

Evaluation of corneal clarity and anterior segment parameters following cataract surgery

Katarakt Cerrahisi Sonrası Kornea Şeffaflığı ve Ön Segment Parametrelerinin Değerlendirilmesi

Corresponding Author: Anil Selim APA^{ID}

Isparta City Hospital, Department of Ophthalmology, Isparta, Turkey

Mail: anilselimapa@gmail.com

Erman BOZALI^{ID}

Mersin City Education and Research Hospital, Department of Ophthalmology, Mersin, Turkey

Mail: ermanbozali@gmail.com

Duygu YALINBAŞ YETER^{ID}

Sivas Cumhuriyet University Faculty of Medicine, Department of Ophthalmology, Sivas, Turkey

Mail: duyguyalinbas@gmail.com

Haydar ERDOĞAN^{ID}

Sivas Cumhuriyet University Faculty of Medicine, Department of Ophthalmology, Sivas, Turkey

Mail: herdogan65@gmail.com

Ayşe VURAL ÖZEÇ^{ID}

Sivas Cumhuriyet University Faculty of Medicine, Department of Ophthalmology, Sivas, Turkey

Mail: vural.ayse@gmail.com

Mustafa Salih KARATEPE^{ID}

Sivas Cumhuriyet University Faculty of Medicine, Department of Ophthalmology, Sivas, Turkey

Mail: drdmsk@gmail.com

Submission Date: December 24, 2025

Acceptance Date: April 7, 2026

ABSTRACT

Purpose: To evaluate the changes in corneal clarity and anterior segment parameters following phacoemulsification surgery.

Material and Methods: Fifty eyes of 36 patients with a complaint of blurred vision diagnosed with cataract who underwent phacoemulsification surgery were included in the study. Anterior chamber angle (ACA), anterior chamber volume (ACV), angle opening distance (AOD), trabecular iris space area (TISA), and anterior chamber parameters measured with anterior segment optical coherence tomography (AS-OCT) and corneal tomography were evaluated. Densitometry values prior to the surgery, at the first week, and first month postoperatively were compared.

Results: Of all patients 19 (52.8%) were female. The mean age was 62.8±11.3 years. The mean best corrected visual acuity (BCVA) of the patients increased significantly, and the intraocular pressure (IOP) decreased significantly after surgery (p=0.001). The ACA, AOD, and TISA via AS-OCT increased significantly postoperatively (p=0.001 for all). A significant postoperative increase was observed in the ACA and ACV obtained with the Pentacam HR device (p=0.001 for all). In corneal densitometry values, a significant increase was observed in several circular area measurements in the anterior, central, and total layers (p<0.05 for all), while no significant difference was observed in the posterior layer (p>0.05).

Conclusion: The anterior chamber deepens following cataract surgery, and an increase in ACA, AOD and TISA is observed. Increase in corneal densitometry particularly within the anterior and central layers has been postulated, potentially attributable to postoperative corneal edema, surgery-induced onset of dry eye, and epithelial alterations secondary to topical medication use.

Key Words: Phacoemulsification, cataract, optical coherence tomography, corneal topography, corneal densitometry.

ÖZET

Amaç: Fakoemülsifikasyon cerrahisi sonrası kornea şeffaflığı ve ön segment parametrelerindeki değişimleri değerlendirmek.

Gereç ve Yöntem: Çalışmaya, görme bulanıklığı şikayeti bulunan, katarakt tanısı konmuş ve fakoemülsifikasyon cerrahisi yapılmış 36 hastanın 50 gözü dahil edildi. Ön segment optik koherens tomografi (ÖS-OKT) ve kornea tomografisi ile ölçülen ön kamara açısı (ÖKA), ön kamara hacmi (ÖKH), açı açılma mesafesi (AAM), trabeküler iris boşluk alanı (TİBA) ve ön kamara parametreleri değerlendirildi. Ameliyat öncesi, ameliyat sonrası birinci hafta ve birinci aydaki kornea dansitometri değerleri karşılaştırıldı.

Bulgular: Hastaların 19'u (%52,8) kadındı. Ortalama yaş 62,8±11,3 yıldı. Hastaların ortalama en iyi düzeltilmiş görme keskinliği (EİDGK) cerrahi sonrası anlamlı şekilde artarken, göz içi basıncı (GİB) anlamlı şekilde azaldı (p=0,001 tümü için). ÖS-OKT ile ölçülen ÖKA, AAM ve TİBA değerlerinde ameliyat sonrası dönemde anlamlı artış izlendi (p=0,001 tümü için). Pentacam HR cihazı ile elde edilen ÖKA ve ÖKH değerlerinde ameliyat sonrası anlamlı bir artış gözlemlendi (p=0,001 tümü için). Korneal dansitometri değerlerinde; ön, merkezi ve total tabakalardaki çeşitli dairesel alan ölçümlerinde anlamlı artış saptanırken (p<0,05 tümü için), arka tabakada anlamlı bir fark gözlenmedi (p>0,05).

Sonuç: Katarakt cerrahisini takiben ön kamara derinleşmekte; ÖKA, AAM ve TİBA değerlerinde artış görülmektedir. Özellikle ön ve merkezi tabakalarda kornea dansitometrisinde gözlenen artışın; ameliyat sonrası kornea ödemi, cerrahi kaynaklı kuru göz başlangıcı ve topikal ilaç kullanımına ikincil gelişen epitelyal değişikliklere bağlı olabileceği öne sürülmüştür.

Anahtar Kelimeler: Fakoemülsifikasyon, katarakt, optik koherens tomografi, korneal topografi, korneal dansitometri.

INTRODUCTION

Cataract, characterized by the progressive opacification of the crystalline lens, remains the primary etiology of preventable blindness and reversible visual impairment on a global scale. Its prevalence increases with age, and with the progressive aging of the global population, cataract has become a major public health concern. Although various systemic and ocular conditions may contribute to its development, age-related cataract represents the most prevalent form, with a multifactorial etiology.

Cataract surgery is currently the most prevalent performed ophthalmic surgical procedure and represents the definitive treatment for restoring vision. Excellent results can be achieved in cataract surgery with the development of phacoemulsification techniques and intraocular lens implantation. Phacoemulsification is currently regarded as the gold standard in modern cataract surgery, attributed to its less invasive nature, rapid restoration of vision, and reduced postoperative complication rates.

Phacoemulsification and intraocular lens implantation cause anatomical and morphological changes within the eye, particularly in the anterior chamber. Clinical experience has shown an increase in anterior chamber depth (ACD), widening of the anterior chamber angle (ACA), and a reduction in intraocular pressure (IOP) following cataract surgery (1).

In clinical practice, slit-lamp biomicroscopy serves as the primary approach for evaluating the anatomical structures of the anterior chamber; nevertheless, its utility in providing quantitative and objective measurements of anterior segment parameters remains limited. Various contact techniques, including the Goldmann three-mirror lens, can be used to assess ACA. During gonioscopy, the ACA can be graded using methods such as Sheie, Shaffer, or Herick; however, these assessments remain subjective. When using applanation or immersion A-scan ultrasonography (USG), measurements are performed in contact mode, require relatively long acquisition times, and may show inter-measurement variability (2). The rotational Scheimpflug camera system, on the other hand, is a user-friendly, non-contact, and rapid biometry device that provides reliable results for anterior segment analysis (3). The reliability of repeated measurements obtained with this device has been reported to be remarkably high (4). Furthermore, anterior segment optical coherence tomography (AS-OCT) devices allow objective evaluation of anterior segment parameters and enable detailed assessment of advanced parameters such as ACA, angle opening distance (AOD) at 500 and 750 μm , and trabecular-iris space area (TISA) at 500 and 750 μm .

Given the increasing number of cataract surgeries performed worldwide and the importance of understanding anterior segment changes after IOL implantation, detailed evaluation using modern imaging techniques has gained clinical relevance. In this study, changes in parameters of anterior chamber volume (ACV), ACA, AOD, TISA, best corrected visual acuity (BCVA), IOP and corneal densitometry, were compared before and after surgery in 50 eyes of 36 patients who underwent phacoemulsification at Sivas Cumhuriyet University School of Medicine Department of Ophthalmology.

MATERIALS AND METHODS

This study was approved by the Ethics Committee for Clinical Studies (No:2021-09/10 Date: 28.09.2021) at Sivas Cumhuriyet University and was conducted in accordance with the Helsinki Declaration and Patient Rights Regulations. Detailed information about cataract and potential complications during or after surgery was provided to the patients in detail, and signed informed consent were obtained from all participants.

Patients who presented to the Sivas Cumhuriyet University School of Medicine Department of Ophthalmology outpatient clinic between July 2021 and January 2022 with low vision who were diagnosed with cataract and underwent phacoemulsification surgery with IOL implantation were included in the study. Data were recorded preoperatively, at the first week, and at the first month postoperatively and evaluated prospectively.

Patients with coexisting ocular pathologies (such as pseudoexfoliation, glaucoma, retinal detachment, uveitis, corneal degeneration), with a history of previous ocular surgery, use of topical or systemic medications that could affect anterior segment parameters, an axial length greater than 26 mm, systemic diseases such as diabetes mellitus or any complications during or after surgery were excluded from the study. To maintain a standardized surgical approach, cases requiring excessive phacoemulsification energy, such as mature cataracts were excluded from the study.

BCVA values were recorded using the Snellen chart. Refractometric and IOP measurements were performed using the Tonoref 2 (Nidek, Gamagori, Japan). Corneal tomographic and densitometric evaluation was performed using Pentacam HR (Oculus GmbH, Wetzlar, Germany), and anterior segment measurements were evaluated with the Solix Fullrange AS-OCT (Optovue Inc., Fremont, CA, USA).

Patient demographics, ocular complaints, and medical history were recorded. Anterior and posterior segment examinations were performed using a slit-lamp biomicroscope. Corneal tomography and AS-OCT imaging were conducted under the same environmental conditions in a dimly lit room. To ensure patient compliance and achieve optimal imaging, detailed information about the imaging process was provided to patients prior to the examination. All imaging was performed by the same experienced technician. In line with the device manuals, best-aligned and fixated scans with the highest quality were included for the analysis following three consecutive scans. Preoperative measurements were obtained one day prior to surgery.

Pentacam was used to measure ACA, ACV, and corneal densitometry. AS-OCT was used to measure ACA, AOD at 500 and 750 μm , and TISA at 500 and 750 μm . The AOD at 500 and 750 μm was measured as the distance from the corneal endothelium to the anterior iris surface at 500 and 750 μm from the scleral spur, perpendicular to the cornea in AS-OCT scans. TISA at 500 and 750 μm was measured as the area bounded by a line perpendicular to the scleral spur and another line drawn perpendicular to the cornea at 500 and 750 μm from the scleral spur.

All patients underwent phacoemulsification and IOL implantation under local anesthesia with topical proparacaine. All surgical procedures were performed by the same experienced surgeon to ensure consistency and eliminate inter-operator variability. Topical 2.5% phenylephrine, 0.5% tropicamide, and 1% cyclopentolate were used for pupil dilation prior to surgery. The surgical site was cleaned with 10% povidone-iodine, and a blepharostat was placed. Diluted 5% povidone-iodine was applied to the ocular surface for at least 3 minutes. A 2.4 mm clear corneal incision was made at the temporal limbus. Continuous circular capsulorhexis was completed after injecting 3% sodium hyaluronate into the anterior chamber. The lens nucleus was mobilized using hydrodissection and hydrodelineation techniques. The nucleus was emulsified using vertical chop technique. Residual cortical material was removed using an irrigation-aspiration cannula. A foldable hydrophobic IOL was implanted into the capsule using 1.4% sodium hyaluronate. Viscoelastic device in the anterior chamber and capsule was removed using irrigation-aspiration. Intracameral cefuroxime (0.1 ml of 10 mg/ml) was administered at the end of surgery for prophylaxis. Stromal hydration was performed to ensure a watertight seal for the corneal incisions.

Patients received a postoperative treatment protocol of topical moxifloxacin (0.5%), dexamethasone (0.1%), and nepafenac (0.1%) for a period of two weeks.

Statistical Analyses

The data obtained in this study were analyzed using the Statistical Package for the Social Sciences (SPSS v22.0, Armonk, NY: IBM Corp.). When parametric test assumptions were met (Kolmogorov-Smirnov), paired t-tests were used to compare two measurements taken from the same individuals at different times or conditions. Repeated measures analysis of variance was used to compare more than two measurements taken at different times, with the Bonferroni test used to identify the specific measurement or group causing significant differences. A p-value of <0.05 was considered statistically significant.

RESULTS

The study included 50 eyes of 36 patients who applied to Sivas Cumhuriyet University School of Medicine Department of Ophthalmology outpatient clinic with complaints of blurred vision and underwent phacoemulsification surgery with IOL implantation. Of the 50 operated eyes, 18 (36%) were right eyes, and 32 (64%) were left eyes. Both eyes of 14 patients were operated on. Of all patients 19 were female (52.8%). The mean age of patients were 62.8±11.3 years (range: 43-84 years) (Table 1).

Table 1 Demographic characteristics of patients (SD: standard deviation)

Age Mean ± SD / (min-max)	62.8±11.3 (43-84)
Gender n (%)	
Male	17 (47.2)
Female	19 (52.8)

SD: standard deviation

The BCVA was recorded as decimals using the Snellen chart and converted to LogMAR. Postoperative BCVA was significantly higher than preoperative values ($p=0.001$) (Table 2).

Preoperative and postoperative IOP (mmHg) measured with the Tonoref 2 (Nidek, Gamagori, Japan) showed that postoperative IOP at 1 month was significantly lower ($p=0.001$) (Table 2).

Table 2 Preoperative and postoperative BCVA and IOP values

Mean±SD	Preoperative	Postoperative 1. Month	P Value*
BCVA (LogMAR)	0.8±0.5	0.08±0.2	P=0.001
IOP (mmHg)	12.9±2.9	11.2±2.8	P=0.001

(* $p<0.05$ significant, BCVA: best corrected visual acuity, IOP: intraocular pressure, SD: standard deviation.)

In AS-OCT (Solix, Optovue Inc., Fremont, CA) scans, postoperative 1-week and 1-month values for ACA, AOD at 500 and 750 μ m, and TISA at 500 and 750 μ m in both nasal and temporal quadrants were significantly higher than preoperative values ($p=0.001$) (Table 3). No significant difference was observed between postoperative 1-week and 1-month measurements ($p>0.05$).

Pentacam HR measurements revealed that postoperative 1-week and 1-month ACV values were significantly higher than preoperative values. Additionally, postoperative 1-month ACV values were significantly higher than 1-week values ($p=0.001$) (Table 3). Postoperative 1-week and 1-month ACA values were significantly higher than preoperative values ($p=0.001$) (Table 3). No significant difference was observed between postoperative 1-week and 1-month ACA measurements.

Postoperative 1-week values in the anterior layer (120 μ m) for 0-2 mm, 2-6 mm, and 6-10 mm circular areas were significantly higher than preoperative values ($p<0.05$ for all), but no significant difference was observed between preoperative and postoperative 1-month values ($p>0.05$) regarding corneal densitometry measurements. Corneal densitometry measurements of total depth in anterior layer showed that postoperative 1-week values were significantly higher than both preoperative and postoperative 1-month values at the anterior layer ($p<0.05$ for all) (Table 3).

Postoperative 1-week values in the 2-6 mm region were significantly higher than 1-month values in the central layer. Postoperative 1-week measurements were significantly higher than both preoperative and postoperative 1-month values at the 6-10 mm region ($p<0.05$ for all). No significant differences were observed in the 0-2 mm, 10-12 mm, and total circular areas between postoperative and preoperative values ($p>0.05$) (Table 3).

No significant differences were observed in the posterior layer (60 μ m) corneal densitometry measurements between preoperative and postoperative values ($p>0.05$) (Table 3).

Table 3 Values measured with Pentacam and AS-OCT

Mean±SD	Preoperative	Postoperative 1. Week	Postoperative 1. Month	P Value*
ACA (AS-OCT) (degree)				
Temporal	35.0±8.7	43.4±7.0	44.7±6.4	P=0.001*
Nasal	34.9±9.4	45.3±7.4	45.3±6.8	
AOD 500 (µm)				
Temporal				
Nasal	777.8±254.3	984.7±226.6	1030.8±230.6	P=0.001*
	725.0±257.6	1061.3±238.0	1067.3±234.5	
AOD 750 (µm)				
Temporal				
Nasal	958.2±287.5	1271.9±264.7	1263.9±306.4	P=0.001*
	920.5 ±280.0	1306.6±321.1	1305.9±257.6	
TISA 500 (µm ²)				
Temporal				
Nasal	308480±93875	404300±119901	414320±93020	P=0.001*
	291120±95182	419900±90391	417800±90211	
TISA 750 (µm ²)				
Temporal				
Nasal	543800±150018	717340±156307	723720±156707	P=0.001*
	511480±152074	7208080±180356	719400±136551	
ACV (Pentacam) (mm ³)				
	134.3±39.0	167.0±33.9	176.1±29.7	P=0.001*
ACA (Pentacam) (degree)				
	33.5±10.6	41.6±7.3	40.1±6.5	P=0.001*
Anterior (120 µm)				
0-2 mm				
2-6 mm	25.6±4.3	27.9±6.7	26.0±5.5	P=0.020*
6-10 mm	24.9±4.7	26.9±6.9	25.1±5.9	P=0.013*
10-12 mm	39.5±15.3	41.8±16.7	38.9±15.4	P=0.001*
Total	49.4±17.7	52.0±18.7	51.4±18.3	P=0.171
	33.4±8.5	35.4±9.9	33.0±8.4	P=0.001*
Center				
0-2 mm	16.9± 2.7	18.3±5.4	16.6±2.4	P=0.052
2-6 mm	16.4±3.3	17.1±3.8	15.9±3.1	P=0.004*
6-10 mm	27.8±10.7	28.8±11.5	27.3±11.1	P=0.002*
10-12 mm	29.8±8.7	31.5±9.2	31.3±9.7	P=0.124
Total	22.2±5.5	22.8±5.7	21.9±5.5	P=0.061

Table 4(Continued) Values measured with Pentacam and AS-OCT

Posterior (60 µm)				
0-2 mm				
2-6 mm	12.8±2.8	13.3±2.8	12.7±2.5	P=0.139
6-10 mm	12.9±3.0	13.3±2.9	12.8±3.2	P=0.139
10-12 mm	20.9±5.9	21.5±6.3	21.0±6.3	P=0.234
Total	23.6±5.8	22.8±7.4	24.8±6.1	P=0.064
	17.1±3.5	17.5±3.5	17.2±3.8	P=0.496
Total				
0-2 mm	18.4±3.0	19.6±4.1	18.2±2.5	P=0.001*
2-6 mm	29.3±10.2	30.4±11.3	29.0±10.6	P=0.001*
6-10 mm	18.1±3.4	18.9±3.7	17.7±3.4	P=0.001*
10-12 mm	34.4±9.9	35.6±10.5	35.8±10.6	P=0.237
Total	24.3±5.6	25.3±6.2	24.1±5.7	P=0.003*

* $p < 0.05$ significant, ACA: anterior chamber angle, ACV: anterior chamber volume, AOD: angle opening distance, TISA: trabecular iris space area, AS-OCT: anterior segment optical coherence tomography, SD: standard deviation.

Postoperative 1-week values in the 0-2 mm, 2-6 mm, 6-10 mm, and total circular areas were significantly higher than both preoperative and postoperative 1-month values at total corneal densitometry measurements ($p < 0.05$ for all). No significant difference was observed in the 6-12 mm total area between preoperative and postoperative values ($p > 0.05$) (Table 3).

DISCUSSION

Advancing age and the development of cataract lead to alterations in anterior segment parameters. The forward displacement of the iris diaphragm by the cataractous crystalline lens results in a relative pupillary block, thereby reducing the ACV and ACD. In a study conducted by Yan et al. using a slit-lamp–modified OCT device, the ACD was demonstrated to decrease by an average of 17 µm per year (5).

Changes in ACA, ACV, ACD, and other anterior segment parameters are observed following phacoemulsification surgery and IOL implantation. An increase in ACD, widening of ACA, and a reduction in IOP have been observed following cataract surgery (6). Several studies have reported that an increase in ACD is accompanied by an increase in ACV (7). Other studies have shown an increase in ACA, ACD, and ACV and a decrease in IOP after phacoemulsification in both glaucomatous and non-glaucomatous eyes (8, 9). A study by Kurimoto et al. showed that ACD increased by 1.37 times and temporal ACA by 1.57 times after cataract surgery (10). Lee et al. reported a statistically significant increase in ACV after cataract surgery (11).

According to a 2014 study by Slabaugh et al., the degree of IOP reduction after cataract surgery in glaucomatous eyes is most strongly correlated with preoperative IOP levels, with higher preoperative IOP resulting in greater postoperative reduction (12). In a study by Şimşek et al. evaluating 50 normal eyes using ultrasound biomicroscopy (UBM), the mean preoperative IOP was 14 mmHg, which decreased to 11

mmHg at 6 months postoperatively. Preoperative ACD was 2.8 mm, increasing to 3.7 mm at 6 months, and preoperative ACA was 27°, increasing to 42° at 6 months. The study suggested that cataract surgery contributes to an increase in ACD and ACA and a reduction in IOP (13). Çetinkaya et al. showed that in patients with ocular hypertension, significant changes in ACA, ACD, and IOP were observed at 1, 3, and 6 months after phacoemulsification surgery, but these changes lost significance after the first year (14).

Lens vault (LV) is defined as the perpendicular distance from a line drawn between the scleral spurs to the anterior pole of the lens. (15). Another study suggested that LV has a more significant role than lens thickness in ACD parameters (16). He et al. noted that an increase in LV causes the anterior lens surface to shift forward, leading to anterior iris positioning and a reduction in ACD and ACV (17).

In our study, Pentacam HR measurements showed that preoperative ACV was 134.3 mm³, increasing to 167.00 mm³ at 1 week and 176.16 mm³ at 1 month postoperatively. Postoperative ACV was significantly higher than preoperative values ($p = 0.001$), and ACV at the postoperative 1-month was significantly higher compared to postoperative 1-week values ($p = 0.001$). Pentacam HR measurements of ACA showed preoperative values averaging 33.5°, increasing to 41.6° at 1 week and 40.1° at 1 month postoperatively. Postoperative values were significantly higher than preoperative values ($p = 0.001$), but no significant difference was found between postoperative 1-week and 1-month values ($p > 0.05$).

The increase in ACA and ACV is thought to result from the posterior movement of the iris diaphragm away from the corneal endothelium (18). A 2009 study by Uçakhan et al. using Pentacam in 44 patients showed a 1.23-fold increase in ACA, a 1.34-fold increase in ACD, and a 1.22-fold increase in ACV at 3 months after phacoemulsification and IOL implantation (3). Scheimpflug imaging also detected a posterior shift in iris configuration (3). A study by Pereira et al.

using UBM showed a posterior shift of the iris diaphragm and an average ACA increase of 10° after phacoemulsification and IOL implantation. ACA measurements in the temporal, nasal, superior, and inferior quadrants increased by 1.26, 1.53, 1.36, and 1.52 times, respectively (19).

It has been reported that aqueous humor synthesis decreases after cataract surgery, while outflow through the trabecular meshwork and uveoscleral pathways increases (20, 21). A study by Dada et al. showed that clear lens extraction in eyes with narrow angles contributed to a significant reduction in IOP, an increase in ACA, and reduced need for antiglaucoma medications (22). Significant reductions in IOP have been observed after phacoemulsification and IOL implantation in both glaucomatous and non-glaucomatous patients. Although glaucomatous patients were not included in our study, our preoperative and postoperative 1-month IOP measurements using the Tonoref 2 device averaged 12.9 mmHg and 11.2 mmHg, respectively, with postoperative 1-month values significantly lower ($p=0.001$).

A study by Kim et al. in non-glaucomatous patients showed significant postoperative increases in AOD 500, TISA 500, and ACA compared to preoperative values (23). Haung et al., using AS-OCT, reported increases in ACA, ACD, and ACV and a reduction in IOP at 3 months after cataract surgery (24). Küçümen et al., in a study of 47 eyes using AS-OCT, found significant increases in postoperative ACD and both temporal and nasal ACA at 1 week and 1 month compared to preoperative values (25). As noted in several studies, the posterior movement of the iris diaphragm after surgery results in an increase in ACA, AOD, and TISA (3). In our study, AS-OCT measurements showed significant increases in postoperative ACA, AOD 500, AOD 750, TISA 500, and TISA 750 in both temporal and nasal quadrants compared to preoperative values ($p=0.001$). However, no significant difference was observed between postoperative 1-week and 1-month values ($p>0.05$).

In our study, Pentacam HR measurements showed that corneal densitometry values in the anterior layer were higher than in the posterior layer both preoperatively and postoperatively. Collagen fibers in the cornea are arranged three-dimensionally and tightly bound to the Bowman's layer. In a healthy cornea, collagen fiber density in the anterior stroma is lower than in the posterior stroma (26). The difference in corneal densitometry between the anterior and posterior layers in our study may be attributed to differences in collagen structure. Additionally, higher anterior layer corneal densitometry may be related to the tendency of extracellular fluid to accumulate more easily in this region due to lower collagen density (27).

Intra- and intercellular fluid accumulation in the corneal epithelium and edematous changes in the stroma can occur after phacoemulsification, contributing to increased corneal densitometry (28). Most of these edematous changes resolve over time. In our study, total corneal densitometry measurements in the 0-2 mm, 2-6 mm, 6-10 mm, and total circular areas at postoperative 1 week were significantly higher than both preoperative and postoperative 1-month values. In the central layer, postoperative 1-week values in the

2-6 mm region were significantly higher than 1-month values, and in the 6-10 mm region, postoperative 1-week measurements were significantly higher than both preoperative and postoperative 1-month values ($p<0.05$ for all).

It has been reported that dry eye disease (DED) may flare up in patients with pre-existing DED after cataract surgery, and DED may develop in those without pre-existing dry eye (29). The use of 5% povidone-iodine solution for preoperative antisepsis can cause corneal epithelial damage (30). Additionally, topical anesthetic drops may also cause corneal epithelial damage. Damage to the epithelial layer may contribute to increased corneal densitometry measurements in the anterior layer (28). In our study, postoperative 1-week measurements in the anterior layer for 0-2 mm, 2-6 mm, and 6-10 mm circular areas were significantly higher than preoperative values. Total corneal densitometry in the anterior layer at postoperative 1 week was significantly higher than both preoperative and postoperative 1-month values ($p<0.05$ for all). No significant differences were observed in posterior layer corneal densitometry measurements between preoperative and postoperative values ($p>0.05$).

CONCLUSION

Anterior segment parameters were evaluated before and after surgery in 50 eyes of 36 patients diagnosed with cataracts who underwent phacoemulsification and IOL implantation in this prospective study. The results showed a significant increase in BCVA and a significant decrease in IOP. Measurements taken with Pentacam HR and AS-OCT devices, consistent with the literature, showed significant postoperative increases in ACA, ACV, AOD (500 and 750 μ m), and TISA (500 and 750 μ m). Additionally, significant increases were observed in corneal densitometry measured with Pentacam HR following surgery.

REFERENCES

1. Yıldırım N, Özer A, Şahin A, Başmak H. The effect of phacoemulsification and intraocular lens implantation on anterior chamber depth, anterior chamber angle, and intraocular pressure. *Türk Oftalmoloji Dergisi*. 2006;36(4):311-5.
2. Giers U, Eppele C. Comparison of A-scan device accuracy. *J Cataract Refract Surg*. 1990 Mar;16(2):235-42.
3. Uçakhan OO, Ozkan M, Kanpolat A. Anterior chamber parameters measured by the Pentacam CES after uneventful phacoemulsification in normotensive eyes. *Acta Ophthalmol*. 2009 Aug;87(5):544-8.
4. Radhakrishnan S, Goldsmith J, Huang D, Westphal V, Dueker DK, Rollins AM, Izatt JA, Smith SD. Comparison of optical coherence tomography and ultrasound biomicroscopy for detection of narrow anterior chamber angles. *Arch Ophthalmol*. 2005 Aug;123(8):1053-9.

5. Yan PS, Lin HT, Wang QL, Zhang ZP. Anterior segment variations with age and accommodation demonstrated by slit-lamp-adapted optical coherence tomography. *Ophthalmology*. 2010 Dec;117(12):2301-7 6. Ní Dhubbghaill S, Rozema JJ, Jongenelen S, Ruiz Hidalgo I, Zakaria N, Tassignon MJ. Normative values for corneal densitometry analysis by Scheimpflug optical assessment. *Invest Ophthalmol Vis Sci*. 2014 Jan 7;55(1):162-8
7. Doganay S, Bozgul Firat P, Emre S, Yologlu S. Evaluation of anterior segment parameter changes using the Pentacam after uneventful phacoemulsification. *Acta Ophthalmol*. 2010 Aug;88(5):601-6.
8. Friedman DS, Gazzard G, Min CB, Broman AT, Quigley H, Tielsch J, Seah S, Foster PJ. Age and sex variation in angle findings among normal Chinese subjects: a comparison of UBM, Scheimpflug, and gonioscopic assessment of the anterior chamber angle. *J Glaucoma*. 2008 Jan-Feb;17(1):5-10.
9. Fernández-Vigo JI, Fernández-Vigo JÁ, Macarro-Merino A, Fernández-Pérez C, Martínez-de-la-Casa JM, García-Feijó J. Determinants of anterior chamber depth in a large Caucasian population and agreement between intra-ocular lens Master and Pentacam measurements of this variable. *Acta Ophthalmol*. 2016 Mar;94(2):e150-5
10. Kurimoto Y, Park M, Sakaue H, Kondo T. Changes in the anterior chamber configuration after small-incision cataract surgery with posterior chamber intraocular lens implantation. *Am J Ophthalmol*. 1997 Dec;124(6):775-80.
11. Lee W, Bae HW, Kim CY, Seong GJ. The change of anterior segment parameters after cataract surgery in normal-tension glaucoma. *Int J Ophthalmol*. 2017 Aug 18;10(8):1239-1245.
12. Slabaugh MA, Bojikian KD, Moore DB, Chen PP. The effect of phacoemulsification on intraocular pressure in medically controlled open-angle glaucoma patients. *Am J Ophthalmol*. 2014 Jan;157(1):26-31.
13. Simsek A, Ciftci S. Evaluation of ultrasonic biomicroscopy results in anterior eye segment before and after cataract surgery. *Clin Ophthalmol*. 2012;6:1931-4.
14. Cetinkaya S, Dadaci Z, Yener HI, Acir NO, Cetinkaya YF, Saglam F. The effect of phacoemulsification surgery on intraocular pressure and anterior segment anatomy of the patients with cataract and ocular hypertension. *Indian J Ophthalmol*. 2015 Sep;63(9):743-5.
15. Friedman DS, Gazzard G, Foster P, Devereux J, Broman A, Quigley H, Tielsch J, Seah S. Ultrasonographic biomicroscopy, Scheimpflug photography, and novel provocative tests in contralateral eyes of Chinese patients initially seen with acute angle closure. *Arch Ophthalmol*. 2003 May;121(5):633-42
16. Sng CC, Foo LL, Cheng CY, Allen JC Jr, He M, Krishnaswamy G, Nongpiur ME, Friedman DS, Wong TY, Aung T. Determinants of anterior chamber depth: the Singapore Chinese Eye Study. *Ophthalmology*. 2012 Jun;119(6):1143-50.
17. He M, Huang W, Li Y, Zheng Y, Yin Q, Foster PJ. Refractive error and biometry in older Chinese adults: the Liwan eye study. *Invest Ophthalmol Vis Sci*. 2009 Nov;50(11):5130-6.
18. Olsen T. Prediction of the effective postoperative (intraocular lens) anterior chamber depth. *J Cataract Refract Surg*. 2006 Mar;32(3):419-24.
19. Pereira FA, Cronemberger S. Ultrasound biomicroscopic study of anterior segment changes after phacoemulsification and foldable intraocular lens implantation. *Ophthalmology*. 2003 Sep;110(9):1799-806.
20. Savage JA, Thomas JV, Belcher CD 3rd, Simmons RJ. Extracapsular cataract extraction and posterior chamber intraocular lens implantation in glaucomatous eyes. *Ophthalmology*. 1985 Nov;92(11):1506-16.
21. McGuigan LJ, Gottsch J, Stark WJ, Maumenee AE, Quigley HA. Extracapsular cataract extraction and posterior chamber lens implantation in eyes with preexisting glaucoma. *Arch Ophthalmol*. 1986 Sep;104(9):1301-8.
22. Dada T, Rath A, Angmo D, Agarwal T, Vanathi M, Khokhar SK, Vajpayee RB. Clinical outcomes of clear lens extraction in eyes with primary angle closure. *J Cataract Refract Surg*. 2015 Jul;41(7):1470-7.
23. Kim M, Park KH, Kim TW, Kim DM. Anterior chamber configuration changes after cataract surgery in eyes with glaucoma. *Korean J Ophthalmol*. 2012 Apr;26(2):97-103.
24. Huang G, Gonzalez E, Lee R, Chen YC, He M, Lin SC. Association of biometric factors with anterior chamber angle widening and intraocular pressure reduction after uneventful phacoemulsification for cataract. *J Cataract Refract Surg*. 2012 Jan;38(1):108-16.
25. Kucumen RB, Yenerel NM, Gorgun E, Kulacoglu DN, Dinc UA, Alimgil ML. Anterior segment optical coherence tomography measurement of anterior chamber depth and angle changes after phacoemulsification and intraocular lens implantation. *J Cataract Refract Surg*. 2008 Oct;34(10):1694-8.
26. Morishige N, Takagi Y, Chikama T, Takahara A, Nishida T. Three-dimensional analysis of collagen lamellae in the anterior stroma of the human cornea visualized by second harmonic generation imaging microscopy. *Invest Ophthalmol Vis Sci*. 2011 Feb 16;52(2):911-5.
27. Sul S. Evaluation of the effect of hypertonic saline solution on corneal edema using anterior segment optical coherence tomography and corneal densitometry. *Türkiye Klinikleri Oftalmoloji Dergisi*. 2020;29(1):38-43.

28. Ishikawa S, Kato N, Takeuchi M. Quantitative evaluation of corneal epithelial edema after cataract surgery using corneal densitometry: a prospective study. BMC Ophthalmol. 2018 Dec 20;18(1):334.
29. Cho YK, Kim MS. Dry eye after cataract surgery and associated intraoperative risk factors. Korean J Ophthalmol. 2009 Jun;23(2):65-73.
30. Ridder WH 3rd, Oquindo C, Dhamdhere K, Burke J. Effect of Povidone Iodine 5% on the Cornea, Vision, and Subjective Comfort. Optom Vis Sci. 2017 Jul;94(7):732-741.

Author Contributions: Working Concept/Design: ZMA, UA, MYÖ, Data Collection: ZMA, UA, MYÖ, Data Analysis / Interpretation: ZMA, UA, MYÖ, Text Draft: ZMA, UA, MYÖ, Critical Review of Content: ZMA, UA, MYÖ, Final Approval and Responsibility: ZMA, UA, MYÖ,

Conflict of Interest: The authors state that there is no conflict of interest regarding this manuscript.

Financial Disclosure: The authors declared that this study has received no financial support.