

# Clinical Evaluation of Patients Undergoing Phacoemulsification for Dry Eye

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## Abstract

**Background:** “Dry eye” is a multifactorial disease of tears and ocular surface that can be result from aqueous deficiency or may be evaporative in nature. Dry eye affects individuals worldwide. Long-term epidemiological studies have shown that the incidence rates among the population between ages 43 and 86 years at 5 and 10 years of follow-up to be 13.3% and 21.6%, respectively.

**Aim of the Study:** The aim of the study was to assess the incidence and severity pattern of dry eye among patients who have undergone phacoemulsification.

**Materials and Methods:** A total of 152 patients undergoing phacoemulsification for matured cataracts in the Department of Ophthalmology of KMCT Hospital were included in this study. The incidence of dry eye on day 7 after phacoemulsification was assessed using the ocular surface disease index (OSDI) questionnaire. Tear breakup time (TBUT), fluorescein staining with Oxford Schema, and Schirmer I test without anesthesia were performed after the questionnaire. The TBUT measures the interval between the last complete blink and the first appearance of a dry spot or disruption of the tear film.

**Observations and Results:** Among 152 subjects, there were 97 male patients (63.81%) and 55 (36.18%) female patients with a male to female ratio 1.76:1. The mean age was  $57.13 \pm 9.50$  years. The eldest patient was aged 78 years. On day 7 postoperatively, the mean scores of OSDI questionnaire (preoperatively vs. postoperatively was 12.57 vs. 35.10, respectively), TBUT (preoperatively vs. postoperatively was  $15.85 \pm 1.25$  s vs.  $13.9 \pm 0.70$  s), Oxford Schema (preoperatively vs. postoperatively was Grades 1 vs. 2), and Schirmer I without anesthesia (preoperatively vs. postoperatively was  $22.10 \pm 5.44$  mm at 5 min [15–35 mm] vs.  $7.50 \pm 2.20$  in 55.30% [6.10–9.05], respectively) showed a trend toward dry eye syndrome during the 1<sup>st</sup> week.

**Conclusions:** Dry eye symptoms can develop immediately after phacoemulsification and the severity can peak on day 7. Both symptoms and signs of dry eye can improve over time. However, it is important that ophthalmologists assess dry eye before and after phacoemulsification to ensure proper treatment, quality of vision, and quality of life for their patients.

**Key words:** Cataract and OSDI questionnaire, Dry eye, Phaco-emulsification

## INTRODUCTION

“Dry eye” is a disease of the pre-corneal tear film with varied etiology and ocular symptoms such as ocular discomfort, visual disturbance, and tears film instability, with potential damage to the ocular surface.<sup>[1]</sup> When the disease is severe it affects the patient’s ocular and general health, well-being, and quality of life.<sup>[2,3]</sup> Epidemiology

of the disease studied worldwide showed that aging, connective tissue disease, history of allergy or diabetes, and use of antihistamines and refractive surgery are some of the risk factors for the dry eye syndrome.<sup>[4-8]</sup> One among the various causes producing dry eye is cataract surgery, the most common procedure performed in ophthalmic departments. Dry eye is complained as a symptom of irritation after cataract surgery. It can occur after an extracapsular cataract extraction because a large incision is created in the eye during the procedure that sometimes damages the cornea.<sup>[9]</sup> Phacoemulsification is another method of commonly performed methods of cataract surgery worldwide where a smaller incision is given, and ultrasonic-driven oscillating tips are used to emulsify or fragment the crystalline lens. However, there are fewer reports of dry eye syndrome, which are focused

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on patients who had undergone phacoemulsification and subsequently developed dry eye.<sup>[1]</sup> Review of literature shows that factors responsible for dry eye after cataract surgeries are prolong use of antibiotic-steroid eye drops, decrease tear film breakup time due to surface irregularity at the site of the incision, decrease mucin production from the conjunctiva secondary to incision placement, decrease corneal sensation due to surgical incision which disrupts the cornea-lacrimal gland loop leading to reduced tear secretion, poor tear film production and stability due to surgically induced ocular inflammation, and exposure to light from the operating microscope.<sup>[10-12]</sup> In the present study, various measurements to assess the incidence and severity pattern of dry eye syndrome among patients who have undergone phacoemulsification was undertaken.

### Type of the Study

This was a cross-sectional, prospective analytical study.

### Duration of the Study

The study was from April 2015 to March 2017.

### Institute of the Study

This study was conducted at KMCT Medical College, Manassery, Kozhikode, Kerala.

## MATERIALS AND METHODS

A total of 152 patients undergoing phacoemulsification for matured cataracts in the Department of Ophthalmology of KMCT Medical College Hospital, Manassery, Kozhikode, Kerala, were included in this study. An Ethical Committee Clearance was obtained before commencing the study. An Ethical Committee cleared consent form was used for the study.

### Inclusion Criteria

- (1) Patients aged above 38 years were included in this study.
- (2) Patients with a cataract without dry eye as assessed by the ocular surface disease index (OSDI) questionnaire (OSDI scores of 25 or less) were included in this study.

### Exclusion Criteria

- (1) Patients below 38 years were excluded from this study.
- (2) Patients who received concomitant medications causing dry eye such as antihistamines, antidepressants, birth control pills, decongestants, medications in the accutane, gabapentin, sildenafil citrate, and anticholinergic drugs and who had autoimmune diseases were excluded from the study.
- (3) Patients developing other complications following phacoemulsification were excluded from the study. After the surgery, the incidence of dry eye in all the patients was assessed using the OSDI questionnaire. The

severity of the dry eye was assessed and calculated from the average of the OSDI scores, tear breakup time (TBUT), the Schirmer I test without anesthesia, and the Oxford Schema. The patients' pre-operative and post-operative characteristics were observed and analyzed. The incidence of dry eye on day 7 after phacoemulsification was assessed using the OSDI questionnaire,<sup>[13]</sup> a 12-item questionnaire used worldwide to accurately assess symptoms of ocular irritation related to dry eye, and vision was modified by omitting items four and five which assess the presence of blurred and poor vision because it is difficult to differentiate the change of these symptoms caused by cataract surgery alone or combined with visual symptoms due to cataract surgery-induced dry eye conditions. The total OSDI score was calculated by using the formula: OSDI score = (sum of all answered questions) × 100/total number of answered questions) × 4. The OSDI scores range from 0 to 100. Scores from 0 to 25 are considered normal; scores exceeding 25 indicate the presence of dry eye symptoms. TBUT, fluorescein staining with Oxford Schema, and Schirmer I test without anesthesia were performed after the questionnaire. The TBUT<sup>[1]</sup> measures the interval between the last complete blink and the first appearance of a dry spot or disruption of the tear film. Three TBUT scores were averaged to determine whether the patient had dry eye. An average score of 10 s or more was classified as normal; a TBUT shorter than 10 s indicated the presence of dry eye. Conjunctival and corneal fluorescein staining were graded using the Oxford Schema<sup>[1]</sup> with 0–I indicating normal and II–V indicating dry eye. For the Schirmer I test<sup>[1]</sup> without anesthesia, Schirmer paper strips were inserted over the lower lid margin, midway between the middle and outer third of the lid. The wetness on the strip was measured 5 min after application. A wet area that measured 10 mm or less was diagnosed as dry eye. The OSDI questionnaire and the three clinical tests were administered on day 0 (baseline), after week 1 and after 1<sup>st</sup> and 3<sup>rd</sup> months after phacoemulsification. Cataract surgeries were performed under topical anesthesia induced with 0.5% tetracaine hydrochloride. Before surgery, the eye was prepared and draped using sterile techniques. Phacoemulsification was performed with a 2.75-mm temporal clear corneal incision and a side port of about 1 mm 90° incision away from the main incision. The range of phacoemulsification time was 5–10 min and foldable intraocular lens was inserted thereafter. There was no intraoperative complication in all cases. After surgery, all patients instilled tobramycin with dexamethasone ophthalmic eye drops 4 times daily for 1 month. All the data were analyzed using standard statistical methods. The associations between age, sex, underlying disease, and dry eye postoperatively were analyzed by Fisher's exact test.

## OBSERVATIONS AND RESULTS

A total of 152 patients undergoing phacoemulsification in the Department of Ophthalmology of a tertiary teaching Hospital of Kerala were included in this study. Totally 152 eyes were assessed for evidence of dry eye by the methods described in materials and methods. The demographic data was tabulated and shown in Table 1. There were 97 male patients (63.81%) and 55 (36.18%) female patients with a male to female ratio 1.76:1. The mean age was  $57.13 \pm 9.50$  years. The eldest patient was aged 78 years.

The data of subjects preoperatively and on days 7, 30, and 90 postoperatively for the OSDI questionnaire and three clinical tests were made available in Table 2 from 152 patients. On day 7 postoperatively, the mean scores of OSDI questionnaire (preoperatively vs. postoperatively was 12.57 vs. 35.10, respectively), TBUT (preoperatively vs. postoperatively was  $15.85 \pm 1.25$  s vs.  $13.9 \pm 0.70$  s), Oxford Schema (preoperatively vs. postoperatively was Grades 1 vs. 2), and Schirmer I without anesthesia (preoperatively vs. postoperatively was  $22.10 \pm 5.44$  mm at 5 min [15–35 mm] vs.  $7.50 \pm 2.20$  in 55.30% [6.10–9.05], respectively) showed a trend toward dry eye syndrome during the 1<sup>st</sup> week. The agreement between the three

clinical tests and the OSDI questionnaire in various combinations was analyzed by Kappa analysis and showed no agreement with each other except for the OSDI questionnaire with the Oxford Schema and the TBUT with the Oxford Schema. Poor agreement was detected between the OSDI questionnaire and the Oxford Schema (agreement 47.2%, kappa 9.8%,  $P = 0.03$ ) and the TBUT and the Oxford Schema (agreement 73.0%, kappa 39.9%,  $P < 0.001$ ) showed fair agreement. The cataract surgery was performed using phacoemulsification in all the eyes. The mean duration of surgery was 27.5 min ( $\pm 10.1$ , range 10–50 min). The total microscope light exposure time was little longer (mean,  $31.1 \pm 10.5$  min) than the duration of actual surgery. The length of main incision in the phacoemulsification group was 2.8 mm.

## DISCUSSION

The basic principle in the causation of the dry eye is either presence of aqueous production deficiency or excessive evaporation of the tears. This syndrome affects individuals worldwide. Long-term population-based studies have shown the incidence rates of dry eye among the population between ages 43 and 86 years at 5 and 10 years of follow-up to be 13.3% and 21.6%, respectively.<sup>[4,5]</sup> Dry eye can occur following ophthalmic surgeries such as photorefractive keratectomy and laser-assisted *in situ* keratomileusis (LASIK). The incidence rates of dry eye, assessed by corneal fluorescein staining after 1<sup>st</sup> week postoperatively for either nasal- or superior-hinge LASIK, were 47.06% and 52.94%, respectively.<sup>[6]</sup> After LASIK surgery, dry eye can persist up to 6 months or more with an incidence of 20%,<sup>[7]</sup> whereas in patients who have undergone blepharoplasty, dry eye can last up to 2 weeks or more with an incidence of 10.9%.<sup>[12]</sup> As it is difficult to assess the dry eye by a single test, different diagnostic tools with different sensitivities and specificities are used to diagnose dry eye.<sup>[13]</sup> In the present study OSDI questionnaire was used to assess the severity, natural history, and effects of dry eye. The OSDI questionnaire was having a sensitivity of 60% and specificity of 79% in the present study. One explanation for TBUT and Oxford Schema indicating more cases of dry eye postoperatively when compared to

**Table 1: The demographic data of the study group (n=152)**

Demographic observation	Male-97	Female-55
Mean age	59.35±2.70	56.10±3.05
Socioeconomic status		
High	24 (15.78%)	14 (09.21%)
Middle	38 (25%)	20 (13.15%)
Low	35 (23.02%)	21 (13.81%)
Educational status		
Uneducated	34 (22.36%)	16 (10.52%)
Vocational courses	43 (28.28%)	31 (20.39%)
Graduation	20 (13.51%)	18 (11.84%)
Smoking	52 (16.44%)	04 (02.63%)
Hypertension	42 (27.63%)	19 (12.5%)
Diabetes mellitus	30 (19.73%)	10 (06.57%)
Dyslipidemia	15 (09.86%)	11 (07.23%)
Heart disease	35 (23.02%)	21 (13.81%)
Glaucoma	11 (%)	09 (%)
Parkinsonism	06 (%)	00
Prostate hypertrophy	16 (%)	--

**Table 2: The pre-operative and post-operative OSDI score and test results (n=152)**

Dry eye assessment tests	Pre-operative Assessment (95% CI)	Day 7 Mean, incidence (95% CI)	Day 30 Mean, incidence (95% CI)	Day 90 Mean, incidence (95% CI)
OSDI questionnaire score	11.64 (07.10–16.35)	35.10 (31.0–42.50)	19.40 (17.65–23.15)	15.30 (13.45–19.40)
TBUT	15.85±1.25 s	13.9±0.70 s	14.7±0.31 s	15.15±1.10 s
Oxford Schema	Grade 1-100%	Grade 3-62.25%	Grade 2-81.45%	Grade 1-96%
Schirmer I without anesthesia	22.10±5.44 mm at 5 min (15–35 mm)	7.50±2.20-55.30% (6.10–9.05)	14.60±1.20-69.25% (12.70–18.30)	18.30±3.50-88.30% (16.25–19.80)

OSDI: Ocular surface disease index, CI: Confidence interval, TBUT: Tear breakup time

the Schirmer I test without anesthesia [Table 2] was that these tests could easily detect tear film instability and ocular surface inflammation respectively. Abnormal TBUT and Oxford Schema could have resulted from microscopic light exposure, toxic substances from inflammatory cytokines, medications, or preservatives. Only mild injected bulbar conjunctiva and without anterior segment, inflammation was found postoperatively in patients who developed abnormal TBUT and Oxford Schema results. Phacoemulsification can affect or interrupt the neurogenic response of the ocular surface and decrease tear secretion.<sup>[13]</sup> However, the small number of cases with an abnormal Schirmer I test without anesthesia indicated that phacoemulsification affects the tear film stability and ocular surface inflammation more than tear secretion. Similar to other studies, this study also reported that dry eye can develop after cataract surgery.<sup>[9,12,14,15]</sup> In particular, Li *et al.*<sup>[12]</sup> reported high percentages of patients who developed dry eye following phacoemulsification; lower tear meniscus height, decreased TBUT scores, decreased Schirmer I test scores, and serious squamous metaplasia detected by impression cytology. Liu *et al.*<sup>[14]</sup> reported worsening of the tear film pattern, height of the tear meniscus, and scores detected by the TBUT, Schirmer I test, and corneal fluorescein staining after phacoemulsification. Whereas Ram *et al.*<sup>[9]</sup> reported no difference in the eye between before and after phacoemulsification in 23 of their patients. The reason for the discrepancy may be due to its small sample size and retrospective study design. There was no evidence of late reaction of dryness such as filamentary keratopathy, superior limbic keratoconjunctivitis, or persistent epithelial defect in this study. Ofloxacin eye drops 4 times daily for 2 weeks, prednisolone acetate ophthalmic suspension 1% 4 times daily for 1 week, and pranopulin eye drops 1% 4 times daily for 1 month were used during the post-operative period in this study. Review of literature shows that one of the factors causing dry eye was the delay in recovery process of the corneal nerves. Cornea is one of the most highly innervated organs with about 44 corneal nerve bundles entering the cornea around the limbus centripetally<sup>[15]</sup> and larger nerve fibers that run from the 9 o'clock to the 3 o'clock position and bifurcate to achieve a homogenous distribution over the entire cornea;<sup>[16]</sup> it is vulnerable to any damage within that region. Temporal corneal incisions created during phacoemulsification can reduce the corneal sensitivity in the surgical area and other areas far from the incision site.<sup>[17,18]</sup> The damage to the corneal nerves may expand when longer phacoemulsification time is needed to break up a dense cataract.<sup>[19]</sup> Disruption of the normal corneal innervations or lacrimal functional unit feedback can reduce the tear flow and blink rate and cause instability of the tear hyperosmolarity and tear film.<sup>[1]</sup> As the corneal healing progresses postoperatively, new neurite

cells emerge, and after 25 days, the neural growth factor is released to regenerate the subepithelial corneal axon.<sup>[20]</sup> Thus, the recovery of the corneal nerves may explain why the dry eye was seen early after surgery and improved thereafter. In the present study also delayed innervations might seem to be played a role in the occurrence of dry eye. Examination of the opposite eye in all the patients in this study did not reveal any significant dryness developing after surgery. Commonly used preservatives like benzalkonium in the local anesthetic eye drops can cause dry eye after phacoemulsification.<sup>[9,11,12,21]</sup> Vigorous irrigation of the tear film and manipulation of the ocular surface during surgery is another factor that may reduce the goblet cell density and result in shortened TBUT postoperatively.<sup>[12]</sup> It was observed in this study that use of light filters, decreased exposure time, appropriate irrigation, and gentle handling of the ocular surface tissue may decrease the postoperative complications. Benzalkonium chloride also can induce tear instability and decrease the number of mucin-expressing cells.<sup>[12,22,23]</sup> Excessive and incorrect use of preserved eye drops is important factors that contribute to the development of dry eye after phacoemulsification and corneal toxicity.<sup>[23]</sup> Minor factors associated with dry eye are elderly age, female gender, and diabetes.<sup>[1,4,12]</sup> However, in the present study dry eye was not associated with those factors, which may have been due to the small sample size in other studies. In some individuals spontaneous appearance of dry eye may also occur hence further studies should be conducted to compare postoperative patients with subjects without operation who serve as control. Pre-operative assessment of the eye for vision as well as presence of dry eye is essential as dry eye may interfere with vision not in mild cases but certainly in moderate and severe cases. Hardten<sup>[24]</sup> suggested using the ocular surface stress test, which takes about 30–60 min to perform and can be done after routine ocular examinations such as the slit-lamp examination and pupil dilatation. If an abnormal ocular surface is detected, the patients are at high risk of developing dry eye postoperatively. Other clinical tests such as the TBUT and fluorescein staining can be used to screen for dry eye. If dry eye is detected preoperatively, artificial tears or topical cyclosporine A can be prescribed postoperatively.<sup>[21]</sup>

## CONCLUSIONS

Dry eye symptoms can develop immediately after phacoemulsification and the severity can peak on day 7. Both symptoms and signs of dry eye can improve over time. However, it is important that ophthalmologists assess dry eye before and after phacoemulsification to ensure proper treatment, quality of vision, and quality of life for their patients.



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