The Influence of Femtosecond Laser Assisted Cataract Surgery on Corneal Endothelium and Keratometric Values

Femtosaniye Lazer Yardımlı Katarakt Cerrahisinin Kornea Endoteli ve Keratometrik Değerlere Olan Etkileri

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ABSTRACT

Purpose: To evaluate the impact of femtosecond laser assisted cataract surgery on corneal endothelium and keratometric values.

Materials and methods: Thirty-six eyes eyes of 24 patients who underwent femtosecond laser assisted cataract surgery in the between the period of June 2013 and June 2014 were reviewed. The visual acuity, anterior and posterior segment examination, intraocular pressure and keratometric values as an indicator of surgically induced astigmatism were measured. Corneal endothelial cell count was evaluated via specular microscope. The visual acuity, keratometric values and corneal endothelial cells were evaluated 3 months later. The results are statistically analyzed with the Chi-square test.

Results: The difference between the pre- and postoperative astigmatism were not more than +/- 0.25 diopters . Mean endothelial cell loss was about 8% after surgery, but in no case the endothelial cell number reached the critical level which leads to corneal decompensation.

Conclusion: The impact of femtosecond laser assisted cataract surgery on corneal endothelium and keratometric values is minimal. The impact of femtosecond laser assisted cataract surgery on corneal endothelium and astigmatism is very low and the visual results are predictable.

Key words: Femtosecond laser, cataract, corneal endothelium, corneal astigmatism

ÖZ

Amaç: Femtosaniye lazer yardımlı katarakt cerrahisinin kornea endoteli ve keratometrik değerlerine olan etkilerini değerlendirmek.

Gereç ve yöntem: Haziran 2013- Haziran 2014 döneminde femtosaniye lazer yardımlı katarakt cerrahisi uygulanan 24 hastanın 36 gözü retrospektif olarak değerlendirildi. Hastaların görme keskinliği, cerrahi olarak oluşturulmuş olan astigmatizmayı değerlendirebilmek amacıyla keratometrik ölçümleri, detaylı ön ve arka segment muayeneleri, göz içi basınç ölçümlerinin yanı sıra, speküler mikroskopi ile kornea endotel hücre sayımı yapıldı. Ameliyattan 3 ay sonra keratometrik ölçümler ve kornea endotel hücre sayıları yeniden değerlendirildi. Sonuçlar istatistiksel olarak ki-kare testi ile analiz edildi.

Bulgular: Preoperatif ve postoperatif keratometrik değerler arasında ortalama +/- 0.25 diyoptrilik bir farklılık mevcuttu. Kornea endotel hücrelerindeki kayıp ise % 8 civarında olup hiçbir hastada dekompanzasyona neden olacak kritik seviyelere ulaşmadı.

Sonuç: Femtosaniye lazer yardımlı katarakt cerrahisinin kornea endoteli ve keratometrik değerlerine olan etkilerinin çok hafif olduğu ve görsel sonuçlarının daha öngörülebilir olduğu sonucuna varıldı.

Anahtar kelimeler: Femtosaniye lazer, katarakt, kornea endoteli, korneal astigmatizma.

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INTRODUCTION

Cataract surgery is one of the most widely performed surgical procedures in ophthalmology clinics. The frequency of complications is not high, but they can be serious and sight-threating. The major goals of cataract surgery are minimal postoperative refractive errors and maximal visual acuity. All technological advances in cataract surgery are guided to these results.

Femtosecond laser assisted cataract surgery (FLACS) has been developed for more predictable results, and to simplify the critical stages of conventional cataract surgery, which makes cataract surgery safer. These stages are anterior capsulotomy, nucleus fragmentation and corneal incisions.[1] Encountered surgical problems during these stages may influence the final position of the intraocular lens (IOL) and final visual acuity of the patient.[2] Beside this, shorter surgical time and lower phaco energy could be considered as its advantages.[3]

Our belief is that lower phaco energy and more precise surgical incisions have a positive influence on the postoperative refractive errors and corneal endothelial cell loss. In this study we aimed to confirm this hypothesis. Therefore we evaluated in patients in whom we performed FLACS the corneal keratometric values, as an indicator of surgically induced astigmatism (SIA) and corneal endothelial cells before and after surgery.

MATERIAL AND METHODS

This was a retrospective chart review, in which the patients who were operated in the …… with FLACS between the period of June 2013 and June 2014 were reviewed. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required. Informed consent was obtained from all patients who were enrolled into the study, that their medical data could be used for scientific studies without personal identification.

Preoperatively, best corrected visual acuity (BCVA) according to the Snellen chart, anterior and posterior segment photos, keratometric values and intraocular pressure (IOP) measurements were recorded. The optical biometric analysis (IOLmaster, Carl Zeiss Meditec AG), corneal endothelial cell count (Noncon Robo SP-9000, Konan Medical) and corneal topography (Pentacam, Oculus Inc.) were recorded before cataract surgery. These measurements and analyses of cataract patients are recorded routinely before and after cataract surgery in the ….. Hospital.

Only subjects with grade 2-3 nuclear cataract were included. Patients with a refractive error of more than ±3.00 diopter (D), diabetes mellitus, underwent intraocular or ocular surface surgery, corneal scar or degenerative ocular surface disorders and underwent any complication during FLACS are excluded. The keratometric values to determinate SIA, corneal endothelial cell counts and visual acuity scores of the 3th month postoperatively were evaluated for this study. The reason for evaluating these parameters 3 months later after surgery was as follows:

The early postoperative results may be confusing due to the impact of surgery on the corneal endothelium and corneal astigmatism. Three months later the effect of the surgical trauma are expected to decrease. Thus, we planned to see the "near final" refractive alterations and the corneal endothelial cells.

Surgical Technique

All operations were performed by one surgeon (HB). Preoperative mydriasis was maintained by topical 1.0% tropicamide, 2.5% phenylephrine and 1% cyclopentolate. 0.5% propacain hydrochloride was used for topical anesthesia. Laser procedure was started with docking of a single-use interface device on the cornea. All incisions were performed on the temporal quadrant at 3.00 or 9.00 o'clock position. All procedures were performed with a 0.9 mm phaco tip and convenient sleeve. Only BSS-Plus were used in all cases as irrigation solution. Corneal incisions, capsulorhexis and nucleus fragmentation were performed with the Femtosecond laser device (LenSx laser, Alcon, Fort Worth, TX) under OCT guidance. The main incision was made in a three-step trapezoid form with 2.3 mm width. Side incisions were made with a 30^{o} angle and 1.2 mm width. The capsulotomy had a diameter of 4.5-5.2 mm. The lens were fragmented into 4 pieces. The whole laser energy and spot sizes were constant (energy: 15mJ, spot distinction: 4 micron, layer distinction: 3 micron)

After completing the laser procedure, the incisions are opened with the aid of a spatula. An ophthalmic viscoelastic device (OVD) has been injected into the anterior chamber (1.65% Na- hyaluronate - 4% chondroitin sulfate, Discovisc). Intracameral 1/10000 adrenaline was used in every irrigation solution to prevent myosis. The anterior capsule were grasped with a capsulorhexis forceps and excised. After hydrodissection the nucleus fragments are aspirated with a phaco device (Infinity, Alcon, Forth Worth,TX). IOL's were implanted with the aid of an OVD. The OVD has been removed then with bimanual aspiration and irrigation. The incisions were hydrated and the procedure completed.

Statistical Analysis

Statistical analysis was performed using SPSS Windows version 15.0 (SPSS Science, Chicago, IL, USA). Chi-square test was used to analyse the data. A p-value of less than 0.05 was considered as a statistically significant result.

RESULTS

Thirty-six eyes of 24 patients were reviewed. Fourteen patients were male and 10 were female. Mean age of the patients were 73.24±5.13. Preoperative mean keratometric values were 43.25±2.25 D, number of corneal endothelial cells 2345±128 and BCVA 0.25±0.12. Mean phaco time was 44.32 ± 7.4 seconds. There was no difference between the mean phaco time between Grade 2 and 3 cataracts (P=0.356). Phaco energy during the aspiration of the nucleus fragments varied between 5-15% of the cases and was independent from the grade of the cataract.

The postoperative results after three months are summarized in table 1. The keratometric values presented no difference. The difference of the endothelial cells numbers and visual acuity before and after surgery were statistically significant ($p<0.001$, $p<0.001$, respectively). No complications such as anterior or posterior capsule laseration, corneal edema, endophthalmitis or any other problem were encountered in any case, neither during nor after surgery.

The mean endothelial cells loss was about 8% after surgery, but this loss did not reach critical levels which lead to corneal decompensation or any problem in any case.

DISCUSSION

Saving corneal endothelial cells after cataract surgery is of high importance to maintain corneal transparency. On the other hand, the patient satisfaction depends highly of the stability of the SIA before and after surgery which influences the refractive errors. In this study we observed that FLACS has no negative influence on both parameters.

Low ultrasonic energy has positive influence of the health of the corneal endothelial cells.[4,5] Recent studies reported that the corneal endothelial cell loss during conventional phaco surgery varies between 1.4% and 23% [6-8]. The endothelial cell loss during FLACS has been reported in various studies. Ho et al. and Abell et al. demonstrated that the endothelial cell loss was higher in the early period in FLACS than conventional phaco, however this difference diminished with time.[9,10] The authors revealed the higher loss to laser-automated corneal incisions. In contrast to these results, Krarup et al. and Conrad-Hegerer et al. reported no difference between both type of surgeries.[11,12] Conrad-Hegerer et al. recommended FLACS especially for patients with low corneal endothelial cell numbers, such as Cornea guttata.[12] Krarup et al. highlighted the importance of cumultative ultrasonic energy. Whereas they measured the mean phaco-time in their case series 8.0±1.9 minutes and cumultative ultrasonic energy 5.45 ± 4.6 J in conventional phaco cases, the mean phaco-time was 9.3±1.9 minutes and cumultative ultrasonic energy 3.78±5.1J in their FLACS cases. The mean endothelial cell loss was about 8% in our series. These results are compatible with the results in the literature.

The precision of the corneal incisions is the main factor which affects the postoperative SIA. SIA has been reduced with the development of better surgical knives, phaco devices which has been enabled to perform surgery from smaller incisions and the attention of the surgeons to making main incision from the vertical axis of the cornea.[13,14] Theoretically, it could be expected that FLACS can reduce the incidence the development of SIA. However, Nagy et al. and Mastropasqua et al. observed no difference between the corneal astigmatic outcomes between FLACS and conventional phaco. We observed only a 0.25 D difference between the pre- and postoperative astigmatic values, which had no clinical importance. Our opinion is that the astigmatic outcomes are more predictable with FLACS.

Our study has its limitations. The first one is the retrospective design. Another important limitation is the low number of the subjects. FLACS is an expensive surgery and this makes it difficult to research large case series in low and mid-term. Because the effects of conventional phaco surgery on corneal endothelium and corneal astigmatism are well established and no significant differences has been reported,[10,11,17] we did not compare our results with conventional phaco cases.

Our study confirms that the influence of FLACS on corneal astigmatism and endothelial cell loss is very low. Beside this, the complete centralization of the capsulorhexis and the facility to design the corneal incisions are its additional advantages. Nevertheless, further studies with higher patient volumes are required for valid investigation of efficiency and safety. Nowadays, this surgery seems to be more predictable on the visual results of cataract surgery. The high costs of the equipment and disposable surgical material are its disadvantages. In the future, with the developments of

Table 1: *The endothelial cell numbers, keratometric values and best corrected visual acuities before and after surgery*

	Before	3 months later	P Value
Endothelial cell loss	2345 ± 128	2157±117	0.001*
Keratometric values (Diopters)	43.25±2.25	43.00±2.00	0.364
BCVA (Snellen)	0.25±0.12	0.92±0.84	0.001*

*Statistically significant BCVA: Best corrected visual acuities

these technologies and the possibility that these devices could be more available, this technique may be used more widely.

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Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required."

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