

A Comparative Study on Surgically Induced Astigmatism after Phacoemulsification and Its Correlation with the Central Corneal Thickness

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Abstract

Background: Cataracts being a disease with a very high prevalence, have been treated with various surgical and conservative forms for centuries. The aim of our study was to determine the correlation between central corneal thickness (CCT) and post-operative astigmatism after phacoemulsification.

Methods and Results: This prospective, observational study was carried out in the Clinic of Ophthalmology at the University Clinical Center of Kosovo. The study included 101 eyes of patients who underwent cataract surgery with phacoemulsification for treatment and intra-ocular lens (IOL) implantation. Patients were divided into two groups, depending on the central thickness of the cornea. Group 1 included 29 patients who had CCT <550 μm and Group 2 included 72 patients who had CCT \geq 550 μm . The mean age of patients in Group 1 and Group 2 was 69.0 ± 10.5 years and 70.1 ± 10.8 years, respectively, without significant difference between groups. The right eye was affected in 54.6% of cases. The patients were followed up for the evaluation of post-operative astigmatism on Day 7, two weeks, and two months after the surgery. Astigmatism was lower in Group 2 than in Group 1 at all stages of the examination but without a statistically significant difference. We did not find significant correlations between the CCT and astigmatism after phacoemulsification.

Conclusion: Results of our study show no significant correlation between CCT and SIA after cataract surgery with phacoemulsification. (*International Journal of Biomedicine*. 2023;13(4):277-280.)

Keywords: central corneal thickness • phacoemulsification • surgically induced astigmatism

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Abbreviations

CCT, central corneal thickness; DCyl, diopter cylinder; ECCE, extracapsular cataract extraction; IOL, intra-ocular lens; OCT, optical coherence tomography; SIA, surgically induced astigmatism.

Introduction

Cataracts being a disease with a very high prevalence, have been treated with various surgical and conservative forms for centuries.⁽¹⁾ Cataracts are the leading cause of vision loss in middle- and low-income countries, thus causing 50% of blindness cases in these countries and 5% in developed countries.⁽²⁾ Every patient who will undergo cataract surgery must undergo a detailed ophthalmological examination,

which includes measurement of the visual acuity, examination with the slit-lamp, tonometry, ultrasound, and pachymetry. Ophthalmological disorders at the time of examination can impact visual acuity (vision). Although most cataract surgeries go without any complications, any potential problem plays a role if the surgery is complicated or prolonged.⁽¹⁾ Preoperative determination of corneal topography is a useful investigation in cataract surgery planning. Corneal topography can be used as an alternative to keratometry because it provides a

representative measurement of the corneal curvature needed to calculate the IOL. Second, corneal topography is important if the degree and location of pre-existing astigmatism are known so that they can be considered during surgery.^(1,3) Determination of corneal topography facilitates meeting the expectations of surgery within 0.5 diopters of emmetropia with minimal astigmatism.^(4,5) In planning the correction of astigmatism, it is not only important to measure the corneal component of astigmatism but also to reduce surgically induced astigmatism (SIA). Extracapsular cataract extraction (ECCE) causes a larger amount of astigmatism than phacoemulsification.⁽⁶⁾ Although manual small-incision ECCE has been proposed to reduce costs and allow a faster recovery than traditional ECCE, phacoemulsification still causes less SIA. It is superior to manual small-incision cataract surgery in uncorrected visual acuity. It has been suggested that the visual rehabilitation, corneal endothelial cell loss, and complication rates after manual small-incision cataract surgery are comparable to those of phacoemulsification, but more SIA is induced, resulting in less desirable uncorrected visual acuity.⁽⁷⁾

Cataract surgical treatment with phacoemulsification proves to be superior to classical ECCE. The literature review of 11 clinical trials comparing these two methods of cataract treatment shows that surgical treatment of cataracts with phacoemulsification is superior to extracapsular treatment both in visual acuity of patients and in fewer intra-operative and post-operative complications.⁽⁴⁾ Considering the size of the incision, the degree of astigmatism in cases treated with phacoemulsification is lower than in cases treated with the classic ECCE method; visual acuity was significantly better in patients treated with phacoemulsification and the degree of astigmatism was lower at all measurement intervals than in the ECCE-treated group.⁽⁵⁾ Since the correlation between CCT and the degree of post-operative astigmatism after phacoemulsification is still a new aspect in the field of cataract and refractive surgery, especially in our country, the main aim of our study was to determine the correlation between CCT and post-operative astigmatism after phacoemulsification.

Materials and Methods

This prospective, observational study was carried out in the Clinic of Ophthalmology at the University Clinical Center of Kosovo. The study included 101 eyes of patients who underwent cataract surgery with phacoemulsification for treatment and IOL implantation. This procedure is routine in the Department of Ophthalmology for treating cataracts and is applied to more than 99% of patients. Therefore, the research is only observational.

The data was collected within a period of 12 months from July 2022 to June 2023, and the cases were treated by surgeons with more than 10 years of experience. This procedure has started to be applied in UCKK since 2015.

Exclusion criteria

- Patients who have had earlier interventions in the eye in which the surgery with phacoemulsification would be performed, such as phototherapeutic keratectomy, photorefractive keratectomy, or laser-assisted in situ keratomileusis

- Patients with diseases/disorders of the cornea, such as degenerative diseases, previous injuries in the eye where the intervention would be performed, keratoconus, or diabetes

The study included 101 patients (54[53.5%] men and 47[46.5%] women) with cataracts. Before the surgery (preoperative) upon admission to the Clinic of Ophthalmology, the patients underwent a detailed ophthalmological examination, which included the determination of the visual acuity (vision); slit-lamp examination, B-scan ultrasound and pachymetry (measurement of CCT) as the key method of this research. After performing the pachymetry, the intra-ocular pressure was measured with a tonometer, and the data were placed on separate forms for each patient. The central thickness of the cornea was measured with OCT. Pachymetry data are saved in the computer from which the data on the corneal thickness of each patient are obtained. The astigmatism was assessed by using the auto kerato-refractometer. The measurement of the CCT was performed before the measurement of the intra-ocular pressure in order to avoid any possible trauma to the cornea that could be caused during the tonometry, which could interfere with the results of the CCT.

Patients were divided into two groups, depending on the central thickness of the cornea. Group 1 included 29 patients who had CCT <550 μm and Group 2 included 72 patients who had CCT \geq 550 μm . The patients were followed up for the evaluation of post-operative astigmatism on Day 7, two weeks, and two months after the surgery.

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 Shapiro-Wilk test. For the descriptive analysis, results are presented as mean (M) \pm standard deviation (SD) or as median and interquartile range (IQR). For data with normal distribution, inter-group comparisons were performed using Student's t-test. The Mann-Whitney U Test was used to compare the differences between the two independent groups (for nonparametric data). Group comparisons with respect to categorical variables were performed using chi-square test. Spearman's rank correlation coefficient (r_s) was calculated to measure the strength and direction of the relationship between two variables. A probability value of $P < 0.05$ was considered statistically significant.

Results

The mean age of patients in Group 1 and Group 2 was 69.0 ± 10.5 years and 70.1 ± 10.8 years, respectively, without significant difference between groups. The right eye was affected in 54.6% of cases (Table 1).

Table 1.

Distribution of respondents by socio-demographic characteristics.

Parameter	Group 1 (n=29)	Group 1 (n=72)	Total (n=101)	P-value
Gender, n (%)				
Male	13 (44.8)	41 (56.9)	54 (53.5)	0.269
Female	16 (55.2)	31 (43.1)	47 (46.5)	
Age, yrs				
Mean \pm SD	69.0 ± 10.5	70.1 ± 10.8	69.8 ± 10.7	0.588
Range	44 - 86	38 - 92	38 - 92	
Eye, n (%)				
OD	14 (48.3)	43 (59.7)	57 (56.4)	0.294
OS	15 (51.7)	29 (40.3)	44 (43.6)	

Mean values of preoperative astigmatism and astigmatism on Day 7, two weeks, and two months after surgery are presented in Table 2. Astigmatism was lower in Group 2 than in Group 1 at all stages of the examination but without a statistically significant difference. We did not find significant correlations between the CCT and astigmatism after phacoemulsification (Table 3).

Table 2.

Preoperative astigmatism and astigmatism on Day 7, two weeks, and two months after surgery.

Astigmatism, dcyL	Group 1 (n=29)	Group 2 (n=72)	P-value
Preoperative			
Mean ± SD Range	-0.66 ± 1.16 -2.75 to 1.25	-0.15 ± 1.09 -2.75 to 1.75	0.092
Day 7 after surgery			
Mean ± SD Range	-0.74 ± 1.66 -4.0 to 2.25	-0.46 ± 1.44 -3.25 to 2.50	0.376
Two weeks after surgery			
Mean ± SD Range	-0.62 ± 1.39 -3.0 to 1.75	-0.37 ± 1.34 -3.0 to 2.50	0.395
Two months after surgery			
Mean ± SD Range	-0.59 ± 1.11 -2.25 to 1.5	-0.32 ± 1.14 -2.25 to 2.50	0.315

Table 3.

Correlations between preoperative astigmatism, SIA (on Day 7, two weeks, and two months after surgery) and CCT.

Astigmatism and CCT	Spearman Correlation		
	r_s	95% CI	P-value
Baseline	0.184	-0.069 to 0.416	0.141
Day 7 after surgery	0.096	-0.109 to 0.295	0.342
Two weeks after surgery	0.031	-0.176 to 0.236	0.761
Two months after surgery	0.165	-0.051 to 0.366	0.121

Discussion

SIA was one of the factors that influenced the desirable refractive outcome.⁽⁸⁾ SIA was related to the characteristics of the incision (length, type, location, structure, etc.); however, the most significant factor was incision width.⁽⁹⁾ As a result, cataract surgeries through small corneal incisions are increasing in popularity,^(10,11) although the proper size for a truly astigmatic cataract incision has not been established. Masket et al.⁽¹²⁾ have demonstrated that SIA with 2.2mm micro-coaxial incisions induce less astigmatism postoperatively than do traditional 3.0mm clear corneal incisions. The reduction of the incision size causes less post-operative astigmatism after cataract surgery.^(13,14)

The correlation between CCT and the degree of post-operative astigmatism after phacoemulsification is still a new

aspect in the field of cataract and refractive surgery, especially in our country. The results of this study could be a milestone in the development of IOL calculation and surgical incision planning based on central corneal thickness to reduce the rate of post-operative astigmatism. This approach would significantly improve post-operative outcomes and increase the quality of vision in patients. There is no relative study on the correlation between corneal thickness and SIA after vitrectomy.⁽¹⁵⁾ But Woo and Lee⁽¹⁶⁾ studied the effect of CCT on SIA in cataract surgery using a temporal precise corneal incision and observed that CCT could negatively influence the amount of SIA immediately postoperatively, but the correlation was not present 2 months after surgery. Results of our study show no significant correlation between CCT and SIA after cataract surgery with phacoemulsification.

Competing Interests

The authors declare that they have no competing interests.

Ethical considerations

Ethical Approval for this research was obtained from the Ethical Committee of the Kosovo Chamber of Physicians (№ 51/2021 dated 06/10/2021) and the Ethical Committee of the Faculty of Medicine, University of Prishtina (№ 13482 dated 24/12/2021).

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