



Correlation between Keratometry and Corneal Incision before and after Phaco Surgery

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Abstract

Introduction: Cataract is a common cause of vision loss and blindness in humans. After surgical management of cataract, all efforts should be focused on reducing postoperative astigmatism thus providing an excellent vision to patients.

Aim: To determine the relationship between corneal incision and refraction changes before and after phacoemulsification surgery in 300 patients undergoing cataract surgery in Khatam hospital in Mashhad, Iran from January 2017 to April 2018.

Materials and methods: Three hundred patients (144 women and 156 men) with cataract undergoing phacoemulsification surgery were recruited in this cross-sectional study. Refraction, keratometry and visual acuity measurement were performed before surgery. Then, a steep-based incision in the cornea was made without stitches. A 3.2 mm corneal incision was made at two supratemporal and temporal sites. The patients were followed-up for one and six months, and one year after surgery monitoring their vision and refraction, and performing keratometric measurements.

Results: The mean age of the patients was 65.7 ± 9.54 years (age range, 42–84 years). No major complications were observed. The greatest mean of changes in corneal power was in the supratemporal incision (1.28 ± 0.6). Keratometry had a significant relation with the incision ($p < 0.04$).

Conclusions: An incision made along the steepest meridian leads to flatness of this meridian, this effect being more pronounced at the supratemporal incision. A temporal incision is recommended in cases where there is little difference in the keratometry of the two axes.

Keywords

incision location, keratometry, phacoemulsification, refraction

INTRODUCTION

Cataract is a common cause of vision loss and blindness in humans.¹ It is the opacity of the eye lens that is a part of the phenomenon of aging and its effects on the eye.² The average age of cataract patients is 60-70 years and the only cure

is surgical treatment.^{3,4} The cataract surgery proposed in the not-too-distant past as a surgery to remove the opaque lens, has recently gained public acceptance as a way to eliminate refractive errors.⁵ Now all efforts have focused on reducing the postoperative astigmatism and providing excellent vision.⁶ There are several ways to remove the lens, one of the newest and most common surgical pro-

cedures for cataract surgery being phacoemulsification. In addition, a variety of incision, including scleral, limbal and corneal incisions at 12 hours and between 9 and 12 hours, the temporal incision and incision in the steep axis of the cornea, and with different lengths, appropriate for the incision and intraocular lens (IOL) are used.⁷ Phaco surgery is a method of extracapsular cataract extraction (ECCE) during cataract surgery.⁸ Ultrasound waves are used to fragment the lens, resulting in reduced wound complications and faster healing compared with other methods requiring a large incision. In addition, using this method, during phaco and aspiration, a closed system is created by which in turn controlling the depth of the anterior chamber and vitreous protection against positive pressure as well as choroid bleeding is possible.^{6,9,10} One of the complications caused by cataract surgery is the astigmatism created after the surgery that reduces the patient's vision. Although the effect of surgical incision cataract on creating astigmatism has been known for years, surgeons have been attracted in recent years to measure and reduce the amount of astigmatism made by surgery.^{11,12} Keratometry is one of the diagnostic tools for astigmatism and a useful tool to determine the refractive status of cornea and it is used for measuring the central anterior corneal curvature.¹³ The basis for measuring corneal curvature by keratometry is to determine the exact size of the retrieved image from the front surface of the cornea.^{10,14}

Surgically induced astigmatism can be evaluated using two methods. The first method is subtraction in which the absolute change of keratometric astigmatism before and after surgery is calculated regardless of the axis. The second method is a vector (axis) analysis that evaluates not only the cylindrical power but also a change in axis of astigmatism. The end cylinder is the result of two inclined intersecting cylinders.^{9,10,15-17}

Some surgeons believe that an incision on two planes is more likely to be associated with astigmatism, and the deeper the vertical incision, the more similar function it has with the plane of astigmatic keratotomy, and the more it can flatten the cornea in that axis. With advances in surgical techniques and the creation of smaller wounds without sutures, attention has been drawn to pre-existing astigmatism correction that to achieve this goal, the size, position, and plane must be taken into account. In addition, other methods like astigmatic keratotomy, limbal relaxing incisions and folding toric intraocular lenses are used to correct previously large quantities of astigmatism.^{9,12,18}

AIM

The aim of this study was to determine the relationship between keratometry and corneal incision before and after phacoemulsification surgery in 300 patients with cataract undergoing surgery over a year.

MATERIALS AND METHODS

In the present study, the effect of different corneal incision in the phacoemulsification surgery on vision and astigmatism were evaluated in 300 patients with cataract surgery in Khatam Hospital in the city of Mashhad from January 2017 to April 2018. The research project was approved by the Ethics Committee of Mashhad University of Medical Sciences. The executive protocol of the study was carried out according to the Helsinki Declaration and after obtaining informed consent from all participants.

The patients in the study had no eye disease other than cataract, did not have previous eye surgery or refractive correction surgery, and their cataract was related to age and appropriate to perform phacoemulsification.

All samples that were eligible for the phacoemulsification surgery were evaluated at admission in terms of vision and astigmatism. The type and degree of astigmatism was measured based on keratometry and by auto-refractometer and then based on that axis, the steep of cornea was determined. All surgeries were done by one anterior segment fellowship surgeon. Ninety-four, 106, and 100 patients were operated in January, March and April 2015, respectively.

Corneal incision was made in the steep axis, and in some cases with zero or close to zero astigmatism, small corneal temporal incision was used. All patients underwent phacoemulsification by the same anterior segment fellowship surgeon. The intraocular pressure in all patients was within the normal range before and after surgery and no cases of endophthalmitis and leakage from the incision were reported.

The cuts we used involve cutting 3.2 mm of the supratemporal cornea and 2.3 mm of temporal cornea. In addition, intraocular lenses of Akreos fit and Morcher were used. The intraocular lens power was calculated using SRK-T or Holladay. The patients were followed-up for one month, six months, and one year after surgery and all data were recorded.

Statistical analysis

In this study, we used descriptive statistics including frequency tables, mean, standard deviation and analytic statistics including correlation coefficient, ANOVA, Student t-test, and general linear model. Also, a *p* value of less than 0.05 was considered to be statistically significant.

RESULTS

Of the 300 studied patients, 156 were male and 144 were female. All patients were over 40 years old. Most of the subjects were in the age group of 60-69 years (38%) and the lowest rates were in the group of over 80 years (3%). The mean age in both groups was estimated to be about 66 years.

Of the 300 operations performed, the temporal incision was 73% and supratemporal incision was 27%.

The vision of the subjects was classified based on the vision more than 5/10 and less than 5/10. As a result, the frequency of those who had a vision less than 5/10 before surgery was 76% and those who had a vision more than 5/10 was 24%. In addition, the patients who had postoperative vision higher than 5/10, reached 75%.

The distribution frequency of cases based on spherical refraction component before surgery is shown in **Fig. 1**. There was no significant difference between six month and one year after operation regarding results of examination (including refraction, uncorrected visual acuity and keratometry).

The highest value of preoperative refraction spherical component was in the range of 1-3 (32%), while the highest and lowest postoperative (one year after surgery) range was between +2 and -1.5, respectively.

Astigmatism refraction in the study varied from -3.5 to +4 before the operation to the range of -1 to +2.5 after the surgery. **Fig. 2** shows the distribution frequency of patients based on spherical refraction component after surgery.

Average power of the cornea before surgery was 44.6 ± 1.48 , and one year after surgery was 44.3 ± 1.40 (D), and the difference was not significant. The least amount was 42.1 and 41 before and after surgery, respectively. The highest amount was 46.75 and 46 before and after surgery (one year), respectively.

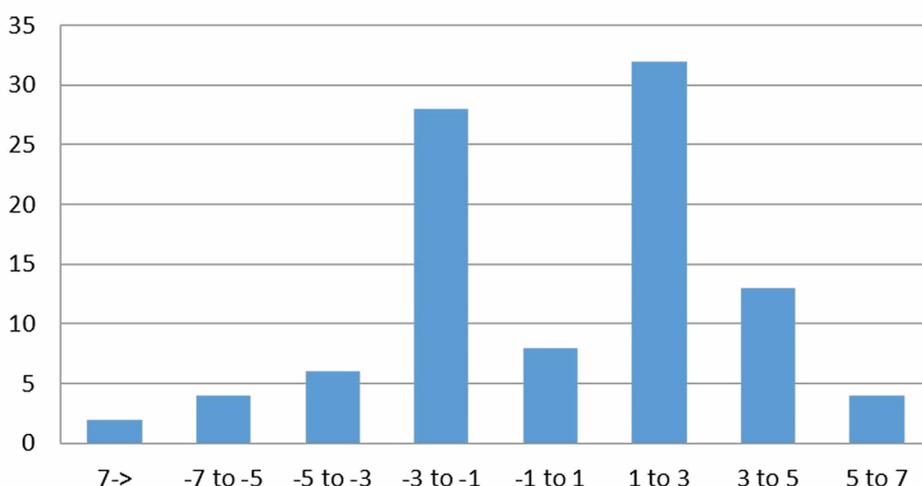


Figure 1. Distribution frequency of patients based on spherical refraction component before surgery.

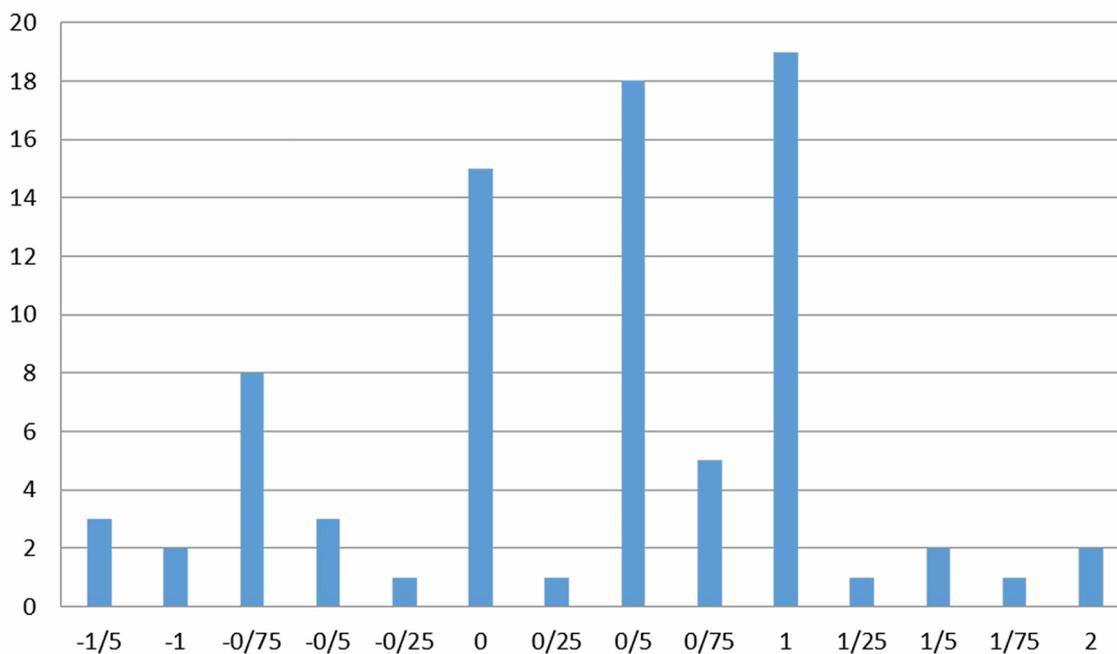


Figure 2. Distribution frequency of patients based on spherical refraction component after surgery.

The highest rate of corneal power on axis one was in the range of 44-45 before surgery (87 patients) and one year after the operation was still in the same range. In addition, the largest number of people regarding corneal power in axis two of keratometry was in the range of more than 46 (n=108) before surgery and 44-46 (n=132) after the operation.

Spherical element average before surgery did not have a significant difference from that after surgery ($p=0.51$). But the average of cylindrical component was significantly different before and after surgery ($p=0.00$). Also, there was a significant difference in corneal power in axis one before and after the surgery ($p<0.00$). However, statistical difference was not found about axis two ($p=0.63$).

Table 1 shows the average of cylindrical component, spherical component and corneal power before and after surgery ($p<0.05$).

Comparing the changes of corneal power (**Table 2**) with location of incision shows the mean of corneal power changes were 1.28 ± 0.6 and 0.56 ± 0.08 in the supratemporal and temporal incision, respectively, that the difference was statistically significant ($p=0.04$).

Table 1. Comparison of cylindrical component, spherical component and corneal power before and after surgery (based on mean and standard deviation)

Surgery	Cylinder	Sphere	Mean corneal power
Before	1.19 ± 0.69	0.38 ± 2.9	44.6 ± 0.14
After	0.74 ± 0.57	0.22 ± 0.77	44.3 ± 0.14
<i>p</i> value	0.05	0.5	0.01

Table 2. Comparison of the mean changes in corneal power of the patient based on the site of incision

Location of incision	Average changes in corneal power	Standard deviation (SD)	<i>p</i> value
Supratemporal	0/6	1/28	0.04
Temporal	0/08	0/56	

primarily depends on the incision location and its structure, and one of the factors affecting the final vision is astigmatism after surgery.²² Since in eye surgery the location of incision has a significant importance in astigmatism after surgery, so the accurate location of incision and its relation with keratometry before surgery has always been considered by surgeons.¹⁶

Based on the study results, incision creation in the steepest meridian leads to flatness of the meridian, therefore, it decreases astigmatism that is similar to the most of previous studies.^{23-25,28} In fact, if a patient has with the rule hyper-astigmatism, an incision in the top will flatten vertical meridian over time, and steeps horizontal meridian. If there is astigmatism against the rule before the surgery, a temporal incision will flatten step vertical meridian over time, and steeps horizontal meridian, and the nearer it is to the center of cornea, the stronger effect it has on astigmatism.^{26,27}

According to the study conducted by Müller-Jensen et al.²⁷ with 61 patients in Germany, astigmatism before surgery was 2.25 ± 0.98 D, and they underwent phaco surgery with a 4 mm incision in the steep axis. It was observed that in the patients who had with the rule astigmatism and the incision was in superior, the astigmatism changed to 1.93 ± 0.97 diopters (D). In addition, in patients who had astigmatism against the rule and the incision was in temporal, it was 1.33 ± 0.73 D. Also, it was shown that with a 4mm incision in the steep axis without keratectomy or limbal relaxing incision (LRI), preoperative astigmatism can be significantly reduced. In this study, just a small 2.3 mm incision was used. Average of astigmatism reduction in superior incision group was 0.99 D, and temporal incision group was 0.45 D. This difference in average can be because of the smaller size of incision.

Also, based on the study results, supratemporal incision of cornea is more effective than temporal incision in reducing astigmatism. In a study in China²⁸, it was observed that in the patients with a corneal incision at the superior or supra-temporal, 0.83 ± 0.65 D of astigmatism was induced; again, in the group with an incision in the steepest axis, 0.55 ± 0.72 diopters of astigmatism were created. Astigmatism change in the first group was 0.11 diopters and 0.39 diopters in the second group that the difference was statistically significant. Thus, the results show that if the corneal incision was done in the steepest axis, the created postoperative astigmatism will be reduced considerably.

DISCUSSION

Phacoemulsification surgery is a method of ECCE in cataract where ultrasound waves are used to fragment the lens.¹⁹ As a result, wound complications are reduced, and healing is faster and retrieval of vision is faster compared with other methods requiring a big incision.²⁰ In this location, incisions must not be considered as a simple entry into the eye.²¹ In fact, retrieval of vision after surgery

CONCLUSIONS

Based on results of the study and compared with previous reports, it can be concluded that making incision in the steepest meridian can flatten this meridian, and this effect is stronger about supratemporal incision. Temporal incision is recommended in cases with a little difference in keratometry of two axes.

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Disclosure

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Корреляция между кератометрией и разрезом роговицы до и после операции факоэмульсификации

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Резюме

Введение: Катаракта – частая причина потери зрения и слепоты у людей. После хирургической коррекции катаракты необходимо приложить все усилия для уменьшения послеоперационного астигматизма, обеспечивая тем самым прекрасное зрение для пациентов.

Цель: Установить взаимосвязь между разрезом роговицы и рефрактерными изменениями до и после факоэмульсификации у 300 пациентов, перенёвших операцию по удалению катаракты в больнице Хатам, Мешхед, Иран, с января 2017 года по апрель 2018 года.

Материалы и методы: Для этого исследования были отобраны триста пациентов (144 женщины и 156 мужчин) с катарактой, которым была проведена факоэмульсификация. Перед операцией были проведены измерения рефракции, кератометрии и остроты зрения. Затем на роговице сделали a steep-based incision без наложения швов. Разрез роговицы 3.2 мм был сделан на двух надвисленных и височных участках. Пациенты наблюдались в течение одного и шести месяцев, а через год после операции мы наблюдали за их зрением и рефракцией и проводили кератометрические измерения.

Результаты: Средний возраст пациентов составил 65.7 ± 9.54 года (возрастной диапазон 42-84 года). Никаких серьёзных осложнений не наблюдалось. Наибольшие изменения силы роговицы были в надвисочном разрезе (1.28 ± 0.6). Кератометрия имела значительную связь с разрезом ($p < 0.04$).

Заключение: Разрез, выполненный на более рефракционном меридиане, приводит к сглаживанию этого меридиана, и этот эффект более выражен в надвисочном разрезе. Височный разрез рекомендуется в тех случаях, когда нет большой разницы в кератометрии двух осей.

Ключевые слова

расположение разреза, кератометрия, факоэмульсификация, рефракция
