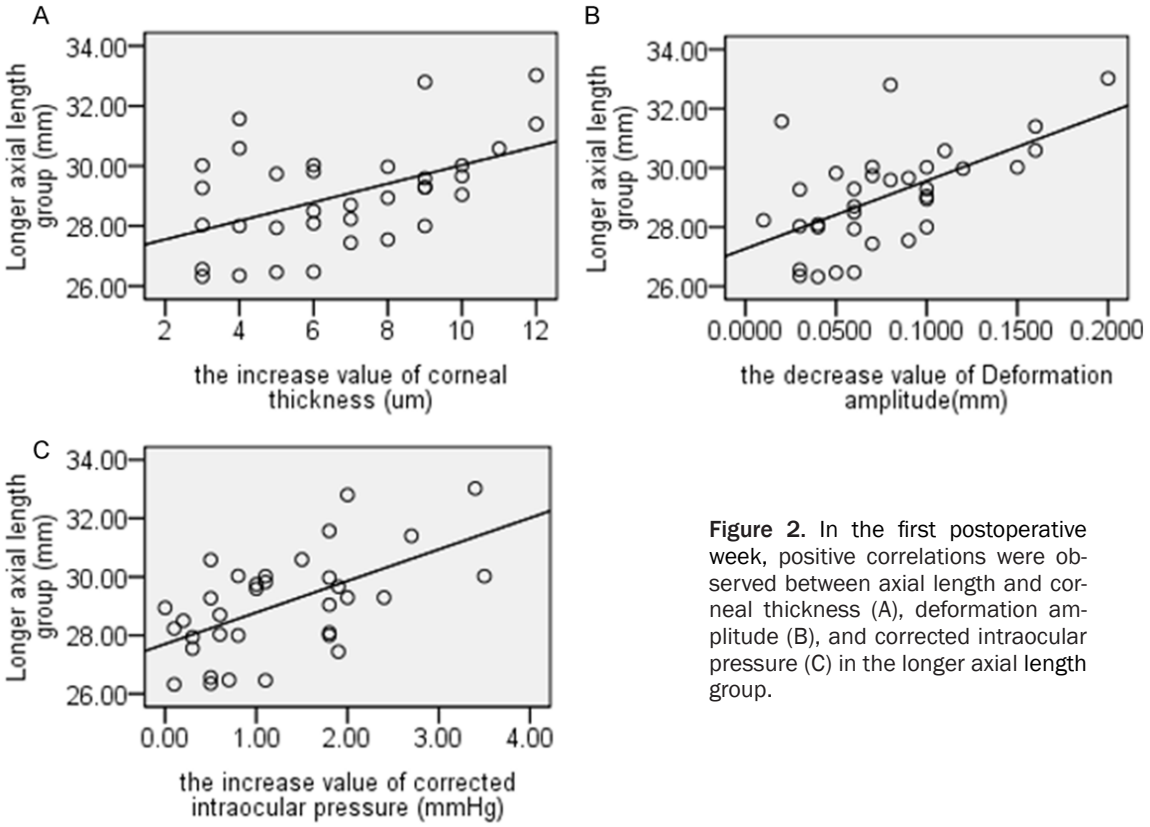

Figure 2. In the first postoperative week, positive correlations were observed between axial length and corneal thickness (A), deformation amplitude (B), and corrected intraocular pressure (C) in the longer axial length group.

that the majority of parameters changed in both groups during the first postoperative day.

In this study, patients with normal axial lengths were considered the control group. orvis ST was used to measure corneal biomechanical changes in patients with longer and normal axial lengths after phacoemulsification. In the first postoperative week, peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure increased significantly in the two groups compared with preoperative values, while deformation amplitude decreased compared to preoperative amplitude in the longer axial length group. These results are consistent with those obtained by Freitas et al. [1]. Most biomechanical properties of the cornea are reflected by the stroma and the composition and structure of collagen fibers in the stroma determine the elastic properties of the cornea. Guiqiu et al. found that the density of stromal keratocytes increased significantly after phacoemulsification [14]. One week postoperatively, varying degrees of corneal edema and an increased number of corneal stromal cells enhanced the compressive strength of the cornea, thus reducing deformation amplitude under the same pressure conditions. Increased corneal thickness and decreased deformation amplitude tend to increase peak distance. Moreover, at 1 week postoperatively, intraocular pressure was increased significantly in both groups. This likely occurred because of intraoperative viscoelastic agent and lens cortex residues as well as increased secretion of reflective aqueous humor such that the inflammatory exudate blocked the trabecular meshwork, resulting in poor aqueous humor circulation. These findings are consistent with results obtained by Zhangzhe et al. [15]. Additionally, other studies have reported that corneal thickness can affect intraocular pressure. A 10% increase in central corneal thickness can cause flattened tonometer intraocular pressure to increase by 3.4 mmHg, even up to 10 mmHg in cases with acute disease [19, 20]. In the first postoperative month, peak distance, central corneal thickness, corrected intraocular pressure, and intraocular pressure returned to preoperative levels in the normal axial length group. Kandarakis et al. carried out similar studies

and found that central corneal thickness first increased and then gradually returned to normal levels in 41 patients with general cataracts undergoing cataract surgery [21]. This was thought to be caused by temporary and reversible postoperative corneal edema. Corneal biomechanics-related parameters also returned to preoperative levels with corneal edema regression. The above research raises concerns regarding the accuracy of Corvis measurement of the CCT in eyes, postoperatively. However, postoperative deformation amplitude was still less than that in the longer axial length group, preoperatively, and corneal central thickness, corrected intraocular pressure, and intraocular pressure values remained higher than before the operation. In this study, axial lengths of patients in the longer axial length group were greater than 26 mm. Axial elongation is the main factor in development of myopia. In this study, preoperative diopters were immeasurable because of cataracts in patients with longer axial lengths. However, they all had high myopia according to their axial lengths. Some studies have found that the density of corneal endothelial cells decreased in patients with high myopia and these patients were more likely to have corneal edema as well as decompensation and other diseases [3]. The cornea is a very complex anisotropic tissue. The strength of the central cornea depends on interlamellar proteoglycan bonding whereas anterior and peripheral strength depend on branching and interlacing of lamellae. With an increased axial length in cases with high myopia, the posterior sclera shows staphyloma and becomes thinner, which tends to cause traction on the cornea toward the surrounding tissues through force conduction, resulting in subtle biological changes in the corneal stroma [22] as well as definite changes in corneal biomechanics. Occurrence and development of myopia have been closely associated with regional changes in corneal biomechanical properties, which tend to induce pathological changes such as thinning of the region beneath the temporal bone and weakened mechanical properties [23]. These results were confirmed by the findings of the present study, in which corneal biomechanics were more likely to change with increased axial length and increased degree of myopia after phacoemulsification in patients with high myopia compared with normal individuals. Some studies have reported that patients with high myopia have a higher risk of glaucoma than normal individuals. Intraocular pressure shows an increasing trend with progression of high myopia [24, 25]. In this present study, a consistently increasing trend in intraocular pressure was observed in patients with high myopia after phacoemulsification. It is believed that the high-myopia group may have higher risk of high intraocular pressure compared with the normal group, postoperatively. Therefore, careful attention should be paid to intraocular pressure changes in patients with high myopia after phacoemulsification to prevent high intraocular pressure and glaucoma complications, postoperatively. In the first postoperative week, biomechanical parameter changes were greater in the longer axial length group than the normal axial length group. However, differences between preoperative values and those in the first postoperative month were greater in the longer axial length group than the normal axial length group. Combined with changes at different time points, it was observed that corneal biomechanics were more likely to change and that recovery was slower in the longer axial length group than the normal axial length group. Analysis revealed positive correlation between axial length and central corneal thickness, corrected intraocular pressure, and deformation amplitude changes in patients with high myopia in the first postoperative week. However, no correlation was found in the normal axial length group, indicating that corneal biomechanics and intraocular pressure could be affected by axial length.

This present study had some limitations. First, the study included patients with both binocular and monocular diseases, possibly affecting results. Therefore, additional comparative analysis is necessary. Furthermore, this study did not determine whether more statistically significant biomechanical changes occurred during the first postoperative day or whether changes in corneal biomechanics and intraocular pressure returned to preoperative levels in patients with longer axial lengths over a longer follow up duration. Moreover, since this study was designed to investigate corneal biomechanical changes in patients with high myopia after phacoemulsification, only patients with axial lengths greater than 26 mm were selected. Patients with axial lengths between 24 mm and 26 mm were not included. Further research

should be conducted to compare corneal biomechanics among patients with different axial lengths.

Conclusion

In summary, phacoemulsification can change corneal biomechanical properties. These changes were more significant and recovery was slower in patients with longer axial lengths than in patients with normal axial lengths. Moreover, since intraocular pressure in patients with longer axial lengths demonstrated an increasing trend, attention should be paid to postoperative intraocular pressure changes and hormone therapy drug administration should be controlled to prevent high intraocular pressure and glaucoma complications, postoperatively. Ultimately, the sample size of this study was small and observation duration was short. Therefore, long-term effects of phacoemulsification on corneal biomechanical properties in patients with longer axial lengths still need to be confirmed by studies with larger sample sizes and longer observation periods.

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Disclosure of conflict of interest

None.

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