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Research Article

# A Clinical study on Impact of Phacoemulsification on Determinants of Dry Eye Syndrome

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**Abstract**: **Introduction** Phacoemulsification, with its small incision and satisfactory safety performance, have become the major procedure in regular cataract surgery. To understand better whether phacoemulsification cataract surgery induces or aggravates postoperative dry eye, we undertook a systematic review and meta-analysis of the published literature on DED-relevant parameters, including questionnaires on subjective symptoms, tear break-up time (BUT), corneal fluorescein staining (CFS), and the Schirmer I test. **Materials And Methods**.This hospital-based observational study was carried out in the Clinic of Ophthalmology, a tertiary care-center over a period of 8 months. We initially enrolled 176 subjects with senile cataract and without pre-existing dry eye syndrome. Subjects underwent detailed history and ocular examination and those with ocular conditions that can contribute to the occurrence of dry eye, such as lid disorders (blepharitis, ectropion, entropion), contact lens wear, allergic conjunctivitis, any past ocular surgeries, chronic conjunctivitis.**Result** In the study, a total of 80 eyes of 80 patients were enrolled in the study. The mean demographic age was noted to be 63.96 ± 6.95 (mean ± SD) years. Also, the mean baseline tear break-up time was 14.50 ± 2.85s. At 1 week postoperatively the value changed to 9.10 ± 3.00 s ($p<0.001$) and at 4 weeks the value reached 13.60 ± 2.85 s ($p<0.001$). Lissamine green staining test had a mean baseline value of 1.30 ± 0.45. At 1 week post-operatively the value became 3.20 ± 0.80 ($p<0.001$) and at 4 weeks the value became 1.50 ± 0.70. **Conclusion** During phacoemulsification cataract surgery, dry eye disease (DED) is a prevalent but transitory side effect that affects the eye surface. A decrease in tear break-up time (TBUT) and Schirmer's test values and a higher ocular surface disease index (OSDI) score indicate tear film instability one week after surgery. After three months, most surgically induced DED patients improved, indicating its transitory nature

**Keywords**: Dry eye, Phacoemulsification, Tear break-up time, Schirmer's test, Lissamine test, Ocular surface disease index

## INTRODUCTION

Dry eye is one of the commonest complaints reported in ophthalmology clinics, currently accounting for 17–25% of outpatient visits (1). The prevalence of dry eye disease (DED) ranges from 6 to 34% (2), and it can lead to a constellation of clinical signs and symptoms, including ocular fatigue, discharge, foreign body sensation, and epiphora (3).Although there are many potentially DED-inducing factors both intraoperatively and postoperatively (4), whether cataract surgery is a risk factor for DED remains controversial. Several studies report that patients remain unsatisfied and disturbed by postoperative DED for long periods (5) whereas others consider DED after cataract surgery to be a manifestation of the transitory impairment of the ocular surface, and that the damaging effect tapers off within 1–3 months (6). Other studies have suggested that the ocular surface is improved after cataract surgery, which is thought to correlate with the postoperative use of eye drops, reduced eye rubbing, and adequate blinking (7). Meibomian gland dysfunction (MGD) is an important etiological factor for DED and is also responsible for postoperative ocular discomfort and dry eye (8).Phacoemulsification, with its small incision and satisfactory safety performance, have become the major procedure in regular cataract surgery. To understand better whether phacoemulsification cataract surgery induces or aggravates postoperative dry eye, we undertook a systematic review and meta-analysis of the published literature on DED-relevant parameters, including questionnaires on subjective symptoms, tear break-up time (BUT), corneal fluorescein staining (CFS), and the Schirmer I test. We paid special attention to potential DED-influencing factors, such as pre-existing MGD, diabetes mellitus (DM) (9), the preoperative status of the ocular surface, the incision size (10), and the country of origin.

# Materials and Methods

This hospital-based observational study was carried out in the Clinic of Ophthalmology at tertiary care-center, over a period of 8 months. We initially enrolled 176 subjects with senile cataract and without pre-existing dry eye syndrome. Subjects underwent detailed history and ocular examination and those with ocular conditions that can contribute to the occurrence of dry eye, such as lid disorders (blepharitis, ectropion, entropion), contact lens wear, allergic conjunctivitis, any past ocular surgeries, chronic conjunctivitis, exposure keratitis, contact dermatitis, and Bell's palsy; those with systemic conditions like diabetes mellitus, hypertension, thyroid-associated diseases, lupus, rheumatoid arthritis, scleroderma, Sjögren's syndrome, vitamin A deficiency, and other factors like smoking; and those with continuous long-term use of ocular or systemic medications (antihistaminics, antidepressants, decongestants, beta blocker drugs, diuretics, and aspirin) were excluded from this study. After excluding subjects who failed to meet the inclusion and exclusion criteria, did not give consent, or were lost to follow-up, there were 120 patients.

All the subjects included in the study best corrected visual acuity was assessed by Snellen chart and intraocular pressure by Goldmann applanation tonometer. Detailed slit-lamp examination was done and the fundus was examined by indirect ophthalmoscopy. Schirmer's test, tear break-up time (TBUT) test, lissamine green staining of the cornea and conjunctiva, and Ocular Surface Disease Index (OSDI) were carried out for evaluation of dry eye.Schirmer's test was done to test basal and reflex tear secretion using a specialized Schirmer's strip prepared from Whatman filter paper no. 41 measuring 40´5 mm, marked 0 to 35 mm. Depending on the wetting of the strip, the results of Schirmer's test were graded as: >10 mm, normal (grade 0); 5-10 mm, mild (grade 1); 3-4 mm, moderate (grade 2); 0-2 mm, severe (grade 3).

TBUT was assessed to test tear film stability and meibomian gland disorder and the grading was done depending upon the time between the last blink and the appearance of a dry spot. TBUT less than 10 s was abnormal and graded as: >10 s, normal (grade 0); 3.1-6 s, moderate (grade 2); 6.1-10 s, fair (grade 1); <3 s, poor (grade 3).

Lissamine green staining of the ocular surface was done to assess the dead and devitalized cells on the ocular surface. Results were graded as: 0, no dry eye; 1, mild dry eye; 2, moderate dry eye; and 3, severe dry eye. OSDI is a 12-item evaluation for dry eye assessed on a scale of 0 to 100, with higher scores representing greater disability. The index demonstrates sensitivity and specificity in distinguishing between normal subjects and patients with dry eye syndrome. The criteria used for the grading was: 0-12, normal; 13-22, mild; 23-32, moderate; and 33-100, severe.

Risk factors such as pre-anesthetic medication, shape of incision, type of cataract surgery (phacoemulsification/SICS), microscope light exposure, CDE manipulation of ocular surface tissue, and intra- and postoperative medications were taken into consideration. Of these factors, all cases had the same pre-anesthetic medication, shape of incision, intra- and postoperative medications (which included a combination of antibiotic and steroid, non-steroidal anti-inflammatory and intraocular pressure-lowering topical eye drops from the same pharmaceutical brands, instilled at similar frequencies), and operating surgeon.

The patients were followed up 1 week and 1 month after the surgery. Evaluations of all dry eye parameters were repeated on both occasions. The study was conducted after ethical approval by the institutional ethics committee in accordance with international agreements and the Declaration of Helsinki, and informed and written consent was obtained from all the subjects included in the study.

**Statistical Analysis**

The statistical analysis was done using Statistical Package for Social Sciences version 21.0 statistical software. The values were presented in number (%) and mean ± standard deviation. P values of <0.05 were considered significant and <0.001 as highly significant..

# Results

**Table 1: Schirmer's test I, in millimeters**

| N | Mean | SD | Median | | 95% CI | P value |
|---|---|---|---|---|---|---|
| Baseline Variables | 80 | 26.30 | 4.85 | 26.00 | - | |
| 1 week | 80 | 15.20 | 4.40 | 15.00 | 9.816-11.58 | p<0.001 |
| 4 week | 80 | 23.10 | 4.60 | 23.00 | 2.595-3.105 | p<0.001 |

In the study, a total of 80 eyes of 80 patients were enrolled in the study. The following results were observed. The mean demographic age was noted to be 63.96 ± 6.95 (mean ± SD) years.

A mean baseline schirmer's test I value was 26.30 ± 4.85 (mean ± SD) mm. Which changed to 15.20 ± 4.40 mm (p value<0.001) at 1 week and at 4 weeks changed to 23.10 ± 4.60 mm (p value<0.001).(Table 1)

**Table 2: Tear break-up time, in seconds**

| N | Mean | SD | Median | 95% CI | | P value |
|---|---|---|---|---|---|---|
| Baseline Variables | 80 | 14.50 | 2.85 | 14.00 | - | |
| 1 week | 80 | 9.10 | 3.00 | 9.00 | 4.68-5.787 | p<0.001 |
| 4 week | 80 | 13.60 | 2.85 | 13.50 | 0.700-0.999 | p<0.001 |

Also, the mean baseline tear break-up time was 14.50 ± 2.85s. At 1 week postoperatively the value changed to 9.10 ± 3.00 s (p<0.001) and at 4 weeks the value reached 13.60 ± 2.85 s (p<0.001).(Table 2)

**Table 3: Lissamine green staining test**

| N | Mean | SD | Median | 95% CI | | P value |
|---|---|---|---|---|---|---|
| Baseline Variables | 80 | 1.30 | 0.45 | 1.00 | - | |
| 1 week | 80 | 3.20 | 0.80 | 3.00 | -2.067 to1.633 | p<0.001 |
| 4 week | 80 | 1.50 | 0.70 | 1.00 | -0.374 to 0.0415 | 0.115 |

Lissamine green staining test had a mean baseline value of 1.30 ± 0.45. At 1 week post-operatively the value became 3.20 ± 0.80 (p<0.001) and at 4 weeks the value became 1.50 ± 0.70. (Table 3)

**Table 4: Ocular surface disease index**

| N | Mean | SD | Median | 95% CI | | P value |
|---|---|---|---|---|---|---|
| Baseline Variables | 80 | 7.50 | 3.20 | 8.00 | - | |
| 1 week | 80 | 23.00 | 6.90 | 27.00 | -20.43 to -16.7 | p<0.001 |
| 4 week | 80 | 12.50 | 5.50 | 12.50 | -5.982 to -3.718 | |

## DISCUSSION

This study documented that alteration of the normal tear physiology was common after clear cornea phacoemulsification with tear production and tear stability reduced, and Schirmer and FTBUT values significantly decreased at 1 week after surgery. Despite the noted alterations, however, they were not sufficient to satisfy the diagnostic criteria for dry eye disease. [11]Contrary to findings from other studies where worsening of dry eye symptoms over time were reported after surgery,6 findings from the current study showed a reduction in the subjective complaints that could be attributed to the confounding factors found in the questionnaires; namely, photosensitivity and blurred vision. [12] Upon removal of these confounders, it was observed that the preoperative and postoperative subjective values no longer differed significantly. A decreasing trend in subjective complaints was also observed from 1 week to 3 months after surgery. [13]The observed decrease in Schirmer test values after the surgery was similar to findings from previous studies that reported significantly worse dry eye test values after phacoemulsification. [14] Proposed mechanisms for decrease in tear production after clear cornea phacoemulsification included: (1) the corneal incisions caused certain corneal irregularities that might produce tear film disruptions; and (2) decrease in corneal sensation secondary to severing of the corneal nerves that disrupted the feedback loop of the cornea and lacrimal gland. The gradual recovery of the tear production could be compared to what happened in LASIK surgery. After LASIK, it was seen that corneal nerves decreased by as much as 90% in the flap and sub-basal areas especially during the first week after surgery. Corneal sensitivity improved 3-6 months after LASIK and corneal nerves reached 50% of its original preoperative count.

The disruption in corneal sensitivity due to the incisions in clear cornea phacoemulsification, although small, could lead to decrease in tear production similar to that found in LASIK. The sub-basal nerve encounters the cornea from the limbal side, mainly from the temporal and nasal quadrants, and then divides toward the central area. Corneal incision at the temporal area may cut the base of corneal nerves,14 and widening the incision may worsen the reduction in corneal sensitivity in the area of penetrated cornea as well as in the areas surrounding it. [15]The theory that reduction in corneal sensitivity affects tear production supports the theory that a feedback mechanism exists between the cornea and the lacrimal gland. [16] Recovery times of 3 weeks to 9 months for corneal sensitivity after LASIK surgery were reported. [17] In this study, the gradual recovery of the Schirmer values over time was postulated to be due to the recovery of the corneal sensitivity, thus enhancing the feedback neural loop of the cornea and lacrimal gland. Although the baseline values were still not reached at 3 months after surgery, a trend towards return to normal levels was observed.The use of topical lubricants may improve dry eye signs and symptoms, as well as improve tear stability after cataract surgery. It is theorized that lubricants aid by replacing missing tear constituents, reducing elevated tear osmolarity, and reducing or washing out of inflammatory or inflammatory-inducing agents. A study by Sanchez and associates documented that the addition of hydroxypropyl (HP)-Guar, a preservative- free artificial tear preparation, to the regular treatment regimen after phacoemulsification improved tear break-up time, and reduced conjunctival epithelial cell expression of inflammatory markers 1 month postoperatively; thus, decreasing signs and symptoms of dry eye. [18]

## Conclusion

During phacoemulsification cataract surgery, dry eye disease (DED) is a prevalent but transitory side effect that affects the eye surface. Surgical stress, inflammation, corneal nerve disruption, and preservativecontaining medicines are among the complicated reasons for postoperative DED. The results revealed that cataract surgery patients need proactive ocular surface care, which affects clinical practice. Preoperative examinations should screen for DED and borderline tear film abnormalities to optimize the ocular surface. Lubricants, antiinflammatories, or meibomian gland therapy can be used. Patients should avoid irritants during postoperative treatment and use preservative-free artificial tears or punctual plugs to repair the tear film. Prevention may expedite recovery, improve patient satisfaction, and improve surgical results

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