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The Relationship between Preoperative Astigmatism and Postoperative Astigmatism Induced by Cataract Surgery and Monofocal IOL Implantation

Flaka Shoshi[1,2], Fitore Shoshi[2*], Ariana Shoshi[3,4,5], Berat Fazliu[6], Ylli Shoshi[7,5], Mire Shoshi[4]

[1]*Department of Ophthalmology, Semmelweis University, Budapest, Hungary*
[2]*Department of Ophthalmology, University Clinical Center of Kosovo, Prishtina, Kosovo*
[3]*Department of Orthodontics, University Clinical Center of Kosovo, Prishtina, Kosovo*
[4]*AMECC "Rezonanca," Prishtina, Kosovo*
[5]*Doctoral School of Dental Medicine, University of Zagreb, Zagreb, Croatia*
[6]*Faculty of Medicine, University of Prishtina, Prishtina, Kosovo*
[7]*Department of Maxillofacial Surgery, University Clinical Center of Kosovo, Prishtina, Kosovo*

Abstract

Background: Cataract is one of the most common ophthalmic disorders among older adults. Even though phacoemulsification is the standard method of treatment, with the improvement of surgical techniques and intraocular lens (IOL) models, the expectations of both patients and physicians have increased. This study aimed to determine the correlation between the pre-existing astigmatism and postoperative astigmatism after cataract surgery and monofocal IOL implantation.

Methods and Results: This retrospective, observational study included the data of 101 patients who underwent cataract surgery with phacoemulsification and monofocal IOL implantation over a 12-month period. The data of patients were collected in two different periods: preoperatively and 2 months postoperatively. All patients underwent a detailed ophthalmic examination with the slit lamp, and the astigmatism was evaluated using the autokeratoferactometer, and the central corneal thickness (CCT) was measured using optical coherence tomography. We divided our patients based on the type of cataract (presenile and senile cataract) and based on the CCT into two groups: Group 1 (n=29): CCT < 550 µm and Group 2 (n=72): CCT ≥ 550 µm. In patients of Group 1, there was a pre-existing astigmatism of 0.66±1.16 dcy; in Group 2, there was a lower pre-existing astigmatism of -0.15±1.09 dcyl; however, there was no statistically significant difference between the groups (P=0.092). The 2-month postoperative astigmatism was -0.59±1.11 dcyl in Group 1 and -0.32± 1.14 dcyl in Group 2, and there was no statistically significant difference between the groups (*P*=0.315). Through regression analysis, we obtained a statistically significant correlation (R=0.7972, *P*<0.0001) between the pre-existing astigmatism and the 2-month postoperative astigmatism. According to our results, the 2-month postoperative astigmatism was affected by the pre-existing astigmatism by 63.5%.

Conclusion: there is a statistically significant correlation between a pre-existing astigmatism and a postoperative astigmatism in patients who undergo cataract surgery and are implanted with monofocal IOLs. Awareness of this correlation by physicians may help to minimize patients' postoperative refractive error and produce better postoperative outcomes after cataract surgery. (**International Journal of Biomedicine. 2025;15(3):531-534.**)

Keywords: astigmatism • cataract surgery • intraocular lens • central corneal thickness

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Abbreviations

CCT, central corneal thickness; **Dcyl**, cylinder diopters, **IOL**, intraocular lens.

Introduction

Cataract, as an ophthalmic disorder, remains one of the preventable diseases that causes blindness in 50% of patients in low-income countries. Cataracts are, in most cases, a side effect of aging;[1] their treatment with phacoemulsification is the most appropriate method. With the ongoing developments in surgical techniques, both surgeons and patients have much higher expectations for postoperative outcomes.[2-4] The demand to minimize postoperative refractive error and to have better postoperative outcomes after cataract surgery is increasing.[4] Among refractive errors, postoperative residual astigmatism may result in reduced unaided distance visual acuity, which in turn may hinder satisfactory postoperative results.[5] Spectacle independence for distance activities is unlikely unless patients achieve ≤0.50 diopters of astigmatism after surgery.[6] One very important factor that plays a key role in postoperative astigmatism after cataract surgery is the pre-existing astigmatism, especially in cases where the IOL selection is limited to monofocal ones.

This study aimed to determine the correlation between the pre-existing astigmatism and postoperative astigmatism after cataract surgery and monofocal IOL implantation.

Materials and Methods

This retrospective, observational study included the data of 101 patients who underwent cataract surgery with phacoemulsification and monofocal IOL implantation over a 12-month period. The data were collected over that 12-month period, and the cases were treated by surgeons with more than 10 years of experience.

The data of patients were collected in two different periods: preoperatively and 2 months postoperatively. We divided our patients based on the type of cataract (presenile and senile cataract) and based on the central corneal thickness (CCT) into two groups: Group 1: CCT < 550 µm and Group 2: CCT ≥ 550 µm.

Inclusion criteria: patients of all ages and genders diagnosed with presenile or senile cataracts, as well as patients diagnosed with astigmatism before cataract surgery

Exclusion criteria: no history of astigmatism, previous cataract surgery and refractive eye surgery, and other corneal diseases.

All patients underwent a detailed ophthalmic examination with the slit lamp, and the astigmatism was evaluated using the autokeratoferactometer, and the CCT was measured using optical coherence tomography.

Statistical analysis was performed using the statistical software package SPSS version 22.0 (SPSS Inc, Armonk, NY: IBM Corp). The normality of distribution of continuous variables was tested by the Kolmogorov-Smirnov test with the Lilliefors correction and Shapiro-Wilk test. For descriptive analysis, results are presented as mean ± standard deviation (SD), standard error of the mean (SEM) and range. For data with normal distribution, inter-group comparisons were performed using Student's t-test. Differences of continuous variables departing from the normal distribution, even after transformation, were tested by the Mann-Whitney U test. Group comparisons with respect to categorical variables are performed using chi-square test or Fisher's exact test. Linear regression was used to measure the strength of association between two parameters using the R-squared value. The *P*-value of <0.05 was considered statistically significant.

Results

Out of 101 eyes, 93.1% were diagnosed with senile cataract, whereas 6.9% were diagnosed with presenile cataract. Based on the type of cataract and the gender of patients, there was no statistical significance (*P*>0.05). (Table 1)

Table 1.

Type of cataract and gender (F/M) of patients

Type of cataract	F		M		Total	
	n	%	n	%	n	%
Presenile cataract	3	6.4	4	7.4	7	6.9
Senile cataract	44	93.6	50	92.6	94	93.1
Total	47	100.0	54	100.0	101	100.0
Fisher's exact test	*P*=0.9999					

Based on the central corneal thickness, there were 29 patients in Group 1 and 72 patients in Group 2. In patients of Group 1 (CCT < 550 µm), there was a pre-existing astigmatism of 0.66±1.16 dcy; in Group 2 (CCT ≥ 550 µm), there was a lower pre-existing astigmatism of -0.15±1.09 dcyl; however, there was no statistically significant difference between the groups (*P*=0.092) (Table 2).

Table 2.

The pre-existing astigmatism.

Astigmatism (dcyl)	Group 1	Group 2
	n=29 (CCT<550 µm)	n=72 (CCT≥550 µm)
Before the intervention		
Mean ± SD	-0.66 ± 1.16	-0.15 ± 1.09
SEM	0.215	0.128
Range	-2.75 to 1.25	-2.75 to 1.75
Statistics	*P*=0.092	

The 2-month postoperative astigmatism was -0.59± 1.11 dcyl in Group 1 and -0.32± 1.14 dcyl in Group 2, and there was no statistically significant difference between the groups (*P*=0.315) (Table 3). Through regression analysis, we obtained a statistically significant correlation (R=0.7972, *P*<0.0001) between the pre-existing astigmatism and the 2-month postoperative astigmatism (Table 4). According to our results,

the 2-month postoperative astigmatism was affected by the pre-existing astigmatism by 63.5%.

Table 3.

The 2-month postoperative astigmatism.

Astigmatism (dcyl)	Group 1	Group 2
	n=29 (CCT<550 µm)	n=72 (CCT≥550 µm
The 2-month postoperative		
Mean ± SD	-0.59 ± 1.11	-0.32 ± 1.14
SEM	0.206	0.134
Range	-2.25 to 1.5	-2.25 to 2.50
P-value	*P*=0.315	

Table 4.

Regression analysis for pre-existing astigmatism and 2-month postoperative astigmatism.

R-squared	0.6355
Adjusted R-squared	0.6303
R	0.7972
P-value	<0.0001

Discussion

A refractive error after cataract surgery is one of the main reasons for postoperative patient dissatisfaction. Patients with cataracts who have pre-existing astigmatism and receive monofocal intraocular lenses, may require additional refractive procedures like limbal relaxing incisions, corneal incisions in the steep meridian, and femtosecond laser-associated astigmatic keratotomy.[7] A study by Patil et al.[8] showed that the implantation of toric intraocular lenses is the appropriate choice to avoid postoperative astigmatism in patients with pre-existing astigmatism. Like other findings reported in the literature,[9-11] our study shows that postoperative residual astigmatism is affected by the pre-existing astigmatism by 63.5%. The correlation between pre-existing and postoperative astigmatism has been documented in the literature; therefore, the implantation of premium intraocular lenses is recommended to correct pre-existing astigmatism.[12] The retrospective study of Schallhorn et al.,[13] including 40,289 eyes, showed that the most accurate method to correct the pre-existing astigmatism is the implantation of toric lenses. In patients with a pre-existing astigmatism between 0.75 dcyl and 1.25 dcyl, toric lens implantation resulted in better refractive outcomes, compared to the group where pre-existing astigmatism was left untreated. In our previous study comparing the refractive outcomes after cataract surgery based on the IOL model implanted, we reported that 1-month postoperative refractive outcomes were 35% better in the group treated with premium intraocular lenses.[14]

Conclusion

Our analysis confirmed that there is a statistically significant correlation between a pre-existing astigmatism and a postoperative astigmatism in patients who undergo cataract surgery and are implanted with monofocal intraocular lenses. Awareness of this correlation by physicians may help to minimize patients' postoperative refractive error and produce better postoperative outcomes after cataract surgery.

Ethical Considerations

The study was conducted in accordance with ethical principles of the Declaration of Helsinki (2000; revised October 2013, Fortaleza, Brazil). The study protocol was approved by the Ethics Committee of the Kosovo Chamber of Physicians (Nr. 51/2021 dated 06/10/2021) and the Ethics Committee of the Faculty of Medicine, University of Prishtina (№ 13482 dated 24/12/2021). Written informed consent was obtained from all the participants.

Competing Interests

The authors declare that they have no competing interests.

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***Corresponding author:** Dr. Fitore Shoshi, MD, PhD. Department of Ophthalmology, University Clinical Center of Kosovo, Prishtina, Kosovo. E-mail: shoshifitore@gmail.com*