

Evaluation of corneal biomechanical properties after uneventful standard coaxial phacoemulsification surgery

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Abstract

Aim: This study was designed to investigate the alteration of intraocular pressure measurements and biomechanical properties of the cornea in patients who underwent uneventful standard coaxial phacoemulsification cataract surgery through 2.75 mm corneal main incision with intraocular lens implantation.

Material and Methods: 15 eyes of 15 patients admitted to our clinic because of the cataract problems in the study. Corneal hysteresis (CH), corneal resistance factor (CRF) measurements, Goldmann correlated (IOPg), and corneal compensated intraocular pressure (IOPcc) values were recorded by ocular response analyzer (ORA) before and 1 day, 1 week and 1 month after surgery.

Results: The mean age of the patients was 64.3 ± 8.06 years. Preoperative mean CH, CRF, IOPg and IOPcc values were 8.23 ± 2.10 , 9.33 ± 2.27 , 18.54 ± 3.42 and 19.66 ± 3.22 , respectively. The mean CH, CRF, IOPg and IOPcc values were 5.50 ± 2.07 , 8.69 ± 2.04 , 22.29 ± 3.37 and 23.83 ± 3.32 , respectively on the first day after the surgery. The mean CH, CRF, IOPg and IOPcc values were 5.25 ± 1.83 , 8.29 ± 2.10 , 18.86 ± 2.72 and 20.20 ± 3.37 , respectively of the first week after the surgery. The mean CH, CRF, IOPg and IOPcc values were 7.88 ± 1.99 , 8.37 ± 1.83 , 15.81 ± 2.60 and 16.41 ± 2.80 , respectively in the first month after the surgery.

Conclusion: These results revealed that the biomechanical properties of the cornea may change during the first one month period after uneventful standard coaxial phacoemulsification surgery.

Keywords: Ocular Response Analyzer; Corneal Biomechanical Properties; Coaxial Phacoemulsification Surgery.

INTRODUCTION

Innovations and improvements in cataract surgery have been still progressing today. Refractive and visual healing is accelerated in parallel with the technological improvements such as the increase of surgical techniques and the reduction of surgical incision sizes. Moreover a significant decrease in intraoperative and postoperative complications has been observed (1).

The use of continuous curvilinear capsulorhexis, hydro dissection, hydro delineation and the use and development of viscoelastic materials provide the cataract surgery as far away from the cornea as possible. Furthermore, in recent years, corneal damage due to surgery has been observed at a fairly low rate due to the considerable reduction in corneal incisional sizes and the minimization of the amount of phaco energy used by new generation phaco devices (2,3). Despite all these developments in cataract surgery, the effect of the applied surgery on the biomechanical properties of the cornea, which has become more popular in recent years, is a matter of curiosity.

The common feature of newly developed tonometries for IOP measurement is that they are affected by fewer corneal parameters (4). The ORA device is also a kind of contactless tonometer that allows the measurement of IOP independent of corneal parameters, which has increased use in recent years in this context (5). The difference between the two applanation values (P1, P2) obtained when the cornea undergoes deformation and returns to its original position after rapid air injection to the central 3 mm area of the cornea is called as corneal hysteresis (CH). CH is a good predictor of the biomechanical properties of the cornea. The average of two applanation pressures is determined as Goldmann-correlated IOP (IOPg). The instrument also determines a second IOP value (IOPcc) considering CH, which is compensated for with the biomechanical properties of the cornea. Another important parameter of the device is corneal resistance factor (CRF) (6,7).

We aimed to investigate the biomechanical properties of the cornea and the alterations in the intraocular pressure measurements in patients undergoing uneventful

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standard coaxial phacoemulsification surgery from 2.75 mm corneal main incision.

MATERIAL and METHODS

Between January 1, and May 1, 2010, 15 eyes of 15 patients who were referred to Malatya State Hospital Ophthalmology Clinic due to loss of vision and cataract detected in ophthalmologic examinations, were included in the study. The mean age of the patients was 64.3 ± 8.06 years.

After informing the participant with appropriate features about the study CH, CRF, IOPg, and IOPcc values were recorded with ORA device following full ophthalmologic examinations including preoperative visual acuities, anterior segment examinations, and fundus examinations after pupillary dilatation.

Patients with any systemic disease (such as connective tissue diseases) that may affect corneal parameters, and who have certain retinal diseases such as diabetic retinopathy and retinal vascular disease, active or inactive uveitis, corneal pathology, or previous ocular surgery were excluded from the study.

A standard coaxial phacoemulsification surgery was performed by the same surgeon and with the same phaco device (Alcon INFINITI® System) through the 2.75 mm corneal main incision (temporal incision) under topical anesthesia, and an intraocular lens (IOL) was implanted in the capsular bag. Also the patients who exposed to any complication during this procedure were not included in the study. In all cases, topical steroid (0.1% dexamethasone) and antibiotic (moxifloxacin 0.5%) treatment were started 4 times a day postoperatively. Corneal edema scoring was performed on the 1st postoperative day and cases with 2+, 3+ corneal edema were not included in the study (Table1). On postoperative 1 day, 1 week, and 1 month; CH, CRF, IOPg, and IOPcc values of the patients who don't have moderate-to-severe corneal edema were re-recorded with ORA.

Table 1. Corneal edema scoring

0 corneal edema	No corneal edema
1+ corneal edema	Iris details are visible despite corneal edema
2+ corneal edema	Pupilla margins are visible, but iris details are invisible
3+ corneal edema	Pupilla margins are invisible

The SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Measurable data of the study was presented as mean ± standard deviation (SD). Wilcoxon test from non-parametric tests was used to compare the results because the variables of the study did not have normal distribution. A p value less than 0.05 was considered as statistically significant.

RESULTS

Fifteen cases were included in the study, 8 of which were

male and 7 of them were female, with a mean age of 64.3 ± 8.06 years. There was no significant difference for age and sex (p = 0.16).

Preoperative mean CH, CRF, IOPg and IOPcc values were 8.23±2.10, 9.33±2.27, 18.54±3.42 and 19.66±3.22, respectively. The mean CH, CRF, IOPg and IOPcc values were 5.50±2.07, 8.69±2.04, 22.29±3.37 and 23.83±3.32, respectively on the first day after the surgery. The mean CH, CRF, IOPg and IOPcc values were 5.25±1.83, 8.29±2.10, 18.86±2.72 and 20.20±3.37, respectively in the first week after the surgery. The mean CH, CRF, IOPg and IOPcc values were 7.88±1.99, 8.37±1.83, 15.81±2.60 and 16.41±2.80, respectively in the first month after the surgery (Table 2).

Table 2. The mean values of CH, CRF, IOPg and IOPcc measured by ORA before the surgery and on the first day, of the first week and in the first month after the surgery

	CH	CRF	IOPg	IOPcc
Preop	8.23±2.10	9.33±2.27	18.54±3.42	19.66±3.22
Postop day 1	5.50±2.07 (p=0.001)*	8.69±2.04 (p=0.001)*	22.29±3.37 (p=0.001)*	23.83±3.32 (p=0.001)*
Postop week 1	5.25±1.83 (p=0.001)*	8.29±2.10 (p=0.001)*	18.86±2.72 (p=0.98)	20.20±3.37 (p=0.87)
Postop month 1	7.88±1.99 (p=0.035)*	8.37±1.83 (p=0.033)*	15.81±2.60 (p=0.033)*	16.41±2.80 (p=0.001)*

CH: Corneal hysteresis, CRF: corneal resistance factor, IOPg: Goldmann correlated intraocular pressure, IOPcc: corneal compensated intraocular pressure, Preop: preoperative, Postop: postoperative, *statistically significance

Preoperative and postoperative CH, CRF, IOPg and IOPcc values were shown in figure 1, 2, 3 and 4.

CH and CRF values were significantly lower (p <0.05) on the first day, in the first week and in the first month after the surgery when compared with the preoperatively measurements. IOPg and IOPcc values were significantly higher (p <0.05) on the first day after the surgery and significantly lower (p <0.05) in the first month after the surgery when compared with the preoperatively measurements.

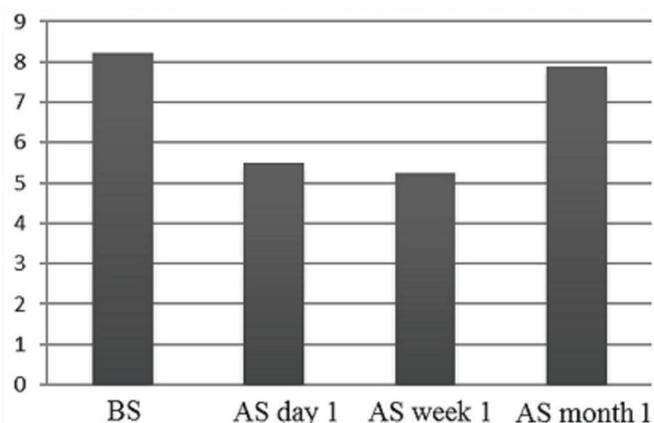


Figure 1. Preoperative and postoperative mean CH values (CH: Corneal hysteresis, BS: before the surgery, AS: after the surgery)

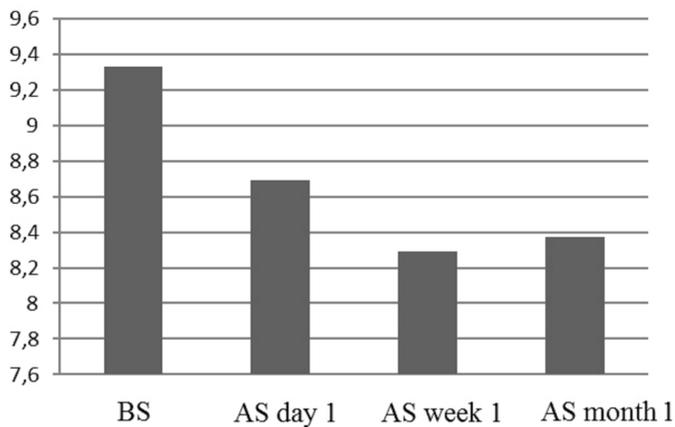


Figure 2. Preoperative and postoperative mean CRF values (CRF: corneal resistance factor, BS: before the surgery, AS: after the surgery)

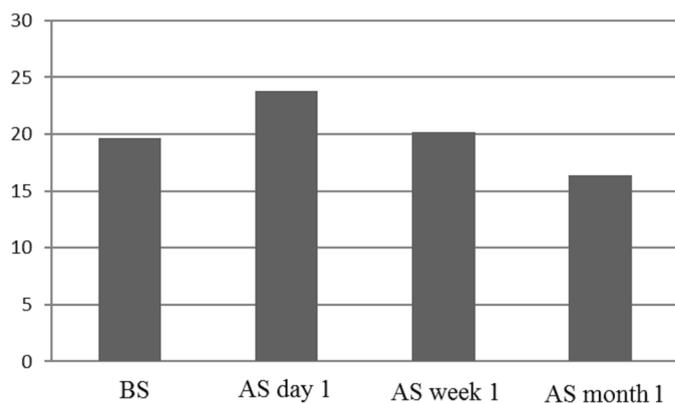


Figure 3. Preoperative and postoperative mean IOPg values (IOPg: Goldmann correlated intraocular pressure, BS: before the surgery, AS: after the surgery)

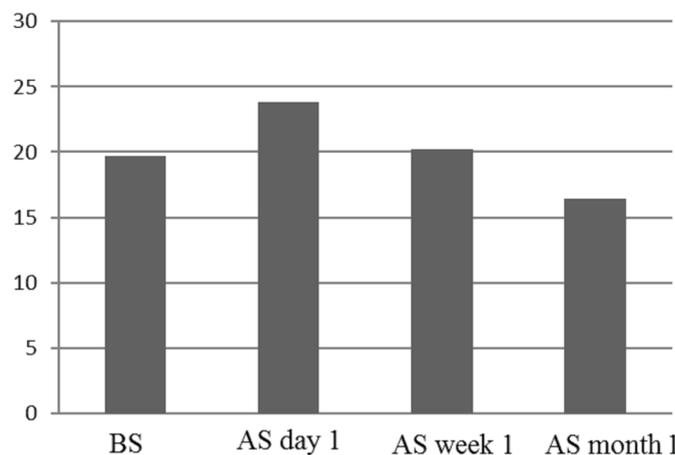


Figure 4. Preoperative and postoperative mean IOPcc values (IOPcc: corneal compensated intraocular pressure, BS: before the surgery, AS: after the surgery)

DISCUSSION

The biomechanical properties of the cornea are one of the important issues that have focused on over recent years. Although the Goldmann applanation tonometry is still the gold standard among the intraocular pressure measurement methods, this method has been shown to

be influenced by many ocular variables such as corneal thickness, refractive errors, corneal edema, and corneal surface defects (8).

Measurements performed with ORA showed a reverse correlation between CH and IOP values. Namely, it can be thought that the higher CH value, the lower the IOP value, and the lower CH value, the higher IOP value (9,10). As a result, it has been reported that CH is a parameter associated with IOP. In our study, similar to the literature, it has been found that there is a negative correlation between CH and IOP both in the early postoperative period (1st day-1st week) and postoperative late period (1st month).

CRF is partially independent from IOP. It has been reported that it has a strong association with especially central corneal thickness (11). An increase in CCT due to early postoperative corneal edema and concomitant increase in CRF may be expected. In our study, because of the patients who had corneal edema in the early postoperative period were not included in the study, There were no increases in observed CRF values.

Various studies have been reported that some changes may occur in anterior chamber structures such as anterior chamber volume, anterior chamber angle, anterior chamber depth, and pupil diameter after cataract surgery (12,13). It is also expected that some refractive and structural changes will occur in the cornea depending on the size of the incision and duration, type and power of the phaco energy used during the operation.

Being parallel with technological developments in cataract surgery, serious reductions in perioperative, postoperative and corneal complications have been noted and accordingly favorable improvements were observed in refractive and visual healing processes. Under the light of this information, it is also a curiosity subject the effect of biomechanical changes that may occur in the cornea after phacoemulsification surgery on intraocular pressure measurements. In this context, a study performed on fifty-four eyes of 33 patients conducted by Kamiya et al (year?) revealed a statistically significant decrease in CH and CRF value on the first day after the surgery, and a rise in IOP value in parallel to the decrease in CH value. They stated that these values were approaching preoperative values in postoperative 1st and 3rd months. Consequently they concluded that cataract surgery did not have a statistically significant effect on corneal biomechanical values except postoperative first day (14). Similarly in our study, there was a statistically significant decrease in CH and CRF values on postoperative day 1, and this decrease was also observed at postoperative 1st week and 1st month. Although CH and CRF values tended to increase after day 1 postoperatively, the values within this time were statistically significantly lower than preoperative values. In parallel with the decrease in CH values, a statistically significant increase was found in IOPg and IOPcc values on the first postoperative day and in the first month, a statistically significant decrease was found in the IOPg and IOPcc values in parallel to the increase of CH value.

Although several causes that cause IOP increase in the early period after phacoemulsification surgery (such as residual viscoelastic substances and inflammation) have been reported (15). We can conclude that one of these reasons is reduced CH.

Similarly, Alio et al found that microcoaxial cataract surgery (2.2 mm main incision) provided more stable corneal biomechanical values than standard coaxial cataract surgery during the first month after surgery (16). For this reason, it is thought that also the incision sizes may have an effect on the postoperative CH and CRF values.

In our study, standard coaxial surgery was performed through the 2.75 mm corneal main incision, and the possible effect of this incision size on CH and CFR values that are observed significant lower even in the first month postoperatively is a matter of debate.

Ozturk et al. evaluated the corneal biomechanical values measured at 2 months postoperatively in pseudophakic patients by comparing them with those of the unoperated other eyes of the same patients and as a result they found that there was no significant change in corneal biomechanical values at 2 months postoperatively in these eyes (17). When these results are compared with our study, it can be predicted that similar results may actually occur. Because, in our study, corneal biomechanical values decreased significantly (especially postoperative day 1 and week 1) especially in the early postoperative period. However, although the statistical decrease in the measured values of month 1 continues, it can be observed that these values tend to approach the preoperative values. At the postoperative 2nd month measurements, it can be predicted that probably corneal biomechanical values would reach the preoperative values as observed in the study conducted by Ozturk et al.

The most important limitations in our study are; number of the patients and follow-up periods. We believe that more patient numbers and longer follow-up period after surgery will lead to more reliable and useful results.

In conclusion, it can be stated that biomechanical properties of cornea and IOP may change in the early period (1 month) after standard coaxial phacoemulsification surgery performed through 2.75 mm corneal main incision, however this alteration tends to increase towards preoperative values. However, it should not be forgotten that the corneal biomechanical values may vary depending on the size of incision and, duration, type and power of the phaco energy used during the surgery.

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