Evaluation of Anterior Segment Parameters with Scheimpflug Camera after Uneventful Phacoemulsification Surgery in Mature Cataracts

Kamil Yavuzer[1], Ali Mesen[2], Beyza Yavuzer[3]

ABSTRACT

Purpose: To evaluate the effects of cataract on the anterior segment parameters and the changes occurred after uneventful phacoemulsification surgery with the Scheimpflug camera system in cases with mature and hypermature cataract.

Materials and Methods: The study included 30 patients who presented to our clinic with senile mature or hypermature cataracts and scheduled for phacoemulsification surgery. Preoperative and in the postoperative 6. weeks, In all patients, anterior segment parameters including anterior chamber depth (ACD), iridocorneal angle (ICA), anterior chamber volume (ACV), central corneal thickness (CCT), corneal volume (CV) and keratometric values (K1, K2, Kmax, anterior and posterior corneal astigmatism) were evaluated at baseline and on week 6 after surgery using Scheimpflug camera system (Sirius Topography, CSO, Italy).

Results: When baseline and postoperative ACD, ACV and ICA values were assessed, it was observed that ACD, ACV and ICA were significantly increased ($p < 0.001$ for all values). However, no significant difference was observed in CCT and CV ($p = 0.128$, $p = 0.277$, respectively). The mean intraocular pressure (IOP) was 21.47±3.30 mmHg at baseline and 17.77±1.68 mmHg after surgery. A significant reduction was observed in IOP after surgery ($p < 0.001$). When the keratometric values were assessed, it was observed that there was no significant change in K1 and K2 values ($p = 0.095$, $p = 0.895$, respectively) but a significant decrease in K max value ($p = 0.013$). Regarding anterior and posterior corneal astigmatism values, it was found that there was no significant difference in posterior corneal astigmatism ($p = 0.161$); however, the anterior corneal astigmatism was decreased ($p = 0.010$).

Conclusion: Mature and hypermature cataract affects the anterior segment structures due to excessive swelling of the crystalline lens, resulting in compression on anterior segment parameters. The compression can be reversed by successful phacoemulsification surgery. The Scheimpflug camera system can document the changes in quantitative manner.

Keywords: Anterior segment structures, Corneal topography, Mature cataract, Phacoemulsification, Scheimpflug camera.

INTRODUCTION

Mature cataract hampers visualizing posterior capsule of lens and identification of fundus reflection.[1] The cortical mature cataract is a form of cataract where opaque, milk-white, liquefied cortex material is prominent. The cortical mature cataract veils the structure of underlying nucleus. The nuclear mature cataract involves a solid and thick nucleus and epinucleus cannot be readily described. In most instances, nuclear mature cataract has both nuclear and cortical components.[2, 3] When cortical fluid is discharged from lens, lens becomes a white and dry which is termed as hypermature cataract. In mature and intumescent cataracts, narrowed anterior chamber and iridocorneal angle, elevated intraocular pressure (IOP) and some corneal changes occur due to anterior displacement of iris-lens diaphragm.[1-3] In mature cataracts, delay in extraction can lead phacomorphic glaucoma. The phacomorphic glaucoma can be defined as secondary angle closure glaucoma which is caused by anterior displacement of swollen cataract and leads pupillary block and iridocorneal angle closure.[2] The cataract extraction is a safe and effective surgery with IOP lowering effect. Although specific mechanism underlying this effect hasn't been fully elucidated, direct inflammatory

1- Assoc. Prof., MD, University of Health Sciences, Van Training and Research Hospital, Department of Ophthalmology, Van, Türkiye

2- Assist. Prof., MD, Kahramanmaraş Sütçü İmam University, Faculty of Medicine, Department of Ophthalmology, Kahramanmaraş, Türkiye

3- MD, University of Health Sciences, Van Training and Research Hospital, Department of Ophthalmology, Van, Türkiye

Received: 14.05.2021
Accepted: 01.03.2022

J Glau-Cat 2022; 17: 173-177

DOİ: 10.37844/glau.cat.2022.17.28

Correspondence Address:
Kamil Yavuzer
Medical Point Gaziantep Hospital, Ophthalmology Clinic, Şehitkamil, Gaziantep Türkiye

Phone:+90 506 325 1336
E-mail: dr.kamilyavuzer@hotmail.com

effect on trabecular network, effect on blood-aqueous barrier, changes in ciliary body and mechanical changes in anterior segment anatomy may help us to understand cataract surgery and its effects on humor aqueous dynamics.[2-3]

It has been shown that components of corneal astigmatism and high-order aberration are increased by advancing age.[4] The altered corneal parameters by age and their effects on cataract surgery are current research topic.[5] Thus, age-related mature cataract, changes in corneal parameters, effects of mature cataract on anterior segment parameters and observation of new condition after surgery have encouraged us for this study.

In this study, it was aimed to evaluate the effects of cataract on the anterior segment parameters and the changes occurred after uneventful phacoemulsification surgery with the Scheimpflug camera system in cases with mature and hypermature cataract.

MATERIALS AND METHODS

This prospective study was approved by Ethics Committee on Clinical Trials of Van Training and Research Hospital (2017/9). The study was conducted in accordance with tenets of Helsinki Declaration. All subjects gave written informed consent. The study included 30 patients who presented to our clinic with senile cataract (mature or hypermature cataract) and scheduled for phacoemulsification. The patient with comorbid ocular diseases, those receiving topical ophthalmological agents, those with previous history of ocular surgery, those underwent additional surgical maneuvers (e.g. capsular tension ring, iris hook, anterior vitrectomy, extra-capsular cataract extraction) other than standard, uncomplicated phacoemulsification surgery and those not attending regular control visits were excluded.

All patients underwent a comprehensive ophthalmological examination. The intraocular pressure was measured using Goldmann applanation tonometry. The cataract was diagnosed by slit-lamp examination after pupillary dilatation using mydriatic agents. The posterior segment was assessed using B-mode sonography. Anterior segment parameters and keratometric values were assessed using Scheimpflug camera system (Sirius Topography, CSO, Italy).

Before surgery, topical anesthesia was achieved using topical 0.5% proparacaine eye drop (3 times by 5-min intervals; Alcaine 0.05%, Alcon, Turkey); in patients with poor adherence to topical anesthesia, retrobulbar lidocaine (4cc, 20 mg/ml; Jetokain, Adeka, Turkey) was administered. A 2.8 mm corneal incision was made at temporal quadrant to enter anterior chamber. Following continuous curvilinear capsulorhexis, phacoemulsification was performed using "phaco-chop" and "divide and conquer" techniques. One-piece, foldable, hydrophobic acrylic intraocular lens was inserted within in a bag through primary incision and surgery was completed. After surgery, 0.5% moxifloxacin and 0.01% dexamethasone (Maxidex, Novartis, Belgium) were prescribed as follows: by 10-min intervals at postoperative period; by 2-hours intervals during first week after surgery and by 6-hours intervals during second week after surgery. The topical antibiotic was discontinued on week 3 and topical steroid was maintained for additional two weeks (by 8-hours interval during third week and by 12-hours interval thereafter).

A comprehensive ophthalmological examination was performed on day 1 and at weeks 1, 4 and 6 after surgery. Anterior segment parameters and keratometric values were re-assessed at week 6 by same physician using Scheimpflug camera system.

Statistical analysis

Data were analyzed using SPSS for Windows version 23.0 (SPSS Inc, Chicago, Illinois, USA). Shapiro-Wilk test was used to assess normal distribution of data. Paired-sample's t test was used to compare preoperative and postoperative IOP, anterior segment parameters and keratometric parameters. A p value<0.05 was considered as statistically significant.

RESULTS

Mean age was 63.5±9.82 years, ranging from 43 to 79 years. There were 5 men (16.7%) and 25 women (83.3%). When preoperative and postoperative anterior chamber depth (ACD), anterior chamber volume (ACV) and iridocorneal angle (ICA) values were assessed, it was observed that ACD and ACV were significantly increased (Figure 1) and ICA was significantly enlarged (Figure 2) ($p < 0.001$ for all values). Table 1 presents preoperative and postoperative ACD, ACV and ICA values. The mean intraocular pressure (IOP) was 21.47±3.30 mmHg at baseline and 17.77±1.68 mmHg after surgery. A significant reduction was observed in IOP after surgery ($p < 0.001$).

The mean central corneal thickness (CCT) was 527.70±34.84 µm before surgery and 522.73±34.83 µm after surgery. The mean corneal volume (CV) was 57.14±4.32 mm^3 before surgery and 56.36±4.08 mm^3 after surgery. No significant difference was detected between preoperative and postoperative CCT and CV values ($p=0.128$ and $p=0.277$, respectively).

When preoperative and postoperative keratometric values were assessed, no significant difference was detected in

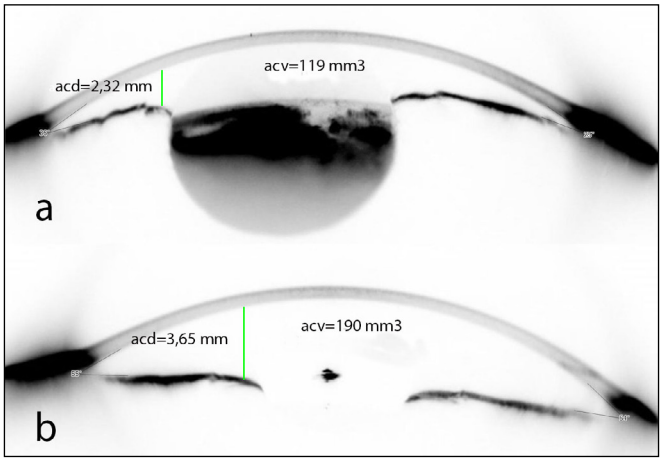

Figure 1: *Imaging anterior segment structures by Scheimpflug camera **a.)** Preoperative image of sample patient **b.)** postoperative image of same patient.*
Acd: Anterior chamber depth, **Acv:** Anterior chamber volume.

K1 and K2 values (p=0.095 and p=0.895, respectively). However, a significant decrease was detected in Kmax value (p=0.013). Regarding anterior and posterior corneal astigmatism values, it was found that there was no significant difference in posterior corneal astigmatism (p=0.161); however, the anterior corneal astigmatism was decreased (p=0.010). Keratometric and corneal astigmatism values are given in Table 2.

DISCUSSION

The advances in ophthalmology has increased the need for ocular parameters that can be used in the diagnosis and treatment planning. The accurate assessment of anterior segment parameters has an important role in understanding

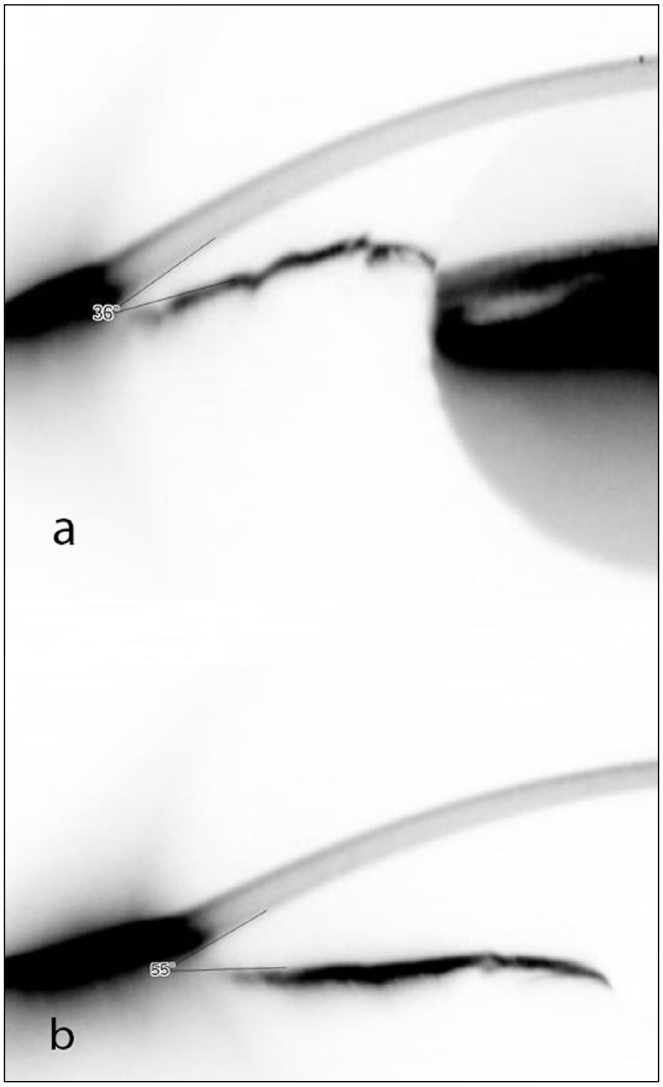

Figure 2: *Imaging iridocorneal angle by Scheimpflug camera **a.)** Preoperative image of sample patient **b.)** postoperative image of same patient.*

Table 1: *Comparison of preoperative and postoperative anterior segment structures.*

	Preoperative±SD	Postoperative±SD	p value
IOP (mmHg)	21.47±3.30	17.77±1.68	**<0.001**
ACD (mm)	2.25±0.52	3.32±0.58	**<0.001**
ACV (mm³)	99.73±31.87	158.94±39.95	**<0.001**
ICA (degree)	35.13±13.23	50.77±8.89	**<0.001**
CCT (µm)	527.70±34.84	522.73±34.83	0.128
CV (mm³)	57.14±4.32	56.36±4.08	0.277

IOP: Intraocular pressure, **ICA:** Iridocorneal angle, **CV:** Corneal volume, **ACD:** Anterior chamber depth, **ACV:** Anterior chamber volume, **CCT:** Central corneal thickness, **SD:** Standard deviation

Table 2: *Comparions of preoperative and postoperative keratometric values.*

	Preoperative±SD	Postoperative±SD	p value
K1 (flat)	41.37±6.34	43.37±1.70	0.095
K2 (steep)	44.91±1.85	44.87±1.48	0.895
K max	45.86±2.92	44.94±1.70	**0.013**
Anterior corneal astigmatism	1.84±1.96	0.88±0.58	**0.010**
Posterior corneal astigmatism	-0.31±0.24	-0.26±0.13	0.161

ocular pharmacokinetics, dynamics of humor aqueous and physiopathology of many ocular diseases such as open-angle glaucoma or angle closure glaucoma as well as success of surgical procedures. Today, widespread use Scheimpflug camera system has encouraged researcher to better understand anterior segment parameters.

It is well-known that IOP is somewhat decreased after cataract surgery.[6] It is thought that there may be IOP alterations due to several biochemical changes resulting from involvement of blood-aqueous barrier. It has been suggested that humor aqueous production is decreased while humor aqueous efflux via trabecular network and uveoscleral route is increased by surgery.[7, 8] In a previous study, it was shown that there was significant decrease in IOP at postoperative period but there was no significant difference in IOP values measured at months 1, 3, 5 and 8. In particular, the extent of IOP reduction was smaller in eyes with shallow ACD before surgery.[9] In our study, the fact that IOP was markedly decreased in all patients after surgery may be attributed to both direct influence of surgery and significant increase in ACD and ICA as our patient had mature cataract.

In some studies on ACD values in healthy individuals, ACD was measured as 2.90±0.44 mm, 2.96±0.3 mm and 3.01±0.3 mm, respectively.[10-12] In these studies, it has been suggested that ACD was decreased by advancing age which resulted from lens swelling. In our study, preoperative ACD was measured as 2.25±0.52 mm, indicating significant reduction in ACD. The ACD was increased o 3.32±0.58 mm after surgery, indicating that ACD is greatly affected by mature cataract. In the same study, ACV and ICA were measured as 160.1±22.1 mm^3 and 43° (22°-53°), respectively. Authors found that these parameters had negative correlation with age.[12] In our study, preoperative ACV and ICA were measured as ÖKH 99.73±31.87 mm^3 and 35.13°±13.23° which were increased up to ÖKH 158.94±39.95 mm^3 and 50,77°±8,89° after surgery, respectively. In our study, it was seen that mature cataract had significant effect on ACV and ICA.

There was no patient with phacomorphic angle closure in our study. In phacomorphic angle closure, the reason is the thick and swollen lens which leads acute obstruction of drainage canals of humor aqueous and sudden elevation in IOP. When lens is swollen, angle closure occurs through pupillary block in acute phase; on the other hand, in late phase, angle closure may develop as a result anterior displacement of peripheral iris even in the absence of lens swelling. However, phacomorphic angle closure does not necessarily occur in all patients with mature cataract.[13] In a study, Mansori et al. compared 28 mature cataract patients with phacomorphic angle closure and 32 mature cataract patients without angle closure.[14] By optical coherence tomography, authors showed that ICA, ACV and ACD were markedly lower while lens volume was higher in patients with angle closure when compared to the patients without angle closure. In the same study, authors compared contralateral eyes of patients with phacomorphic angle closure with contralateral eyes of patients without angle closure; it was reported that ICA, ACV and ACD were lower while lens volume was higher in the phacomorphic angle closure group despite lack of marked cataract in the eyes. Scheimpflug camera system allows assessment of ICA, ACV and ACD; thus, it will help us to identify patients at higher risk for phacomorphic angle closure.

There may be changes in CCT at early phase after cataract surgery. This leads corneal edema and temporary increase in the corneal thickness as result of loss of endothelial cells and pump dysfunction.[12,15,16] In a previous study, it was shown that corneal thickness was increased at early phase after cataract surgery ad returned to normal thickness at month 1 after surgery.[17] Similarly, in our study, there was no significant difference in CCT on postoperative week 6 when compared to baseline. Since CV is linked to corneal thickness; the CV also showed no significant difference when compared to baseline. This indicates that phacoemulsification surgery can be safely preferred in patients with mature cataract.

Although irregular corneal astigmatism, corneal asymmetry and high-order irregularity components are increased in eyes underwent cataract surgery, they are markedly increased from middle ages to advanced ages in eyes without history of cataract surgery. In addition, it was shown that these components were positively correlated with age of patient.[4] Previous studies have shown that K values were somewhat steeped by advancing age.[12] The changes in K values have been considered as the cause of irregular astigmatism.[18] In our study, no change was detected between preoperative and postoperative K1, K2 and posterior corneal astigmatism values. However, a significant reduction was detected in Kmax and anterior corneal astigmatism. This may be due to corneal incision employed during surgery. We think that anterior bulging of lens affects ACD, ACV and ICA in mature cataract; in addition, it may have relative effect on corneal refractivity and corneal astigmatism. These values may be improved by successful phacoemulsification surgery. In particular, the reduction in Kmax and anterior corneal astigmatism may have indicate such improvement.

In conclusion, anterior segment parameters are affected due to swelling in lens in mature and hypermature cataract and lens swelling leads compression in these parameters.

This compression may be reversed by successful phacoemulsification surgery. Scheimpflug camera system can quantitatively document these changes. By technological advances in ophthalmology, these changes can be elucidated more clearly.

REFERENCES

1. Ermiş S, Oztürk F, Inan UU. Comparing the efficacy and safety of phacoemulsification in white mature and other types of senile cataracts. Br J Ophthalmol 2003; 87: 1356-9.
2. Subbiah S, Thomas PA, Nelson Jesudasan CA. Comparison of ultrasound biomicroscopy and ultrasonographic parameters in eyes with phacomorphic glaucoma and eyes with mature cataract. Int Ophthalmol 2017; 37: 849-58.
3. Masis Solano M, Lin SC. Cataract, phacoemulsification and intraocular pressure: Is the anterior segment anatomy the missing piece of the puzzle? Prog Retin Eye Res 2018; 64: 77-83.
4. Hayashi K, Kawahara S, Manabe S, et al. Changes in Irregular Corneal Astigmatism With Age in Eyes With and Without Cataract Surgery. Invest Ophthalmol Vis Sci 2015; 56: 7988-98.
5. Li C, Zhang J, Yin X, et al. Distribution and related factors of corneal regularity and posterior corneal astigmatism in cataract patients. Clin Ophthalmol 2019; 13: 1341-52.
6. Yavuzer K, Meşen A. Komplikasyonsuz Fakoemülsifikasyon Cerrahisi Sonrası Enflamasyon Tedavisi ve Enfeksiyon Profilaksisinde Moksifloksasin/Deksametazon Kombinasyonu Tek İlaç Kullanımı. MN Oftalmoloji 2019; 26: 184-9
7. Savage JA, Thomas JV, Belcher CD 3rd, et al. Extracapsular cataract extraction and posterior chamber intraocular lens implantation in glaucomatous eyes. Ophthalmology 1985; 92: 1506-16.
8. McGuigan LJ, Gottsch J, Stark WJ, et al. Extracapsular cataract extraction and posterior chamber lens implantation in eyes with preexisting glaucoma. Arch Ophthalmol 1986; 104: 1301-8.
9. Kashiwagi K, Kashiwagi F, Tsukahara S. Effects of small-incision phacoemulsification and intraocular lens implantation on anterior chamber depth and intraocular pressure. J Glaucoma 2006; 15: 103-9.
10. Savini G, Barboni P, Carbonelli M, et al. Repeatability of automatic measurements by a new Scheimpflug camera combined with Placido topography. J Cataract Refract Surg 2011; 37: 1809-16.
11. Jorge j, Rosado JL, Diaz-Rey JA, et al. Central corneal thickness and anterior chamber depth measurement by Sirius Scheimpflug tomography and ultrasound. Clinical Ophthalmology 2013; 7: 417-22.
12. Kazancı L, Eren S, Aydın E, et al. Evaluation of Cornea and Anterior Chamber Measurements Using Sirius® Topographer in Adults. Glo-Kat 2016; 11: 225-9.
13. Lee SJ, Lee CK, Kim W-S. Long-term therapeutic efficacy of phacoemulsification with intraocular lens implantation in patients with phacomorphic glaucoma. J Cataract Refract Surg 2010; 36: 783-9.
14. Mansouri M, Ramezani F, Moghimi S, et al. Anterior segment optical coherence tomography parameters in phacomorphic angle closure and mature cataracts. Invest Ophthalmol Vis Sci 2014; 55: 7403-9.
15. Kosrirukvongs P, Slade SG, Berkeley RG. Corneal endothelial changes after divide and conquer versus chip and flip phacoemulsification. J Cataract Refract Surg 1997; 23: 1006-12.
16. Ventura A, Walti R, Bohnke M. Corneal thickness and endothelial density before and after cataract surgery. Br J Ophthalmol 2001; 85: 18-20.
17. Perone JM1, Boiche M, Lhuillier L, et al. Correlation Between Postoperative Central Corneal Thickness and Endothelial Damage After Cataract Surgery by Phacoemulsification. Cornea 2018; 37: 587-90.
18. Goto T, Klyce SD, Zheng X, et al. Gender- and age-related differences in corneal topography. Cornea 2001; 20: 270-6.