The Astigmatic Effect of Clear Corneal Incisions Performed on Steep Axis in Phacoemulsification

Fakoemülsifikasyonda Dik Eksenden Yapılan Saydam Kornea Kesilerinin Astigmatik Etkisi

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ABSTRACT

Purpose: To evaluate the astigmatic effect of 2.8 mm clear corneal incisions performed on steep corneal axis in phacoemulsification.

Materials and Methods: 49 eyes of 49 patients who had corneal astigmatism over 0.5 diopters (D) were randomly distrubuted into two groups. A superior clear corneal incision was performed in group 1 (25 eyes) and steep axis incision was performed in group 2 (24 eyes). Corneal topography was performed in all cases at preoperative and postoperative first day, second and fourth weeks. Changes in corneal astigmatism were calculated by vector analysis method.

Results: In group 1, mean corneal astigmatism increased from 1.09±0.44 D to 1.40±0.70 D after surgery. In group 2, mean astigmatism decreased from 1.35±0.85 D to 0.95 ±0.78 D 1 month after surgery. The change in mean corneal astigmatism at first month between two groups was statisticially significant (p<0.001). The astigmatism created by corneal incisions were compared between two groups by vector analysis method. Although surgically induced astigmatism was lower in group 2, this difference was not statistically significant.

Conclusion: Clear corneal incision performed on steep axis results in less postoperative astigmatism compare to standard superior incision in phacoemulsification.

Key Words: Phacoemulsification, steep axis, incision, topography, astigmatism.

ÖZ

Amaç: Fakoemülsifikasyonda 2.8 mm'lik saydam kornea kesilerinin astigmatizmaya etkisini araştırmak.

Gereç ve Yöntem: 0.5D'nin üzerinde astigmatı olan 49 hastanın 49 gözü rastgele iki guruba bölündü. 1.gurupta (25 göz) superior saydam kornea kesisi, 2. gurupta (24 göz) ise topografiyle saptanan dik eksenden kesi yapıldı. Tüm olgulara ameliyat öncesi, postopetif 1. gün, 2. gün ve 4. haftada kornea topografisi yapıldı. Korneal astigmatizmadaki değişim vektör analiz yöntemiyle hesaplandı.

Bulgular: Grup 1'de ameliyattan 1 ay sonra ortalama korneal astigmatizma 1.09±0.44 D den 1.40±0.70 D'ye çıktı. Grup 2'de ortalama korneal astigmatizma 1.35±0.85 D'den 0.95±0.78 D'ye düştü. Birinci ayda iki grubun ortalama korneal astigmatizmaları arasındaki fark istatistiksel olarak anlamlıydı (p<0.001). Her iki grupta kesilerin yarattığı astigmatizma, vektör analizi yöntemiyle karşılaştırıldı. Cerrahi olarak indüklenen astigmatizma grup 2'de düşük olmakla birlikte, bu fark istatistiksel olarak anlamlı değildi.

Sonuç: Fakoemülsifikasyonda dik eksenden yapılan saydam kornea kesileri ameliyat sonrası standart superior kesilere göre daha düşük astigmatizmayla sonuçlanmaktadır.

Anahtar Kelimeler: Fakoemülsifikasyon, dik eksen, insizyon, topografi, astigmatizma.

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Geliş Tarihi - Received: 02.11.2014
Kabul Tarihi - Accepted: 12.01.2015
Glo-Kat 2015;10:273-277

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PURPOSE

The goal of modern cataract surgery is not only to complete surgery without complications but also to achieve postoperative emmetropia and improve uncorrected visual acuity.[1] A careful preoperative biometry and elimination of astigmatism are obligatory for a successful outcome. Nil or a small "with the rule" astigmatism is desirable after cataract surgery. Small incision phacoemulsification surgery has made it possible to reduce surgically induced astigmatism and provided patients with a better postoperative refraction.[2] In order to induce less surgical astigmatism and correct preoperative astigmatism, ideal incision size and location is still under investigation.[3] Reducing postoperative cylindrical error provides a better uncorrected visual acuity to the patient. The surgically induced astigmatism created by different type and location of corneal incisions can be analyzed by corneal topography.[4] In our comparative study, the astigmatic effect of corneal tunnel incision on steep axis was compared with standard superior incision.

MATERIALS AND METHODS

49 eyes of 49 patients, with a corneal astigmatism more than 0.5 diopters (D), operated between January 2012 to April 2013 were included into study. All surgeries were performed by two surgeons (BY, SGK). An informed consent was taken from all patients. The study was performed under the ethical considerations of Helsinki Declaration. Local ethical committee approval was taken. Patients with other pathologies such as glaucoma, ocular surface disease, corneal degeneration, ectasia and pterygium or patients who had previous ocular surgery were excluded. Patients experienced intraoperative or postoperative complications, sulcus IOL implantation, corneal phaco burn, wound leakage as well as hydration, widening or suturing of the incision were excluded from the study.

Before the operation corneal topography was performed with Keratograph 3 (Oculus, Wetzlar, Germany). Preoperative biometry was performed with optical coherens (IOLMaster, Carl Zeiss Meditec AG, Jena, Germany) or A scan biometry (Sonomed Inc., NY, USA). SRK-T formula was used for IOL power calculation. Patients with astigmatism more than 0.5 D in corneal topography were selected. Thorough ophthalmologic examination including visual acuity measurement, biomicroscopy, applanation tonometry and fundus biomicroscopy through dilated pupil was performed in all cases. Patients were randomly distrubuted into two groups. Group 1 eyes (n=25) were operated with a superior (90 degree) clear corneal incision. Group 2 eyes (n=24) were operated with a clear corneal incision on the corneal steep axis that was preoperatively determined by corneal topography. Steep axis of group 2 patients were marked during preoperative biomicroscopic examination.

All patients were operated with a standard phacoemulsification technique under local anesthesia (topical or peribulbar). Clear corneal biplanar tunnel incision was performed with a 2.8 mm disposible knife on twelve o'clock position in group 1 and on steep axis in group 2. Anterior chamber was filled with 1.4% Na Hyaluronate (B-visc, Megapol-med, Izmir, Turkey). Two sideport incisions were opened. After completion of continious curvilinear capsulorhexis and hydrodissection, nucleus was emulsified with Infiniti phocoemulsification machine (Alcon Laboratories, Inc., Fort Worth, Texas) by using stop and chop technique. Cortical material was removed with bimanual irrigation-aspiration. Capsuler bag was filled with Na Hyaluronate and a hydrophylic acrylic foldable IOL was inserted with a disposable injector. Viscoelastic was removed and 0.1 mg/ml sefuroxim was injected into the anterior chamber for endophthalmitis prophylaxis. Side openings were closed with stromal hydration. Before terminating the operation, wound closure was checked. Postoperative follow-up examinations were performed at the first day, 15th day and first month. Amount and the axis of surgically induced astigmatism (SIA) was calculated by using Egrilmez's Vector Analysis 2002 software.[5]

Statistical Analysis: SPSS 19 was used for statistical analysis. Independent t test was used to compare the two groups. Paired t test was used for comparison of dependent groups. Repeated mixed model test was used in comparison between multiple groups with repeated measurements. Pearson Chi-Square test was used for comparison of categorical data. Data were analyzed within 95% confidence interval and p value under 0.05 was considered as statistically significant.

RESULTS

There were 14 female and 11 male in Group 1 and 18 female, 6 male in Group 2. Age of the patients were between 47 and 84. Mean age of was 70.1±9.1 in group 1 and 65.6±8.0 in group 2. There was no statistically significant difference between two groups in terms of preoperative astigmatism, sex, age or laterality ($p>0.05$).

Mean topographic astigmatism values at preoperative and postoperative first day, 15th day and first month, are shown in table 1. Mean preoperative astigmatism was 1.09±0.44 D in group 1, it increased to 1.40±0.70 D at postoperative first month. There was 0.31 D increase in astigmatism after surgery. This increase was statistically significant ($p=0.003$). Mean postoperative astigmatism was 1.35±0.85 D in group 2, it was found 0.95±0.78 D at the first month. There was 0.40 D decrease in mean astigmatism from the baseline. This difference was also statistically significant ($p<0.001$, Figure 1).

Table 1: *Mean preoperative, postoperative first day, 15th day and first month astigmatic values of two groups.*

P (Preop-1.month) <0.001	Mean astigmatism (D)			
	Group 1		Group 2	
	Mean	SD	Mean	SD
Preoperative	1.09	0.44	1.35	0.85
1.day	1.46	0.66	0.90	0.69
15.day	1.53	0.70	0.99	0.71
1. month	1.40	0.70	0.95	0.78
P value	0.003		<0.001	
Astigmatic change (Preop-1.month)	+0.32	0.47	-0.40	0.44

A comparison of the two groups in terms of changes in the mean topographic steep axis at preoperative and postoperative periods may be seen in table 2. Mean preoperative steep axis degree in 85.5±67.4 group 1 and 90.2±59.7 in group 2. Since topographic steep axis varies between 0-180 degrees, mean value is around 90 degrees in both groups. Mean astigmatism axis change between baseline and postoperative first month was found to be statistically significant in group 1 (p=0.016). However, in group 2; mean preoperative astigmatism axis was compared with that of postoperative first month, the difference was not found as statistically significant implying that the axis of astigmatism was more stable after surgery in group 2. The patients were also classified in three different groups according to the degrees of the topographic steep axis. These groups were temporal, superior and oblique. Since "against the rule" astigmatism is more common in elderly, topographic steep axes cumulated in temporal meridian in both groups (Figure 2).

Surgically induced astigmatism (SIA) values calculated by vector analysis at postoperative 1st day, 15th day and 1st month were shown in table 3. Mean SIA decreased difference from baseline to the postoperative first month in both groups. Although this decrese was larger in group 2, there was no statistically significant difference between two groups (p=0.606). When the change of SIA values with time was analysed, a statistically significant decrease was found in mean induced astigmatism in group 2 (p=0.005).

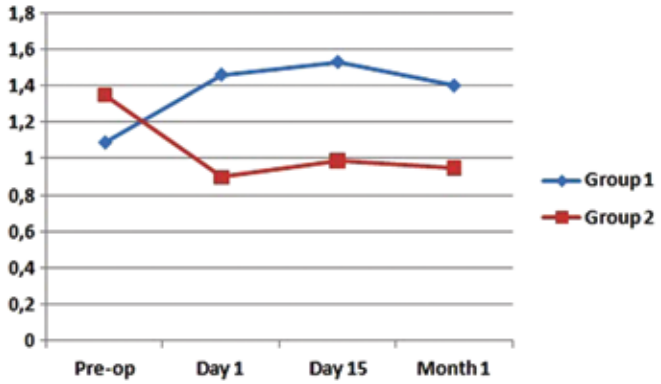

Figure 1: *The postoperative changes in mean astigmatic values (in diopters) in the two groups.*

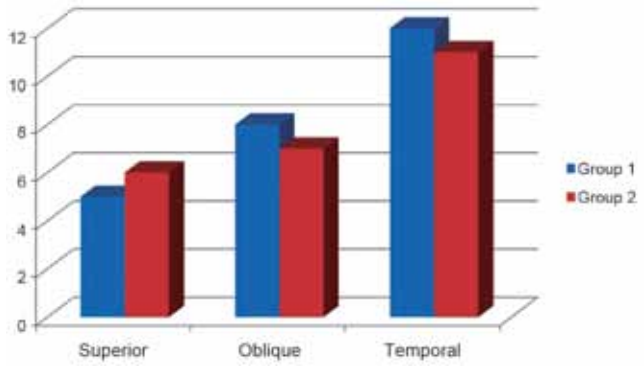

Figure 2: *Distrubition of the corneal steep meridian determined by preoperative topography in two groups.*

Table 2: *Mean astigmatic axis of two groups: preoperative, postoperative first day, 15th day and first month.*

P (Preop-1.month)=0.019	Mean astigmatism axis (degrees)			
	Group 1		Group 2	
	Mean	SD	Mean	SD
Preoperative	85.5	67.4	90.2	59.7
1.day	51.8	61.8	97.3	58.1
15.day	64.6	66.7	78.8	57.5
1. month	73.8	70.7	97.1	60.7
P value	0.016		0.309	
Astigmatic change (Preop-1.month)	11.7	46.9	-6.9	34.6

Table 3: *The changes in surgically induced astigmatism and axis values calculated by postoperative vector analysis in groups.*

P (SIA Preop-1.month)=0.606	Surgically induced astigmatism (D) and Axis (degree)			
	Group 1		Group 2	
	SIA±SD	Axis±SD	SIA±SD	Axis±SD
1.day	0.85±0.45	68.6±62.7	0.78±0.45	87.2±46.4
15.day	0.82±0.27	47.9±47.2	0.59±0.46	83.2±47.7
1.month	0.76±0.27	63.4±60.6	0.63±0.38	83.3±47
P value	0.295	0.199	0.005	0.304
(1. day – 1. month)	0.10±0.43	5.16±65.6	0.15±0.28	3.8±46.8

DISCUSSION

Corneal astigmatism after phocoemulsification depends on the location, type and dimension of the incision, suturation, distance of incision from the centre of the cornea and surgical procedure itself.[6,7] Aim of modern cataract surgery is to keep surgically induced astigmatism minimum and to correct preoperative astigmatism if possible. Mild to moderate astigmatism can be surgically corrected during surgery by changing the size, the meridian of the incision or changing the distance of the incision to the centre of the cornea as well as placing the incision on the steep axis. If there is still more astigmatism, limbal relaxing incisions, arcuate keratotomy or toric IOL implantation may be necessary.[8,9]

Small corneal tunnel incision was preferred in our surgeries. Reasons for this preference were the advantage of bloodless surgery, fast wound healing, easy surgical manipulation and minimum astigmatic effect.[10] Keeeping the incision small is known to be effective in reducing postoperative astigmatism. Kohnen et al followed the patients operated with 3mm, 4mm and 5 mm temporal clear corneal incisions and observed the change in astigmatism for six months. They observed less astigmatic change with smaller incisions.[11]

Another factor affecting postoperative astigmatism is the location of the incision. Oshima et al reported that the temporal CCI leads to “with the rule” astigmatism whereas superior incision increases “against the rule” astigmatism.[12] The horizontal diamater of the cornea is 1 mm wider than the vertical diameter. So that superior incisions are nearer to the corneal apex than temporal incision. Due to this difference, the impact of superior incisions on corneal curvature is larger.[13] A higher astigmatic effect has been shown in superior 3.0 mm CCIs than 3.0 mm temporal incisions.[14] Şimşek et al.,[15] reported a similar result in their study. Nielsen et al suggested that the superior incisions increase the astigmatism no more than temporal incisions, they just shift the axis.[16] Altan-Yaylacıoğlu et al.,[17] used a 3.5 mm corneal incision placed on steep axis in their study comprising 182 patients with preoperative astigmatism over 0.75 D. They have found a slight decrease in astigmatism in temporal, superior and superotemporal incisions but an increase in superonasal and nasal incisions.

In another study, patients with astigmatism over 0.5 D were classified in three groups of temporal, superior and superotemporal and a 3.0 mm corneal incision on steep axis. The surgical astigmatism was assessed with polar value analysis and a statistically significant decrease was found in postoperative astigmatism in all three groups.[18] Similarly in our study, a significant decrease in topographic corneal astigmatism was observed in our Group 2 patients in whom the incisions were made on steep axis. Although, the SIA calculated by vector analysis was lower in group 2, the difference between two groups was not statistically significant. This finding means that the two types of incision induce the same amount of astigmatism. However, SIA is a vector and it has a power (D) and also a direction (herein degree of axis). That power was found approximately 0.8 D in both groups of our study. When this power is put on the flat axis of the cornea, it flattens further and astigmatism increases. Whereas if it is put on the steep axis, the steepening lessens, cornea becomes more spherical and astigmatism of the patient decreases. This decrease provides us to treat the patient’s existing astigmatism.

Masket et al reported that the postoperative astigmatism stabilized after two weeks in temporal corneal incisions and there was no difference between two weeks and sixth month.[19] Likewise, mean postoperative astigmatism became stable in both groups of our patients after two weeks. The most striking change in astigmatism was seen in postoperative day one in both groups. However, group 2 patients showed a faster stabilization during one month follow up.

Amount of preoperative astigmatism may influnce both postoperative astigmatism and the axial shift. It has been suggested that in patient with preoperative astigmatism more than 1.2 D, efforts to lessen the astigmatism by changing the location of incision,

might result in even higher postoperative astigmatism.[20] In another study, corneal incision was performed on 90 degrees in patients with astigmatism less than 1.5 D and the astigmatic axis shift was found to be higher in patients with preoperative steep axis between 0-30 degrees than 61-90 degrees. Although there were patients with preoperative astigmatism higher than 1.5 D in our study, the shift of the axis of astigmatism was less in steep axis incision group.

In conclusion; CCI made on steep axis reduces the astigmatism in patients with preoperative astigmatism, whereas standard superior incisions increase the preoperative astigmatism. Therefore, in patients with corneal astigmatism over 0.5 D; corneal topography must be performed and the steep axis should be determined before the phacoemulsification surgery, and the incision should be performed on the steep corneal axis.

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