Effect of Clear Corneal Incision Location on Tear Film
following Phacoemulsification Surgery

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Abstract

**Purpose:** To investigate tear film status after phacoemulsification surgery with temporal and supratemporal clear corneal incision in a cohort of patients with senile cataract

**Methods:** We enrolled sixty eight eyes of 68 patients with senile cataract requiring phacoemulsification in a prospective, cohort study. All patients underwent Basic Tear Secretion Test (BTST), Tear Meniscus Height (TMH), Tear Break Up Time Test (TBUT) and Schirmer I test (SIT), preoperatively and three months after surgery. Preoperative keratometry was used to determine the steepest meridian and corresponding location of clear corneal incision.

**Results:** The cohort included 46 men (67.6%) and 22 women (32.3%), with an age range of 48 to 82 years (mean 66.9±9.4 years). Phacoemulsification was performed with temporal clear corneal incision in 36 eyes (52.9%) and with supratemporal clear corneal incision in 32 eyes (47.1%). There was no statistically significant difference between the results of pre and postoperative SIT, TMH and BTST. The results of these tests were not statistically different according to incision location. In contrast, TBUT results differed significantly in pre and postoperative examination in both incision location groups (P<0.001); however, there was no statistically significant difference in TBUT results according to incision location.

**Conclusion:** Phacoemulsification cataract surgery has no significant effect on tear film. In addition the location of clear corneal incision had no effect on tear film tests.

**Keywords:** Dry Eye, Cataract, Phacoemulsification, Clear Corneal Incision

Introduction

Senile cataract is the leading cause of blindness and visual impairment. It is specially important in the aged population of developed and developing countries. At the same time, cataract surgery is the most classic and successful surgery in the field of ophthalmology. Dry eye is a common problem in the elderly and there are several reports on aggravation of dry eye following cataract surgery, specially with conventional extracapsular methods. However, little is known about the effect of small incision cataract surgery on tear film using phacoemulsification. In addition, considering effect of corneal innervations on tear production, the question is whether the site of clear corneal incision has any effect on tear film?

Patients with dry eye who had cataract surgery are reported to have a relatively less favorable outcome. In conventional cataract surgery, a large incision is made at the limbus, denervating the superior half of the cornea. This leads to corneal desensitization with subsequent complications. This, combined with the presence of sutures and prolonged use of topical steroids and antibiotics postoperatively, often precipitates the dry eye complications, sometimes with a devastating outcome. Phacoemulsification is increasingly applied in the management of cataract because of earlier refractive stabilization, reduced astigmatism, and milder postoperative inflammation. Although such a large corneal incision is no longer a matter with phacoemulsification, in this method denervation of the corneal nerve which has greatest density in temporal site may again leads to decreased corneal sensation and subsequent dry eye.

To the best of our knowledge there is no study on the effect of the location of clear corneal incisions on dry eye after phacoemulsification surgery. The current study investigate the effect of clear corneal incision location on tear film properties in a cohort of patients with senile cataract undergoing phacoemulsification cataract surgery with either temporal or supratemporal incisions. The results of the current study would help ophthalmic surgeons to make decision about best incision location in patients with or prone to dry eye.

Methods

The study was a prospective, observational, cohort study in eye research center and Khatam Anbia eye hospital, Mashhad University of Medical Sciences. Patients with senile cataract requiring phacoemulsification were selected consecutively. Sixty eight patients were eligible to the study criteria. Patients with Sjögren syndrome or dry eye needing treatment were excluded. A complete set of ophthalmic examinations were done for each patient. Tear Meniscus Height (TMH), Schirmer I Test (SIT), Tear Break Up Time (TBUT), and Basic Tear Secretion Test (BTST) were done for all patients before surgery. We determined the location of clear corneal incision based on keratometric data. For patients having with-the-rule astigmatism (WTRA); vertical steep meridian of 1.5 diopters (D) or more, we used a supratemporal clear corneal incision. In patients without such a corneal astigmatism, a temporal clear corneal incision was made. All of the incisions were made using a 3.2 mm, single-use knife (MSL 32, Mani Ophthalmic Knife, Japan) and left un-sutured at the end of surgery. A standard phacoemulsification surgery with foldable posterior chamber intraocular lens was done in all cases. All of the surgeries were performed by one surgeon (H.G.). Postoperatively chloramphenicol 0.5% and betamethasone 0.1% eye drops were given four times daily for one week, and tapered over one month. No additional topical or systemic medication was given. In addition to routine postoperative follow-up examinations, all patients were recruited with phone calls at three month postoperatively for an additional complete set of ophthalmic examinations and tear related tests.

The tear tests were performed in the following order: The first step was the measurement of TMH by slit lamp observation with a heat-absorbing filter. Then, commercially available Schirmer paper [Schirmer-Plus®, Gecis, Beuvron, France] was placed over the junction of the middle and lateral thirds of the lower eyelid. After five minutes wetting height of paper was measured. The result was recorded as SIT result and the values of less than 10 mm after 5 minutes were considered abnormal. To minimize the effect of conjunctival irritation, one hour after SIT, we applied fluorescein
strip to the inferior fornix and used a broad beam of cobalt blue light to evaluate ocular surface. After blinking for three times, the time measured between the last blink and the appearance of the first randomly distributed dry spot was recorded as TBUT. Results less than 10 seconds were considered abnormal. The last step was the instillation of one drop of tetraracain 0.5% (Anestocaine®, Sina Darou, Iran) in the inferior fornix and measurement of BTST using the aforementioned Schirmer test paper.

Examination results were recorded in special sheets and at the conclusion of the study, a chart review was done for data collection and analysis. Paired T-test and Chi-square test were used for data analysis. Statistical significance was set at P<0.05 level.

Results

Sixty eight eyes of 68 patients, including 46 (67.6%) men and 22 (32.3%) women, were enrolled in this study. The patients' age ranged from 48 to 82 years (mean, 66.9±9.4 years).

Phacoemulsification was performed with temporal clear corneal incision in 36 eyes (52.9%) and with supratemporal clear corneal incision in 32 eyes (47.1%). The cohort consisted of 42 right eyes (61.8%) and 26 left eyes (38.2%).

Based on TMH test only two cases in temporal clear corneal incision group had abnormal results in both preoperative and postoperative tests (Table 1). The average of TMH in the cohort was 1.5 mm and 1.0 mm before and after surgery, respectively (Table 2). No statistically significant difference was observed between pre and postoperative results. Moreover, incision location had no effect on TMH results.

There was no statistically significant difference in SIT result before and after surgery in the cohort; in addition main incision location had no effect on SIT (P=0.179). In supratemporal incision location, 8 patients before surgery and 10 patients three months following surgery, had abnormal SIT results. In temporal incision group, 16 patients preoperatively and 12 patients postoperatively had abnormal SIT results (Table 1). Mean SIT was 14 mm preoperatively and 15.8 mm postoperatively in the entire cohort (Table 2). Abnormal TBUT results were seen in 12 cases (17.6%) before the operation and in 40 cases (58.8%) after then (Table 1). Mean preoperative TBUT was 12 seconds, decreasing to 9 seconds after operation (Table 2). The difference was statistically significant (P<0.001). In temporal incision group, 6 patients before and 24 patients following phacoemulsification had abnormal results. In supratemporal group, abnormal results were seen in 6 and 16 patients before and after surgery, respectively. The difference between the two surgical groups was not statistically significant.

BTST test results were abnormal in 24 patients (35.5%) both before and after surgery (Table 1). Mean preoperative BTST was 12.9 mm and mean postoperative BTST was 13.7 mm (Table 2). The difference was not statistically significant. In addition there was no significant difference between different surgical groups.

| Table 1. The frequency of cases with abnormal pre and postoperative results in two incision groups |

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<thead>
<tr>
<th></th>
<th>Temporal incision</th>
<th>Supratemporal incision</th>
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<tbody>
<tr>
<td>TMH</td>
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<tr>
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<td>0</td>
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<tr>
<td>Postoperative</td>
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<td>0</td>
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<tr>
<td>SIT</td>
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<tr>
<td>Preoperative</td>
<td>16</td>
<td>8</td>
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<tr>
<td>Postoperative</td>
<td>12</td>
<td>10</td>
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<tr>
<td>TBUT</td>
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<tr>
<td>Preoperative</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Postoperative</td>
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<td>16</td>
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<td>BTS</td>
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<td>Preoperative</td>
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<td>Postoperative</td>
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TMH: Tear meniscus height
SIT: Schirmer I test
TBUT: Tear break up time
BTS: Basic tear secretion
Table 2. Mean test results before and after phacoemulsification

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
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<tr>
<td>TMH</td>
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<td>SIT</td>
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<td>TBUT</td>
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<td>BTS</td>
<td>12.9 mm</td>
<td>13.7 mm</td>
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TMH: Tear meniscus height
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Discussion

The normal function of tear film is fundamental for the corneal function. Cataract surgery in patients with dry eye is associated with a high risk of ocular morbidity. Various factors play role in determining the outcomes of surgery in the patients with dry eye, Which the postoperative corneal desensitization may be the most important. Conventional extracapsular cataract extraction requires an incision that involves at least 4 to 5 clock hours of the limbus, denervating the superior half of the cornea. Lyne reports that the loss of corneal sensitivity after cataract surgery often persists for more than 2 years and can be permanent. The sensory denervation interferes with the normal physiology of the corneal epithelium and decreases epithelial cell mitosis which leads to delayed wound healing. The inability of the epithelium to reestablish the continuity of the corneal surface also triggers certain cell biologic and biochemical mechanisms. This deficiency in the aqueous layer and an unstable tear film make the cornea susceptible to epithelial breakdown, leading to superficial punctate keratopathy, erosions, or ulceration of the cornea. However, in phacoemulsification cataract surgery, the incision is much smaller and there is less corneal denervation. It is speculated that by cutting nerve fibers on richly innervated horizontal area of cornea in temporal incisions, there might be less tear secretion and resultant neurotrophic keratopathy. However, there are little evidence based documents for dry eye after phacoemulsification.

In the current study, we focused on tear film changes after phacoemulsification and the effect of clear corneal incision location on tear film. We found no statistically significant difference between the results of pre and postoperative SIT, TMH, and BTST. In addition, clear corneal incision location had no effect on these tear film tests in our series. However, although incision location had no statistically significant effect on TBUT results, TBUT test differ significantly before and after phacoemulsification.

Khanal et al investigated post-phacoemulsification changes in corneal sensitivity and tear physiology in 18 patients. They found that deterioration in corneal sensitivity and tear physiology is seen immediately after phacoemulsification. Despite a trend toward full recovery, corneal sensitivity does not return to preoperative levels until 3 months postoperatively, whereas the tear functions recover within 1 month. In addition, postoperative treatment with tear lubricant was not found to have an effect on the improvement of tear physiology and corneal sensitivity after surgery. In the current study, we evaluated tear film properties 3 months after surgery and similarly we did not found statistically significant changes in tear tests.

In another study, Ram et al evaluated the outcome of phacoemulsification in 23 patients with dry eye. Although a minimal detrimental effect on Schirmer and TBUT tests was found, they concluded that phacoemulsification was safe and led to minimal complications in patients with age related dry eye with or without associated systemic disorders.

Liu et al compared 25 diabetic cataract patients with 20 age matched non diabetic
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cataract patients. They found that tears secretion was reduced in diabetic cataract patients after phacoemulsification, which worsened dry eye symptoms and predisposed those patients to ocular damage. However, in non diabetics there was no significant, persistent change in tear film. As we found in our study, they also observed a transient increase in SIT in the early postoperative period, which returned to preoperative levels in 180 days.

Li and colleagues\textsuperscript{19} investigated pathogenic factors responsible for dry eye in patients after cataract surgery. They stated that misuse of eye drops is one of the major pathogenic factors that causes dry eye after cataract surgery. Other authors had similar findings previously.\textsuperscript{11,13} It is advised that eye drops should be carefully administered before and after cataract surgery to avoid or reduce the occurrence of dry eye postoperatively. In current study we investigated dry eye, two months after discontinuation of topical medications and found no significant change in tear film properties. Increased TBUT in the last visit may be due to the diminished patient adherence to lid hygiene in the postoperative period and the resultant aggravation of meibomian gland dysfunction.

To the best of our knowledge, this is the first study investigating the effect of clear corneal incision location on tear film properties. We speculated that cutting more sensory nerves on the rich temporal meridians would have more effect on the tear film properties. However, this hypothesis was not confirmed in our study. Vroman and colleagues\textsuperscript{20} investigated the effect of hinge location on corneal sensation and dry eye after laser in situ keratomileusis in a cohort of 47 myopic patients. In their series patient with a nasal hinge had significantly better corneal sensation than those with a superior hinge; however, dry eye occurred with the same frequency in both groups.

Conclusion

In conclusion, phacoemulsification cataract surgery had no significant adverse effect on tear function tests, except for TBUT results. The location of clear corneal incision had no effect on tear film. It seems that phacoemulsification cataract surgery would not result in persistent dry eye signs in patient without preoperative dry eye. However, additional study with a more diverse and numerous patient groups would be necessary for further investigation of the current study results.

References