

# Dry Eye After Clear Cornea Phacoemulsification

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## ABSTRACT

**Objective:** To determine the incidence of dry eye in patients undergoing clear cornea phacoemulsification and to investigate its effects on dry eye symptoms and tear function.

**Methods:** This was a single-center, prospective, non-randomized study involving forty-nine (49) eyes from forty-four (44) patients without preoperative dry eye, who underwent clear cornea phacoemulsification for age-related cataract. Main outcome measures were subjective grading of ocular discomfort, ocular surface disease index (OSDI), fluorescein tear break-up time (FTBUT), and Schirmer tests without anesthesia and with anesthesia. They were measured before surgery and 1 week, 1 month, and 3 months after surgery.

**Results:** None of the patients qualified for the definition of dry eye disease before and after clear cornea phacoemulsification. Preoperative FTBUT ( $14.01 \pm 0.56$  seconds) decreased at 1 week ( $3.97 \pm 0.21$  seconds;  $p < 0.001$ ) and at 1 month ( $5.82 \pm 0.32$  seconds;  $p < 0.001$ ) after the surgery and gradually improved by 3 months ( $8.26 \pm 0.54$  seconds;  $p < 0.001$ ) after surgery. Preoperative Schirmer test without anesthesia ( $18.78 \pm 1.17$  mm) decreased at 1 week ( $14.02 \pm 1.52$  mm;  $p < 0.001$ ) and subsequently recovered by 3 months ( $16.31 \pm 1.34$  mm;  $p > 0.05$ ). Preoperative Schirmer test with anesthesia ( $14.24 \pm 0.94$  mm) decreased at 1 week ( $11.98 \pm 1.00$  mm;  $p = 0.046$ ) after surgery and went back to baseline levels by 3 months ( $13.80 \pm 1.12$  mm;  $p > 0.05$ ).

**Conclusion:** Patients without dry eye disease, who underwent clear cornea phacoemulsification, did not develop dry eye disease after the surgery. Temporary reduction in physiologic tear levels seen one week postsurgery gradually returned to near-normal baseline levels by the third postoperative month.

**Keywords:** Dry Eye, Cataract Surgery, Phacoemulsification, Dysfunctional Tear Syndrome, Tear Film, Tear Break-Up Time.

In 2007, the International Dry Eye Workshop defined dry eye disease as “a multifactorial disease of the tears and ocular surface that results in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface.”<sup>1</sup>

Corneal surgery has been identified as one of the risk factors for the development of dry eye disease. For instance, development of dry eye is a known complication of laser-in-situ keratomileusis (LASIK). Several published studies have cited LASIK as causing disruption of normal ocular homeostasis by decreasing corneal sensation<sup>2, 3</sup> and changing the contour of the ocular surface as a result of the inflammation caused by its surgical trauma.<sup>4,5</sup> Other corneal surgical procedures may disrupt normal corneal innervations and severely affect corneal sensitivity, which may result to the development of dry eye signs and symptoms.

Clear cornea phacoemulsification has become one of the safest, most successful, and most frequently performed outpatient surgeries nowadays; however, as with other corneal surgeries, it may alter the ocular surface and disrupt normal tear function. There are currently no published reports on the incidence of dry eye disease in patients after undergoing clear cornea phacoemulsification. The course of change of tear function, as documented by Schirmer test and tear break-up time, on this group of patients is also not well studied. Liu<sup>6</sup> compared the tear break-up time and Schirmer tests of diabetic and non-diabetic patients before surgery and at 1 day, 1 week, 1 month, 3 months, and 6 months after clear cornea phacoemulsification. Data from this study showed reduction in tear secretion after phacoemulsification in diabetic patients. A randomized prospective study by Sanchez<sup>7</sup> compared the effect of adding hydroxypropyl (HP)-Guar to the regular post-phacoemulsification treatment in patients with dry eye signs and symptoms and reported a reduction in signs and symptoms after the surgery in the HP-Guar group.

This study determined the incidence of dry eye in patients undergoing clear cornea phacoemulsification and investigated the effects of surgery on dry eye symptoms by comparing the results of various tear function tests, such as fluorescein tear break-up time (FTBUT), corneal staining with fluorescein, conjunctival and posterior lid margin staining

with lissamine green, and Schirmer I tests without and with anesthesia. The study also examined the course of change in tear function after clear cornea phacoemulsification and identified risk factors that could have affected it.

## METHODOLOGY

The study was a single-center, non-randomized, longitudinal, prospective, observational clinical study conducted at the University of the Philippines - Philippine General Hospital (UP-PGH). All participants were informed about the nature of the study, including the possible risks and benefits accompanying it. An informed consent was obtained before subject enrollment. The study was conducted after acquiring approval from the hospital’s Institutional Review Board and in accordance with the guidelines set by the Declaration of Helsinki.

Forty nine (49) eyes of forty four (44) patients diagnosed with age-related cataract, who underwent clear cornea phacoemulsification between January 2012 to September 2012, were enrolled into the study. Patients were eligible for inclusion into the study if they had a primary diagnosis of age-related cataract; were 50 – 80 years old; of either gender; and underwent uncomplicated, uneventful cataract surgery with in-the-bag intraocular lens implantation via phacoemulsification through a temporal clear cornea incision. Total operative time should be less than one hour. Exclusion criteria are listed in Table 1.

**Table 1:** Exclusion criteria.

<b>Ocular</b>	
Previously diagnosed with dry eye disease	History of pterygium excision
Previous eye surgery	History of eye trauma
Diagnosed with non-age related cataract	History of ocular allergies
History of herpetic keratitis or herpes zoster ophthalmicus	Active anterior blepharitis
History of other neurotrophic disorders	Chronic inflammation of ocular surface
Lid abnormalities (i.e. trichiasis, lagophthalmos, ptosis)	Conjunctival scarring or symblepharon
<b>Miscellaneous</b>	<b>Systemic</b>
Contact lens wearer	Use of any systemic medication
Presence of punctal plugs or punctal cautery	History of hypertension and diabetes
Use of any preoperative topical eye drop within the last 30 days	
Smoker	
Patients who will not consent to the study	

Signed informed consent was obtained from all eligible patients. The following data were collected from patients: ocular, medical, surgical, and medication history. Prior to surgery, patients underwent basic eye examination. Dry eye tests were performed in the following order: slit lamp examination of the lids and anterior segment, fluorescein-based tear break-up time (FTBUT), examination of the cornea after fluorescein staining, examination of the conjunctiva and posterior lid margin after lissamine staining, and Schirmer tests without and with anesthesia. Patients were also asked to accomplish the Subjective Grading of Ocular Discomfort (SGOD) and the Ocular Surface Disease Index (OSDI) questionnaires. All tests and examinations were done following standard techniques by a single investigator.

All patients underwent clear cornea phacoemulsification. The procedure was performed by 5 surgeons using standard preoperative, intraoperative, and postoperative techniques and regimens. Tropicamide-phenylephrine hydrochloride 0.5%/0.5% (Sanmyd-P, Santen Pharmaceuticals, Osaka, Japan) was used three times over half an hour to dilate the pupil before the surgery. Proparacaine hydrochloride 0.5% (Alcaine, Alcon-Couvreur, Puurs, Belgium) was used as surface anesthesia. Two incisions were made on the cornea during the surgery. The first incision, of about 1 mm, was made along the 6 or 12 o'clock position of the peripheral cornea. The second incision was a temporal corneal tunnel incision about 2.75 mm wide, located about 90° from the first incision. Only patients who underwent uneventful clear corneal phacoemulsification with in-the-bag intraocular lens implantation were included in the study. Postoperatively, patients received topical prednisolone acetate 1% (Pred Forte, Allergan, USA) 4-6x/day and topical moxifloxacin hydrochloride 0.5% (Vigamox, Alcon, USA) 4x/day for a duration of 1 month.

The SGOD and OSDI questionnaires, FTBUT, corneal staining with fluorescein, conjunctival and posterior lid margin staining with lissamine green, and Schirmer I tests without anesthesia and with anesthesia were measured at 1 week, 1 month, and 3 months after the surgery.

The SGOD questionnaire, devised by Lim-Bon-Siong and Sy (Profile of patients in a tertiary hospital dry eye specialty clinic in the Philippines, 2007, unpublished), was based on the most common symptoms documented at the Dry Eye Clinic of the

Department of Ophthalmology and Visual Sciences, UP-PGH. The symptoms were graded using a five-point scale. The sum of the scores were classified into mild (<14), moderate (15 – 21), or severe (22-28). The OSDI questionnaire evaluated the effects of dry eye on quality of life divided into three subscales: ocular symptoms, vision-related function, and response to environmental triggers. It used a 4-grade scale.

Fluorescein tear break-up time (FTBUT) was determined using a fluorescein impregnated paper strip (BioGlo Sterile Fluorescein Strips, California, USA). The fluorescein strip was moistened with one drop of normal saline and applied onto the inferior fornix, avoiding contact with the ocular surface. The patient was instructed to blink naturally several times, without squeezing, to distribute the fluorescein. Within 30 seconds of fluorescein instillation, the patient was asked to stare ahead without blinking. The interval in seconds between the last blink and the appearance of the first fluorescein progressive discontinuity at the center of the cornea was observed through a slit lamp with diffuse illumination and 10x magnification using cobalt blue light. Time was measured using a digital timer. Three consecutive FTBUTs were measured and the average was used for analysis of data.

Corneal staining with fluorescein was evaluated using a slit lamp with diffuse illumination and 16x magnification with cobalt blue light. The upper eyelid was lifted slightly to grade the whole corneal surface. The Oxford scheme of grading staining was used: five areas of the cornea were independently graded based upon a six-point scale (0, 1, 2, 3, 4, 5), where the maximum possible grade was 5. This was evaluated after 30 seconds and within 2 minutes of fluorescein strip application.<sup>8,9</sup>

To assess conjunctival and posterior lid margin staining, a lissamine green paper strip (Lissamine Green Sterile Strips, California, USA) was utilized. The strip was moistened with 2 drops of normal saline, agitated for 15 seconds, and then applied to the lower palpebral conjunctiva. Using the Oxford scheme of grading staining, the six areas of the interpalpebral conjunctiva (three areas each of the temporal and nasal conjunctivae) were independently graded based on a six-point scale (0, 1, 2, 3, 4, 5), with 5 as the maximum grade for each area.<sup>8,9</sup> Scores for each area were combined (maximum combined score of 30). To grade the temporal zone, the patient looked nasally; to grade the nasal zone, the patient looked temporally.

Posterior lid margin staining with lissamine green was graded as follows: 0 = staining in <25% of the width of the wiper, 1 = staining of 25 to <50% of the width of the wiper, 2 = staining of 50 to <75% of the width of the wiper, and 3 = staining of >75% of the width of the wiper.<sup>10</sup> A photographic scale was used.

The Schirmer I test was performed under natural light with and without topical anesthetic. Schirmer I test without anesthesia was performed first, immediately followed by another Schirmer I test with instillation of a topical anesthesia. Standardized Whatmann filter paper 5 x 35 mm (TearFlo Sterile Strips, California, USA) was inserted over the lower lid margin, midway between the middle and outer third away from the cornea. This was kept in the lower conjunctival sac for 5 minutes with patient's eyes closed. Test results were reported as the length of the strip that was moistened measured in millimeters (mm).<sup>8,9</sup>

The Schirmer I test with anesthesia was performed by instilling one drop of proparacaine (Alcaine, Alcon-Couvreur, Puurs, Belgium) in the lower cul-de-sac. After 2 minutes, excess fluid was dabbed using a clean paper tissue. Standardized Whatmann filter paper 5 x 35 mm (TearFlo Sterile Strips, California, USA) was inserted over the lower lid margin, midway between the middle and outer third away from the cornea, and was kept in the lower conjunctival sac for 5 minutes with eyes closed. The length of the strip that was moistened was measured in millimeters (mm).<sup>8,9</sup>

## Outcome Measures

Subjective outcome measures included ocular discomfort grading and quality of life scores recorded using the SGOD and OSDI questionnaires, respectively. Objective measures included FTBUT, fluorescein corneal staining scores, lissamine green staining scores, and Schirmer test results. All measurements were taken prior to cataract surgery (baseline) and at 1 week, 1 month, and 3 months after surgery.

A FTBUT of less than 10 seconds was accepted as abnormal. For corneal and conjunctival staining, an increase in the Oxford grading indicated an abnormality. The higher the score for posterior lid margin grading indicated increasing severity of dry eye. A reading of less than 10 mm in the Schirmer I test without anesthesia was considered abnormal; a reading of less than 5 mm in the Schirmer I test with

anesthesia was abnormal. A higher OSDI score implied greater disability and worsening of symptoms.

Criteria used to make a diagnosis of dry eye disease were: (1) Subjective Grading of Ocular Discomfort (SGOD) score of at least 15; (2) Ocular Surface Disease Index (OSDI) score of at least 40; (3) FTBUT score less than 10 seconds; (4) Schirmer I test without anesthesia of less than 10 mm; and (5) Schirmer I test with anesthesia of less than 5 mm. All the listed criteria should be present in a patient to qualify for the diagnosis.

## Statistical analyses

Sample size computation was performed using SAS 9.1's Proc Power. To detect an increase of 0.6 in the mean Schirmer I test without anesthesia after one month, observing one-sided significance level of 0.05, and assuming 1.1 standard deviations of the differences, a total of 28 eyes would provide 80% power of the statistical test.

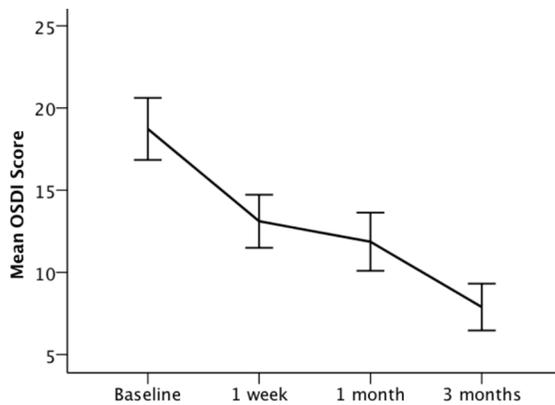
Paired t-test and repeated measures analysis of variance (RMANOVA) (SPSS 17.0) were performed for the quantitative data. Wilcoxon rank sum test (SPSS 17.0) and non-parametric RMANOVA (nparLD package of R 2.15-1 for ordinal data) were also applied. Cochran's Q test (MedCalc 12.1) was used for the data in counts. Results were considered statistically significant if p-values were less than 0.05.

## RESULTS

A total of 49 eyes of 45 patients were initially enrolled in the study. Two patients (2 eyes) were unable to continue with the study because of development of complications intraoperatively; while 2 patients (2 eyes) failed to complete the follow-up period. Data from these 4 patients were excluded from the final data. The outcomes from 45 eyes of 40 subjects were included in the final analysis.

### Ocular Survey Disease Index (OSDI)

The mean OSDI score at baseline after 1 week, 1 month, and 3 months postsurgery were significantly different (Table 2). There was a linear declining trend (Figure 1) of OSDI scores. Moreover, all patients had actual OSDI scores of less than 40 at all time frames observed (Table 3).



**Figure 1:** Mean OSDI scores at baseline, 1 week, 1 month, and 3 months postsurgery.

**Subjective Grading of Ocular Discomfort (SGOD)**

The SGOD score after 1 week, 1 month, and 3 months were significantly less than the baseline (Table 2). Although these results were all classified as mild discomfort (<14), they indicated that, subjectively, the patients were feeling better after 3 months.

**Fluorescein Tear Break-Up Time (FTBUT)**

The mean fluorescein tear break-up time at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). The mean FTBUT decreased after one week and gradually improved thereafter; but the values were still less than baseline.

The number of patients with abnormal FTBUT (<10 mm) before the surgery was 0, which increased to 45 at 1 week after the surgery. FTBUT subsequently improved, with only 42 and 33 patients with abnormal FTBUT at 1 month and 3 months after surgery, respectively (Table 3).

**Corneal Staining with Fluorescein**

The corneal staining at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). While the scores after one week (p<0.001) were greater than the baseline, those taken at one month (p=0.87) and three months (p=0.06) following surgery did not differ significantly from baseline.

**Conjunctival Staining with Lissamine Green**

The conjunctival staining at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). While the scores after one week (p=0.002) were greater than the baseline, those taken after one

**Table 2:** Outcome measures after clear cornea phacoemulsification.

Variables	Baseline	1 week	1 month	3 months	p-value
OSDI score	18.73 ± 1.89	13.11 ± 1.61	§11.86 ± 1.77	§7.89 ± 1.42	<0.001*
SGOD score	5 [3 to 8]	§2 [0 to 4]	§2 [0 to 4]	§2 [0 to 2]	<0.001**
FTBUT (sec)	14.01 ± 0.56	§3.97 ± 0.21	§5.82 ± 0.32	§8.26 ± 0.54	<0.001*
Corneal stain	1 [0 to 2]	§3 [2 to 4]	1 [0 to 2]	0 [0 to 0]	<0.001**
Conjunctival stain	6 [3 to 8]	§8 [6 to 11.5]	7 [6 to 10]	6 [4 to 8.5]	<0.001**
Posterior Lid Margin	1 [1 to 1.5]	1.5 [1 to 1.5]	1 [1 to 1.5]	1 [1 to 1]	0.013**
Schirmer I test w/o anesthesia (mm)	18.78 ± 1.17	§14.02 ± 1.52	§14.91 ± 1.48	16.31 ± 1.34	<0.001*
Schirmer I test with anesthesia (mm)	14.24 ± 0.94	§11.98 ± 1.00	13.44 ± 1.18	13.80 ± 1.12	0.046*

Values displayed were mean ± SEM (n = 45), or median and interquartile range (IQR) in brackets.

§ Significantly different from the baseline (p<0.05).

p-values were based on \*repeated measures analysis of variance (RMANOVA) or \*\*non-parametric RMANOVA.

**Table 3:** Frequency distribution of eyes with abnormal outcome measures.

Variables	Baseline	1 week	1 month	3 months	p-value
OSDI (≥40)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
SGOD (≥15)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
FTBUT (<10 secs)	0 (0%)	§45 (100%)	§42 (93.3%)	§33 (73.3%)	<0.001
Schirmer w/o anes (<10 mm)	0 (0%)	§20 (44.4%)	§19 (42.2%)	§10 (22.2%)	<0.001
Schirmer with anes (<5 mm)	0 (0%)	2 (4.4%)	3 (6.7%)	1 (2.2%)	0.230

Values displayed were counts and percentages (n=45) in parentheses.

§ Significantly different from the baseline (p<0.05).

\* p-values were based on Cochran's Q Test.

month (p=0.13) and three months (p=0.97) following surgery did not differ significantly from baseline.

**Posterior Lid Margin Staining with Lissamine Green**

The posterior lid margin staining at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). However, compared with baseline, the scores did not differ significantly after one week, one month, and three months.

### Schirmer I Test Without Anesthesia

The mean results of Schirmer test without anesthesia at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). The values decreased after one week and subsequently improved.

There were no patients with measurements less than 10 mm before the surgery. This number increased to 20 at 1 week after the surgery and subsequently improved, with 19 and 10 patients still with abnormal measurements at 1 month and 3 months after the surgery, respectively (Table 3).

### Schirmer I Test With Anesthesia

The mean results of Schirmer test with anesthesia at baseline, after 1 week, 1 month, and 3 months were significantly different (Table 2). The values decreased after one week and gradually improved thereafter, such that the scores were not different from baseline at one month ( $p=1.000$ ) and three months ( $p=1.000$ ) after the surgery.

The number of patients with measurements less than 5 mm at baseline, after one week, one month, and three months postsurgery did not differ significantly (Cochran's  $Q = 3.750$ ,  $df=3$ ,  $p=0.23$ ) (Table 3).

Despite observed trends from the various parameters, no patients satisfied the criteria for the diagnosis of dry eye disease.

## 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.

Contrary to findings from other studies where worsening of dry eye symptoms over time were reported after surgery,<sup>6</sup> 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. Upon removal of these confounders, it was observed that the preoperative and postoperative subjective values no longer differed significantly (Table 4). A decreasing trend in subjective complaints was also observed from 1 week to 3 months after surgery.

**Table 4:** Outcome measures of subjective complaints after clear cornea phacoemulsification.

Variables	Baseline	1 week	1 month	3 months	p-value
OSDI (actual OSDI score)	18.73 ± 1.89	13.11 ± 1.61	§11.86 ± 1.77	§7.89 ± 1.42	<0.001*
OSDI (without visual symptoms)	10.98 ± 1.59	13.11 ± 1.61	11.86 ± 1.77	7.89 ± 1.42	0.042*
SGOD score	5 [3 to 8]	§2 [0 to 4]	§2 [0 to 4]	§2 [0 to 2]	<0.001**
SGOD score (without visual symptoms)	2 [0 to 3]	2 [0 to 4]	2 [0 to 4]	2 [0 to 2]	0.105**

Values displayed were mean ± SEM (n = 45), or median and interquartile range (IQR) in brackets.

§ Significantly different from the baseline ( $p<0.05$ ).

p-values were based on \*repeated measures analysis of variance (RMANOVA) or \*\*non-parametric RMANOVA.

During the immediate postoperative period, tear film stability was significantly compromised as supported by low FTBUT values. This finding could not be attributed to clear cornea phacoemulsification alone. The low FTBUT values were likely to be the result of the use of topical eye drops with preservatives as they could cause toxicity to the cornea and conjunctiva. These preservatives acted like detergents that caused break down of the tear lipid layer resulting in low FTBUT. A study by Pisella and colleagues who compared the ocular symptoms (foreign body sensation, tearing, burning sensation, and itching) of patients on preservative and preservative-free glaucoma medications showed a significant decrease in symptoms with the use of preservative-free medication and a reversal of symptoms after the medication with preservative was removed.<sup>11</sup> In our study, the FTBUT gradually improved 1 month after the surgery which could be due to the discontinuation of topical medications at around this time and returned to near normal levels 3 months after surgery.

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.<sup>7</sup> 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.<sup>12,13</sup>

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,<sup>14</sup> 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.<sup>15</sup> 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.<sup>16</sup> Recovery times of 3 weeks to 9 months for corneal sensitivity after LASIK surgery were reported.<sup>3</sup> 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.<sup>7</sup>

In conclusion, the current study showed that all patients without dry eye disease, who underwent clear cornea phacoemulsification, did not develop dry eye disease after the surgery. It was observed, however, that phacoemulsification is capable of decreasing tear production and tear film stability, leading to occurrence of ocular discomfort symptoms for the patients. The observed changes in tear physiology were temporary, and a gradual recovery to near normal tear function level was observed 3 months after the surgery. Patients should be informed of this phenomenon and the use of preservative-free lubricants should be considered postoperatively.

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