Effectiveness of Nasal and Temporal Limbal Incisions in Phacoemulsification: A Comparative Study

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ABSTRACT

Purpose: Cataract is the most common cause of vision disorders and blindness worldwide. Phacoemulsification is widely performed in the treatment of cataract; however, surgery-induced astigmatism is a major concern in this treatment. Selection of incision site is effective to improve outcomes. The present study aimed to compare the effectiveness of nasal and temporal limbal incisions on post-operative outcomes in phacoemulsification.

Materials and Methods: In this retrospective study, 771 eyes of 514 patients (298 males, 58%; 216 females, 42%) were operated and data of 746 eyes (383 right eyes, 51.3%; 363 left eyes, 48.7%) were analyzed. Nasal and temporal limbal incisions were performed in the left and right eyes, respectively. Pre-operative keratometry (flat and steep keratometry), axial length (AL), and intraocular lens power measurements as well as post-operative (1 month after the operation) keratometry and auto refractometry measurements were performed both for the right and left eyes of the patients.

Results: The percentage changes in the keratometric measurements were higher in the nasal incision . Emmetropia was more achieved in the temporal incision in patients with an AL of <22 mm, whereas emmetropia was more achieved in the nasal incision side in those with normal (22-24 mm) and longer (>24 mm) AL. Better cylindrical diopter values were observed in the nasal incision in patients with an AL of <22 mm.

Conclusion: Both nasal and temporal limbal incisions are safe and effective in phacoemulsification. Nevertheless, vision acuity and astigmatism might be associated with AL, which necessitates individual pre-operative patient assessment.

Keywords: Phacoemulsification, Cataract, Limbal incision, Nasal, Temporal, Surgery-induced astigmatism.

INTRODUCTION

According to the recent epidemiological data about vision disorders in the world, cataract is the second most common cause of visual impairments and leading cause of blindness.[1] Today, phacoemulsification is the most commonly used treatment method both in developing and developed countries as a safe and effective therapeutic intervention for cataract.[2,3] Nevertheless, phacoemulsification is also associated with some complications; residual astigmatism after cataract surgery may result in suboptimal visual acuity.[4] Post-surgical refractive outcomes are associated with several factors including intra operative incision techniques for optimal access. Modifying the incision parameters such as localization or incision size is theoretically expected to decrease post-operative astigmatism; however, there is still an uncertainty in the literature on these approaches.[5] Currently, methods being utilized for minimizing or eliminating the post-operative astigmatism include but not limited to toric intraocular lens (IOL) implantation, opposite clear corneal incisions on the steep meridian, and limbal relaxing incisions.[6-8] Based on this background, the present study is aimed to evaluate and compare the post-operative outcomes of nasal and temporal limbal incisions used in phacoemulsification

MATERIALS AND METHODS

This retrospective study included patients who underwent phacoemulsification at the Ophthalmology Clinic of Gazi Yasargil Research and Training Hospital in 2018. Patients with a history of previous eye surgery, those

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Received: 30.06.2020
Accepted: 25.12.2020
Glo-Kat 2021; 16:42-46
DOİ: 10.37844/glauc.cat.2021.16.8

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with a history of trauma, and patients who developed intra-operative complications were excluded. Eyes with myopia, astigmatism, pseudoexfoliation, glaucoma, were not excluded however those with uveitis, dry eye and any corneal diseases were excluded. No inclusion criteria was applied based on age or type of cataract. All the surgeries were performed by the same surgeon (SB). The study was approved by the Clinical Research Ethics Committee of Gazi Yasargil Research and Training Hospital (Approval number: 162, Date: 26.10.2018). Informed consent was obtained from all patients.

Phacoemulsification was carried out in all patients with the incisions performed at the posterior of the limbus instead of transparent cornea. Temporal and nasal limbal incisions were performed at 180º at the right and left eye of the patients, respectively. A limbal side port entry was performed at the 6 and 12 o'clock positions. A viscoelastic agent was administered to the anterior chamber and a scleral tunnel of 2.75 mm in length was opened in the right eye from the temporal side and in the left eye from the nasal side. After performing a capsulorhexis of 5.5 mm in size, hydrodissection and then cleaning of the lens using the phaco-chop method and the cleaning of the cortex material with irrigation and aspiration were performed. For all patients single piece, acrylic, foldable IOL (Alcon SA60AT) implantation to the capsular sac was performed using a hydro-implantation technique, which prevents intraocular pressure from being increased; sodium-hyaluronate was not used during this implantation. Hydration was used for sealing of the corneal incisions and 0.1% cefuroxime-axetil was injected into the anterior chamber.

In order to determine the most effective incision approach, pre-operative keratometry (flat keratometry [K1] and steep keratometry [K2]), axial length (AL), and IOL power measurements as well as post-operative (1 month after the operation) keratometry and auto refractometry measurements were performed both for the right and left eyes of the patients. The IOL powers were calculated using the Sanders-Retzlaff-Kraff(SRK)-II and SRK/Theoretical (SRK-T) formulas.

Statistical Analysis

Data analyses were performed using the IBM SPSS Statistics for Windows Version 21.0 software (IBM Corp., Armonk, NY, USA) was used for the statistical analyses. Numerical data were expressed as mean and standard deviation and categorical data were expressed as frequency and percentage. Comparisons between independent groups were performed using the Mann-Whitney U test and pre- and post-treatment changes were compared using the Wilcoxon test. A p value of <0.05 was considered statistically significant.

RESULTS

In the study, phacoemulsification was performed in 771 eyes of 514 patients (298 males, 58%; 216 females, 42%) and data of 746 eyes (383 right eyes, 51.3%; 363 left eyes, 48.7%) were included in the analysis; 25 eyes were excluded due to missing data.

The comparisons of the right and left eyes in terms of pre- and post-operative keratometric measurements as well as pre-operative AL and IOL powers are shown in Table 1.

Table 1: *Comparison of the right (temporal incision) and left (nasal incision) eyes in terms of pre- and post-operative keratometric measurements as well as pre-operative axial lengths and intraocular lens powers.*

	Right eye (temporal incision)	**Left eye (nasal incision)**	**p**
	Mean±SD	**Mean±SD**	
Pre-operative K1, D	43.33±1.68	43.34±1.89	0.902
Pre-operative K2, D	44.16±1.68	44.24±1.93	0.814
Post-operative K1, D	43.49±1.72	43.71±1.75	0.049
Post-operative K2, D	44.03±1.67	44.25±1.71	0.115
Pre-operative AL, mm	23.87±1.26	23.63±1.25	**0.003**
Pre-operative IOL power, D			
SRK-T	19.24±3.42	19.76±3.5	**0.045**
SRK-II	19.27±3.06	19.7±3.12	0.055

SD: standarddeviation, **K1:** flat keratometry, **K2:** steep keratometry, **D:** diopters, **AL:** axial length, **IOL:** intraocular lens, **SRK-T:** Sanders-Retzlaff-Kraff Theoretical, **(SRK)-II:** Sanders-Retzlaff-Kraff II.

It was observed that the post-operative K1and the pre-operative IOL power calculated by the SRK-T formula were significantly higher in the left eyes (nasal incision) (p=0.049 and p=0.045, respectively) and the pre-operative AL was significantly longer in the right eyes (temporal incision) (p=0.003).

The comparisons of pre- and post-operative keratometric measurements for the right and left eyes revealed that the post-operative K1 values were significantly higher than the pre-operative K1 values for both eyes (p<0.001 for both); however, no significant difference was observed between the pre- and post-operative K2 values for both eyes (Table 2). While the percent change in K1value was significantly higher in the left eyes (nasal incision)than in the right eyes (temporal incision) (p=0.025), the percent change in K2 value did not significantly differ between the right and left eyes (p=0.313).

The distribution of the left and right eyes of the patients in the AL groups (those with an AL of <22 mm, those with an AL of 22-24 mm, and those with an AL of >24 mm) according to their post-operative spherical and cylindrical measurements (in diopters [D])is presented in Table 3. The analyses revealed that emmetropia was more achieved in the right eyes of the patients with shorter AL. For the patients with normal and longer AL, emmetropia was more achieved in the left eyes. For corneal astigmatism, normal D values were not significantly different between the left(nasal incision) and right (temporal incision) eyes in the patients with an AL of 22-24 mm and in those with an AL of >24 mm; however, normal cylindrical D values were more achieved in the left (nasal incision) eyes in the patients with an AL of <22 mm. The percent changes in the keratometric measurements revealed that the percentage changes in the K1 and K2 values did not differ between the right and left eyes in the patients with an AL of 22-24 mm. However, in the patients with an AL of <22 mm, the percent changes in the K1 and K2 values was higher in the right (temporal incision) eyes. In the patients with an AL of >24 mm, the percent change in the K1 value was higher in the left eyes (nasal incision) and the percent change in the K2 value was higher in the right eyes (temporal incision).

DISCUSSION

In the present study, the outcomes of nasal and temporal incisions used in phacoemulsification were evaluated and compared in order to determine the most effective incision approach. The comparisons of pre- and post-operative keratometric revealed that both incisions provided significant flat keratometric changes, whereas steep keratometric changes were similar for both approaches. Balsak et al. found similar results for temporal & nasal incisions in an earlier study where they applied Phaco-Trabeculectomy[9]. The percent changes in flat keratometric measurements were significantly higher in nasal approach.

The ultimate goal of cataract surgery is recovering the vision and maximizing the emmetropia. Nevertheless, postsurgical astigmatism is an important concern in these procedures. It is well-established that incision type, length,

Table 2: *Comparisons of the pre- and post-operative keratometric values for the right (temporal incision) and left (nasal incision) eyes.*

	Pre-operative Mean±SD	**Post-operative Mean±SD**	**p**
Right eyes (temporal incision)			
K1 (flat keratometry), D	43.33±1.68	43.49±1.72	**<0.001**
K2 (steep keratometry), D	44.16±1.68	44.03±1.67	0.128
Left eyes (nasal incision)			
K1 (flat keratometry), D	43.34±1.89	43.71±1.75	**<0.001**
K2 (steep keratometry), D	44.24±1.93	44.25±1.71	0.938
	Right eyes (temporal incision) Mean±SD	**Left eyes (nasal incision) Mean±SD**	**p**
Percent (%) change in			
K1 (flat keratometry), D	-0.5±2.42	-0.79±2.73	0.025
K2 (steep keratometry), D	0.18±2.02	0.04±2.29	0.313

SD: standard deviation, **D:** diopters.

Table 3: *Distribution of the left and right eyes of the patients in the axial length groups according to their post-operative spherical and cylindrical measurements,*

	Axial length					
	<22 mm		22-24 mm		>24 mm	
	Right eye	Left eye	Right eye	Left eye	Right eye	Left eye
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Spherical						
<-1 D	1 (10)	3 (21.4)	4 (1.9)	13 (5.6)	10 (6.5)	5 (4.5)
-1 to 1 D	8 (80)	11 (78.6)	189 (89.2)	212 (90.6)	131 (85.1)	101 (91.8)
>1 D	1 (10)	-	19 (9)	9 (3.8)	13 (8.4)	4 (3.6)
Cylindrical						
<-1 D	4 (40)	4 (28.6)	40 (18.9)	41 (17.5)	20 (13)	19 (17.3)
-1 to 1 D	6 (60)	10 (71.4)	162 (76.4)	178 (76.1)	119 (77.3)	85 (77.3)
>1 D	-	-	10 (4.7)	15 (6.4)	15 (9.7)	6 (5.5)
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Percent (%) change in K1	-0.36±2.59	-0.02±5.03	-0.67±2.48	-0.67±2.55	-0.27±2.35	-1.12±2.7
Percent (%) change in K2	0.52±2.66	0.25±2.07	0.03±1.87	0.01±2.29	0.38±2.18	-0.03±2.33

and suture closures are important factors that affect the degree of post-operative astigmatism.[10,11] Among these factors, the choice of incision site is the main focus of debates and studies evaluating correction strategies for astigmatism. Numerous studies have reported that superior approach is more associated with postsurgical astigmatism than temporal approach.[12,13] The nasal approach is generally not preferred by many surgeons due to the difficulty of performing this incision.[11] However, several studies comparing the nasal and temporal approaches have reported that surgery-induced astigmatism significantly differs between two incision approaches at the early post-operative period[14,15] but is similar in the long-term follow-up[14]. In the present study, it was observed that nasal incisions might provide more favorable outcomes; however, this was found to be also associated with the AL of the patients. While the patients with shorter AL might benefit from the temporal approach regarding emmetropia, the nasal approach might provide less astigmatism. On the other hand, while the patients with an AL of 22 mm might benefit more from the nasal approach regarding emmetropia, the nasal and temporal approaches did not differ in terms of astigmatism in these patients.[3]

The difference between the two incision sites is generally associated with the ultrastructure of the eye. The distribution of the peripheral fibrils around the cornea is heterogeneous in the limbus and optical center of the cornea has a more nasal localization.[15,16] As a consequence, nasal incisions during cataract surgery have been suggested to affect the corneal curvature more because of this histological and optical characteristics of the eye.[11].q This was also supported by our findings, which revealed that the percent change in the keratometric measurements, especially in flat keratometry, was significantly higher in nasal incisions. Nevertheless, this was also associated with the AL; a higher percent change was observed in the nasal incision side in the patients with an AL of >24 mm. On the other hand, the patients with an AL of <22 mm had greater percent change in K1 measurements in the temporal incision side.

Another important factor for surgery-induced astigmatism is the selection of the distance of the incision site to the cornea. Theoretically, the longer the distance from the optical center of the cornea, the safer the choice for incision site is. If the posterior limbal incisions are preferred, better results can be achieved.[11] In the present study, posterior limbal incisions were performed to maximize the distance from the cornea for decreasing the post-operative astigmatism risk and the high proportion of favorable outcomes in the study might be closely associated with this choice. In a study by Sönmez et al it has been shown that the corneal surgically induced astigmatism is affected by the location and the tunnel length of the incision.[17] Nevertheless, apart from limbal localization, selection of incision site might also be associated with other factors affecting the

operative success, such as wound healing process. It has been suggested in the literature that temporal incisions might be associated with better healing[11];however, in the present study, all of our patients completed the treatment without any complication both for temporal and nasal incision sides.

CONCLUSIONS

Both nasal and temporal limbal incisions are safe and effective in phacoemulsification. Nevertheless, the outcomes regarding post-operative vision acuity and astigmatism might be associated with AL in these patients. Individual patient assessment is crucial for better outcomes in phacoemulsification.

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