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# Cataract Surgery Outcomes: Comparison of 2.4 mm and 2.8 mm Clear Corneal Incisions

## *Katarakt Cerrahisi Sonuçları: 2,4 mm ve 2,8 mm Korneal İnsizyonların Karşılaştırılması*

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**ABSTRACT**

**Objective**: To compare clinical outcomes of cataract surgeries with 2.4 mm and 2.8 mm clear corneal incisions.
**Materials and Methods**: This retrospective study comprised 2 groups of cataract surgery cases with different wound lenghts of group 1; 2.4 mm and group 2; 2.8 mm. We evaluated 80 eyes of 72 patients with 3-month follow-ups. Procedures carried out using the temporal self-sealing incision technique. Measured intraoperative parameters included phacoemulsification time, mean cumulative dissipated ultrasound energy and total volume of balanced salt solution used. Keratometric data, specular microscopy and macular thickness were measured preoperatively, and postoperative 1 and 3 months. Vector analysis calculated the surgically induced astigmatism. SPSS 15.0 were used for statistical analysis.
**Results:** There were no significant differences in intraoperative ultrasound energy, total phacoemulsification time and volume of balanced salt solution analyzed between two groups (p>0.05). There were no statistically significant difference between two groups in macular thickness alteration and endothelial cell loss (ECL) (p>0.05). The mean surgically induced astigmatism was significantly less in group 1 in each visit (p<0.05).
**Conclusion:** Phacoemulsification surgery through a 2.4 mm incision size appeared to be safe and less surgically induced astigmatism.

**Key Words:** Cataract surgery, incision size, surgically induced astigmatism, endothelial cell loss, macular thickness

**ÖZET**

**Amaç:** 2,4 mm ve 2,8 mm saydam korneal insizyon ile yapılan katarakt cerrahisi sonuçlarının karşılaştırılması.
**Gereç ve Yöntemler:** Bu çalışma retrospektif bir çalışma olup, katarakt cerrahisi yapılan; 2,4mm ve 2,8mm korneal giriş yeri olan 2 grup hasta grubunu kapsamaktadır. 72 hastanın 80 gözü çalışmaya dahil edilmiş olup, takibi 3 ay sürmüştür. Tüm yapılan cerrahi müdahaleler kendiliğinden kapanan temporal kesi ile yapılmıştır. İntraoperatif olarak ölçülen parametreler; fakoemülsifikasyon zamanı, ortalama kümülatif ultrason enerjisi ve total kullanılan dengeli tuz solüsyonu miktarıdır. Keratometrik değerler, speküler mikroskopi ve makuler kalınlık preoperatif, postoperatif 1.ay ve 3. ay ölçülmüştür. Cerrahi ile indüklenmiş astigmatizma vektör analizi kullanılarak değerlendirilmiştir. İstatistik programı olarak SPSS 15.0 kullanılmıştır.
**Bulgular**: İntraoperatif ultrason enerjisi, total fakoemülsifikasyon zamanı ve kullanılan dengeli tuz solusyonu miktarı parametreleri değerlendirildiğinde gruplar arasında istatiksel olarak anlamlı fark bulunmamıştır (p>0.05). Karşılaştırılan postoperatif makuler kalınlık ve endotelyal hücre kaybı parametrelerinde postoperatif 1. ve 3. ayda gruplar arasında istatiksel olarak anlamlı fark bulunmamıştır.(p>0.05). Ortalama cerrahi ile indüklenmiş astigmatizma 1. ve 3. ayda grup 1'de grup 2'ye göre düşük bulunmuştur (p<0.05).
**Sonuç:** 2,4mm korneal insizyon ile yapılan katarakt cerrahileri güvenli ve daha az indüklenmiş astigmatizma ile sonuçlanabilmektedir.

**Anahtar Kelimeler**: katarakt cerrahisi, insizyon büyüklüğü, cerrahi ile indüklenmiş astigmatizma, endotelyal hücre kaybı, makuler kalınlık

## Introduction

In recent years, the size of the incision has been reduced by the development of facoemulsification handpieces and the progression of foldable lens technology. Cataract procedures through smaller clear corneal incisions allow rapid incision healing, corneal biomechanics stability and reduced surgically induced astigmatism (1).

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But it is not certain that the effect of smaller incision cataract surgery to phaco time, cumulative energy and other surgical parameters.

In this study, we compared surgical efficiency of two different incision sizes 2,4 mm and 2,8 mm. The aim of our study is to evaluate the outcomes of surgically induced astigmatism (SIA), endothelial cell loss and macular thickness as a result of two different incision sizes.

## Materials and Methods

In our study, we evaluated 80 eyes of 72 patients including 47 males and 25 females with age related cataract performed phacoemulsification surgery between February and June 2013 at Haseki Education and Research Hospital, Istanbul, Turkey retrospectively. The protocol was in accordance with the basis of Helsinki and was approved by the local Ethics committee. All patients assured informed consent in written before surgery. Patients were divided in two groups. Group 1 included 40 eyes operated through 2,4 mm and group 2 included 40 eyes through 2,8 mm temporal clear corneal incision. All patients underwent uneventful phacoemulsification using the Infiniti Vision System (Alcon, laboratories İnc, Fort Worth, TX). Inclusion criteria was the entity of cataract from grade 2 to 3 on the lens opacities classification system III (LOCS III).

**Surgical technique**: Mydriasis was obtained by instilling topical tropicamide. A balanced salt solution (BSS) and sodium hyaluronate (Viscoat,Provisc) were used in all patients. All cases were operated through clear corneal incision at temporal horizantal meridian. Continuous curvilinear capsulorhexis was made using a cystotome needle. After hydrodissection performed, the nucleus was rotated. The nucleus emulsificated using divide and conquer technique. Bimanual irrigation/aspiration (I/A) was performed for cortex removal. Acriva (VSY) hydrophobic coated intraocular lens were implanted to each eye The ocular viscoelastic device was removed at the end of the surgery. The side ports were hydrated.

Postoperative topical therapy included ofloxacin and dexamethasone 4 times per a day.

The follow-up assessments were performed at week 1, month 1 and 3. Keratometry, specular microscopy and optical coherence tomography (OCT) were performed preoperatively, postoperatively 1 and 3 months. Phaco time, total ultrasound energy and total volume of BSS used were recorded intraoperatively.

**Statistical Analysis:** We used SPSS 15.0 program for statistical analysis. Descriptive statistics; number and percentage for categorical variables, and mean, standard deviation for numerical variables. The Student-t test was performed at the condition where the independent two-group comparisons provided the numerical variables normal distribution condition. The ratios of the categorical variables among the groups were tested by Chi-square analysis. The relationships between numerical variables were analyzed by Spearman correlation analysis because parametric test condition was not provided. Differences between groups of follow-up data were assessed by repeated measures ANOVA. Statistical significance level of alpha was accepted as $p < 0.05$.

## Results

Study included 80 eyes of 72 patients. Males constituted 65.3% (47/72) of the group and females 34.7% (25/72). All surgeries were successfully completed. No intraoperative complications (vitreus loss, wound burns, posterior capsule tear) occurred. 40 eyes were left and 40 were right. The mean age of patients was 71.65±8.62 years. Age was comparable among the two groups.

Intraoperative ultrasound (US) energy, total phacoemulsification time and used fluid analyzed between two groups. Surgical parameters were higher in group 1 than group 2 but that difference was not statistically significant. ($p>0.450$. $p>0.290$, $p>0.137$ respectively-Table 1).

Endothelial cell loss (ECL) were 393,60 cells/mm² (17.3%) and 361,75 cells/mm² (15.9%) in group 1 and 2 at postoperative month 1 respectively; 428.30 cells/mm² (%18.9) and 408,78 cells/mm² (%18.0) at month 3 respectively. ECL during the follow-up was not statistically significant between the groups (p:0.689 at month 1; p:0.799 at month 3- Table 1).

Macular thickness change were 32.73 µm and 38.17 µm respectively in group 1 and 2 at postoperative month 1; 67.55 µm and 49.45 µm at month 3 respectively. Two groups were similar in macular thickness alteration at each visits (p:0.668, p:0.427 respectively- Table1).

Surgically induced astigmatism were 0.43 D and 0.67 D in group 1 and 2 at postoperative month 1 respectively; 0.26 D and 0.40 D at month 3 respectively. Both two visits there was statistically difference between two groups (at month 1 p:0.02; at month 3 p:0.01). 2.4 mm wound size induced less astigmatism. SIA in both groups decreased in month 3 compared to month 1 (Table 1). In two groups when all patients were evaluated, ECL was correlated with preoperative endetelial cell count, intraoperative total US energy and total US time. Central macular thickness alteration was correlated with axial length

**Table 1.** Comparison of 2,4 mm and 2,8 mm wound size outcomes

| | | Group 1 (n=40) | Group 2 (n=40) | p |
|---|---|---|---|---|
| Phaco time | | 1.66±0.86 | 1.53±0.70 | 0.450 |
| CDE | | 18.96±9.72 | 16.77±8.93 | 0.290 |
| BSS used | | 99.63±35.82 | 88.15±24.43 | 0.137 |
| AL | | 23.35±0.66 | 23.29±0.76 | 0.714 |
| Ac | | 3.14±0.46 | 3.10±0.38 | 0.722 |
| Keratometry | Preop | 43.59±1.62 | 43.63±1.76 | 0.813 |
| | 1. month | 43.51±1.65 | 43.58±1.73 | 0.869 |
| | 3. month | 43.44±1.64 | 43.33±1.94 | 0.992 |
| | Time effect p=0.016 Group vs. time effect p=0.363 | | | |
| Astigmatism | Preop | 0.71±0.94 | 0.83±0.76 | 0.242 |
| | 1.month | 0.93±0.82 | 0.91±0.64 | 0.915 |
| | 3.month | 0.88±0.96 | 0.70±0.54 | 0.866 |
| | Time effect p=0,281 Group vs. time effect p=0.334 | | | |
| Specular cd | Preop | 2263.08±407.59 | 2258.40±487.66 | 0.963 |
| | 1.month | 1869.48±487.82 | 1896.65±463.37 | 0.799 |
| | 3.month | 1834.78±443.60 | 1849.63±485.08 | 0.887 |
| | Time effect p<0.001 Group vs. time effect p=0.787 | | | |
| Specular cv | Preop | 32.45±7.35 | 34.35±8.35 | 0.589 |
| | 1.month | 33.28±6.05 | 33.48±6.03 | 0.883 |
| | 3.month | 32.28±5.79 | 32.25±5.81 | 0.985 |
| | Time effect p=0.297 Group vs. time effect p=442 | | | |
| CMT | Preop | 189.93±54.68 | 187.63±44.01 | 0.958 |
| | 1.month | 222.65±94.73 | 225.80±107.47 | 0.780 |
| | 3.month | 257.48±138,84 | 237.08±103.05 | 0.817 |
| | Time effect p<0,001 Group vs. time effect p=0,420 | | | |
| Pachimetry | Preop | 530.25±45.17 | 528.58±44.65 | 0.912 |
| | 1.month | 540.50±52.12 | 528.25±38.01 | 0.233 |
| | Time effect p=0,176 Group vs. time effect p=149 | | | |
| SIA | 1.month | 0.43±0.24 | 0.67±0.36 | 0.002 |
| | 3.month | 0.26±0.21 | 0.40±0.22 | 0.001 |
| Endothelial cell loss | 1.month | 393.60±410.49 | 361.75±287.15 | 0.689 |
| | 3.month | 428.30±386.20 | 408.78±289.23 | 0.799 |
| CMT alteration | 1.month | 32.73±81.43 | 38.18±86.42 | 0.668 |
| | 3.month | 67.55±124.90 | 49.45±90.08 | 0.427 |

CDE: cumulative dissipated ultrasound energy, BSS: balanced salt solution, AL: Axial length, Ac: anterior chamber, Cd:endothelial cell density, Cv: coefficient of variation, CMT: central macular thickness,SIA: surgically induced astigmatism

(at month 1 p:0.030, at month 3 p:0.044- Table 2).

## Discussion

It is assumed that a smaller incision depends on early stabilization of refraction, shortening of the healing period and greater anterior chamber stability at phacoemulsification surgery (2,3). But use of smaller incision can cause prolonged surgery time and other surgical parameters. Lee et al. (4), demonstrated that 1,8 mm group had a longer ultrasound time and greater mean CDE compared with 2,2 mm incision size. Luo et al. (5), compared 1,8 mm, 2,2 mm and 3,0 mm. And US time, CDE and total fluid volume did not show any significant difference. In our study CDE, ultrasound time and total fluid used were higher in small incision group (2,4 mm). But that difference was not statistically significant. Most authors have accepted that a temporal incision induces less astigmatism (6,7). Kohnen et al. (6)

**Table 2.** Effects of preoperative and intraoperative parameters on SIA, endothelial cell loss and cmt alteration

| All patients | | SIA 1month | SIA 3month | Endothelial cell loss 1month | Endothelial cell loss 3month | CMT alteration 1month | CMT alteration 3month |
|---|---|---|---|---|---|---|---|
| Age | Rho | 0.100 | 0.043 | -0.005 | 0.024 | -0.078 | -0.135 |
| | P | 0.377 | 0.704 | 0.965 | 0.831 | 0.493 | 0.232 |
| Phaco time | Rho | -0.200 | -0.183 | 0.317 | 0.362 | 0.086 | 0.062 |
| | P | 0.076 | 0.105 | 0.004 | 0.001 | 0.446 | 0.584 |
| CDE | Rho | -0.147 | -0.115 | 0.294 | 0.285 | 0.091 | 0.028 |
| | P | 0.192 | 0.310 | 0.008 | 0.011 | 0.423 | 0.802 |
| BSS used | Rho | -0.087 | -0.032 | 0.109 | 0.145 | 0.142 | 0.080 |
| | P | 0.445 | 0.778 | 0.335 | 0.198 | 0.209 | 0.482 |
| Axial length | Rho | -0.041 | 0.047 | 0.113 | 0.103 | 0.242 | 0.226 |
| | P | 0.718 | 0.677 | 0.317 | 0.361 | 0.030 | 0.044 |
| Ac | Rho | -0.049 | 0.036 | 0.024 | -0.025 | 0.158 | 0.167 |
| | P | 0.669 | 0.749 | 0.831 | 0.825 | 0.161 | 0.140 |
| Preoperative average keratometry | Rho | 0.164 | 0.147 | -0.015 | -0.006 | -0.069 | -0.075 |
| | P | 0.146 | 0.192 | 0.897 | 0.956 | 0.545 | 0.506 |
| Preoperative average astigmatisma | Rho | -0.117 | 0.013 | -0.197 | -0.198 | -0.132 | -0.157 |
| | P | 0.301 | 0.910 | 0.080 | 0.079 | 0.244 | 0.164 |
| Preoperative specular cd | Rho | -0.029 | -0.080 | 0.256 | 0.278 | 0.117 | 0.125 |
| | P | 0.800 | 0.478 | 0.022 | 0.012 | 0.302 | 0.270 |
| Preoperative specular cv | Rho | -0.008 | -0.009 | 0.001 | -0.064 | 0.045 | 0.041 |
| | P | 0.940 | 0.936 | 0.991 | 0.573 | 0.691 | 0.721 |
| Preoperative CMT | Rho | -0.055 | -0.109 | 0.008 | -0.092 | 0.057 | 0.038 |
| | P | 0.628 | 0.335 | 0.944 | 0.417 | 0.614 | 0.738 |
| Preoperative pachy | Rho | -0.158 | -0.011 | 0.043 | 0.045 | -0.041 | -0.059 |
| | P | 0.162 | 0.920 | 0.704 | 0.689 | 0.717 | 0.600 |

SIA: surgically induced astigmatism, CMT: central macular thickness, CDE: cumulative dissipated ultrasound energy, BSS: balanced salt solution, Ac: anterior chamber, Cd:endothelial cell density, Cv: coefficient of variation, Pachy: pachmetry, P value: Student's t test, Rho: Spearman's rank correlation coefficients.

demonstrated that in the postoperative early period; there was a difference of induced astigmatism betweeen a temporal and nasal limbal incision. They showed that a nasal incision would have a greater effect on corneal curvature alterations than a temporal incision because of being closer to the center of the cornea and wound. We also thought that the temporal incision causes less astigmatism so we performed all operations with temporal incisions.

Luo et al. (5), said that movement from 3,0 mm to 2,2 mm resulted less surgically induced astigmatism, but 1,8 mm incision did not provide any other benefit in reducing astigmatism. However the conclusion that they reached was the smaller is not always better. Moon et al. (8), compared 3 wound sizes, 2,5- 3,0 and 3,5 mm. And they found best values in 3,0 mm group about induced astigmatism. They said that the potential of an astigmatic shift may not always be reduced by a smaller incision. Mohammed et al. (9) studied SIA through 3.2 mm temporal incision. SIA was 0,71 D at 1 week, 0,63 D at 1 month and 0,26 D at 6 months. They showed that the induced astigmatism at 6 months was lower than the first postoperative visit. Hayashi et al. (10) stated that the induced astigmatism was 0,74 D after 2.65 mm phacoemulsification surgery and 0,56 D after 2.00 mm phacoemulsification surgery at 2 months postoperatively. Wei et al.(11) found that SIA was lower in 2.5 mm group compared with 3.5 mm group at 4 weeks, but there was no statistically difference at 12 weeks from the operation. In our study 2,4 mm incision group induced less astigmatism than 2,8 mm group at month 1 and 3. That difference was significant at month 1 and 3.

Lucena et al. (12), found that loss of corneal endothelial cells was associated with CDE and volume of fluid used. Soliman et al. (13) showed that there was a correlation between endothelial cell loss and total ultrasound energy, aspiration time and total amount of BSS. Baradaran-Rafii A. et al. (14), showed that there was a powerful association between CDE and ECL but there was no relationship between total amount of BSS and ECL. In our study ECL was correlated with preoperative endothelial cell count, CDE and total us time. We didn't find any association between ECL and total fluid used.

Phacoemulsification became the most common intraocular surgery. Inflammatory response caused by surgery may worsen diabetic macular edema and Irvine-Gass syndrome (15). The release of prostaglandins mostly stimulates the inflammatory (16). Animal studies demonstrated that cataract surgery worsen macular edema and cause a defect in the outer blood-retinal barrier (17). In another research, it was shown that lenticular debris may cause to impaired inner blood-retinal barrier (18).

Even though the rate of positive angiographic findings of macular thickness increase can range from 9% to 19% with the modern phacoemulsification, it does not decrease visual acuity. After routine use of OCT, it has been detected that macular edema may occur subclinically after surgery. Macular thickness returns to baseline after several months of surgery, (19). Gharbiya et al. (20), demonstrated macular thickness increase after uncomplicated phacoemulsification surgery. But they could not find any statistically correlation between intraoperative factors (phaco time, CDE) and macular thickness change. Chen et al. (21), analyzed the influence of intraocular pressure on postoperative macular thickness during uncomplicated phacoemulsification surgery. They found a positive relation between the increase in macular thickness and the irrigation time in the subgroup of patients undergoing longer irrigation time. They proposed that intraocular pressure effect on macular thickness may be cumulative. Jagow et al. (22) discussed macular edema in a similar study. They founded a mild increase of foveal thickness could be observed and it was not correlated with intraoperative factors and axial length. In our study we found a statistical correlation between axial length and macular thickness alteration. We could not find any relationship between macular thickness alterations, other surgical parameters and incision sizes.

Sethi et al. (23) studied the surgically induced astigmatism, endothelial cell loss and central corneal thickness compared with 2,2 mm and 2,8 mm incision size. They did not find any statistically significant difference between two groups in all parameters.

In conclusion, cataract surgery through 2,4 mm incision group had less surgically induced astigmatism than 2.8 mm group. We did not find any statistical difference between two groups in surgical parameters, endhotelial cell loss and macular thickness alteration.

**Informed consent**: Retrospective study.

**Authorship Contributions:** The first and second authors contributed to conception, acquisition and interpretation of data and drafting. The third author contributed to statistical analyses and interpretation. The fourth and fifth author contributed to interpretation of data and revising the manuscript

**Conflict of Interest:** The authors declare that there is no conflict of interest regarding the publication of this paper.

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