Section A-Research paper

Evaluation Of Dry Eye Disease (DED) After Phacoemulsification: A Retrospective Study

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Abstract

Aim of the work: The aim of this study is to evaluate changes in tear film function to detect dry eye disease (DED) in patients after uncomplicated phacoemulsification surgery for cataract removal.

Patients and Methods: This is a retrospective clinical cohort study. The study included 30 eyes of 30 patients who underwent uncomplicated phacoemulsification surgery for cataract removal. Evaluation of lacrimal tear function was done using tear film break up time (TBUT), tear meniscus height (TMH) and Schirmer I test. All patients were followed up for one week, 1 & 3 months postoperatively with recording of the previously mentioned parameters.

Results: The mean preoperative Schirmer I test, TBUT and TMH values were 12.36±3.1mm, 11.6±2.12 seconds, 336.2 ± 67.5µm, respectively decreased to 10.2±2.05 mm, 8.26±1.95 seconds, 321.8±60.9µm, respectively, at first postoperative week and to 8.61±1.72 mm, 8.49±2.14 seconds, 312.1±59.8µm, respectively, at the first month postoperatively. Then elevated after 3 months postoperatively to 11.1 ± 1.93 mm, 10.05 ± 1.98 seconds, 327.3 ± 63.5 µm, respectively. This decrease was statistically significant in all parameters except TMH.

Conclusion: Dry eye disease is common after phacoemulsification surgery for cataract removal. The tear film changes are mostly temporary and became near to normal values approximately after 3 months.

Keywords: Dry eye disease, Phacoemulsification, Tear meniscus height (TMH), tear film break up time (TBUT), Schirmer I test.

Introduction

Tear Film (TF) is a trilaminar, dynamic fluid that covers the entire ocular surface. It is made up of a mucus, aqueous, and lipid layer that interacts deeply with one another to create a smooth ocular surface for light to pass through. Tear Film is also crucial for the formation of clear images because it serves as the body's first refractive medium and protects against infection **[1].**

The use of phacoemulsification, which involves making a smaller incision and using ultrasonic-driven oscillating tips to emulsify or fragment the crystalline lens, is becoming more and more common in the management of cataracts. This method allows for earlier refractive stabilisation, less astigmatism, and milder postoperative inflammation **[2].**

Despite these benefits, it has been observed that many patients do not feel content despite the good visual outcomes due to changes in the tear film that follow surgery. Patients who are affected may have red or watery eyes and a persistent feeling of a foreign body. The cornea may have lesions such epithelial defects and superficial punctate keratitis **[3].**

The avoidance and minimization of non-sight-threatening adverse events should not be overlooked because they can have a significant impact on patient quality of life (QOL), despite the fact that research, clinical,

and technological advancements tend to concentrate on the prevention of complications that can result in blindness. For instance, cataract surgery's harmful effects on the ocular surface can both directly induce and worsen dry eye disease (DED), as is the case with other eye conditions. This is significant for both the accuracy of pre-operative assessments as well as the symptomatology and consequences of DED, such as an increased risk of infections. For surgical planning and potential post-operative visual performance, precise topography, tonometry, and biometric measures are necessary. They need an undamaged, healthy pre-corneal tear film since it is the first component of the eye that adjusts vision **[4]**.

The aim of this study is to evaluate tear film changes in patients after phacoemulsification cataract surgery.

PATIENTS AND METHODS

This retrospective cohort study was conducted on 30 eyes of adult patients at the El-Fath Eye Hospital in Zagazig, Egypt at a period of 6 months from May 2022 to November 2022. The study had approval from the Institutional Review Board (IRB) and Ethical Committee of Faculty of Medicine, Zagazig University according to the Declaration of Helsinki, and adequate informed consent was obtained from all patients included in the study. The total sample size of 30 eyes of 30 patients with uncomplicated phacoemulsification cataract surgery were included in the study. Both sexes of adult age more than 45 years were included. However, patients with previous ocular pathology, previous ocular surgery including refractive surgery, previous ocular trauma, proptosis, eyelid disorders as facial palsy, trichiasis, ectropion, entropion, blepharitis, contact lens wearer, corneal and conjunctival disorders as keratoconus, dystrophy, ulcers, as well as patients with known dry eye disease or nasolacrimal duct obstruction were excluded.

Evaluation of Dry Eye Disease (DED):

DED was detected before and after phacoemulsification surgery by Schirmer's test 1 ($\leq$5 mm/5 min with topical anesthesia). Tear film break up time (TBUT) as well as tear meniscus height (TMH) were determined by slit lamp (SL) examination and anterior segment optical coherence tomography (AS-OCT).

Schirmer's I test:

Using paper strips inserted into the eye for several minutes to measure the production of tears. This test consists of placing a small strip of filter paper inside the lower eyelid (inferior fornix). The eyes are closed for 5 minutes. The paper is then removed, and the amount of moisture is measured. Results of the Schirmer's test I: Normal, which is $\geq$15 mm wetting of the paper after 5 minutes. 2. Mild DED, which is 14-9 mm wetting of the paper after 5 minutes. 3. Moderate DED, which is 8-4 mm wetting of the paper after 5 minutes. 4. Severe DED, which is <4 mm wetting of the paper after 5 minutes.

TBUT test:

Sodium fluorescein dye was added to eye and the tear film is observed under the slit lamp using a blue filter while the patient avoids blinking until tiny dry spots develop. Generally, >10 seconds is thought to be normal, 5 to 10 seconds, marginal, and < 5 seconds is considered low.

Tear meniscus height (TMH) test:

The measurement of the tear meniscus height (TMH) was performed by using Swept-source anterior segment optical coherence tomography instrument (Triton, Topcon, Japan).

Procedure: The imaging of inferior tear meniscus was done at the lower cornea-lid junction with a 6mm vertical × 2.8mm depth scan using a Fourier-domain OCT (FD-OCT) system (RTVue, Optovue, Inc., Fremont, CA).

An FD-OCT system (DRI-OCT1 Atlantis system, Topcon, Tokyo, Japan) with a Corneal Adaptor Module (CAM) was used which produces telecentric scanning for anterior segment imaging using either a wide-angle or high-magnification adaptor lens which was placed in front of the retinal objective lens of RTVue to focus the OCT beam on the anterior segment. We used the wide-angle lens, which provides a scan of up to 6 μm and a transverse resolution of 15 μm. A set of goose-neck lights were used to illuminate the anterior segment for concurrent video imaging and for fixation of the contralateral eye. All tests were performed in a dim lit room between 21-25^{o}C with regulated humidity to avoid reflex tearing. All patients were instructed not to use any topical eye drops at least 2 hours before testing to negate the effect of medication on tear film. Patients were asked to look straight ahead at the fixating target within the OCT system. Subjects were instructed to blink and OCT measurements were taken immediately after blinking to avoid the effects of

delayed blinking. The OCT pattern used to scan the lower tear meniscus was CL (cross line) with its two lines, horizontal on lower lid margin and vertical on inferior cornea at 6'0 clock hour. One or more images were taken until a good quality scan, showing the concave profile of the tear meniscus from the inferior lid margin to the corneo-conjunctival surface, were captured. All measurements were taken from the inferior tear meniscus because of the fact of less visualization and less retention of upper tear meniscus due to presence of eye lashes.

Follow-Up

All patients underwent evaluation of Schirmer test I values, tear break up time and tear meniscus parameters by using the same location as the preoperative image with the internal registration software 1 week, 1 and 3 months postoperatively.

Statistical Methods

All statistical analyses were done by using SPSS v25 statistical software (SPSS, Inc, Chicago, Illinois). Quantitative variables (mean, standard deviations, frequencies) by using paired 2-tailed Student t-test or the Wilcoxon matched-pairs test. For qualitative variables descriptive statistics (Chi square) was used. Correlation was calculated for all measures by using the non-parametric Spearman test. A p value of ≤ 0.05 was considered significant.

RESULTS

The study constituted 30 eyes of 30 patients who underwent uncomplicated phacoemulsification cataract surgery. They were 12 males (40%) and 18 females (60%) with age ranged between 55 to 77 years and mean of 68.9 ± 7.13 years **(Table 1).**

Assessment of tear film was done before and after surgery. Schirmer's I test, TBUT and TMH were significantly decreased 1 week and 1 month after surgery, then increased at 3 months postoperatively to near preoperative values but still less than the baseline. Comparison between preoperative and each follow-up level (1 week, 1, 3 months) postoperatively were statistically significant ($p < 0.05$), except TMH that showed non-significant difference at 3 months postoperatively **(Table 2).**

Correction coefficient between phaco times and occurrence of dry eye (Schirmer I test) showed non-significant positive correlation ($r = 0.1393$, $p = 0.065$). Also, correction coefficient between microscopic light exposure times and occurrence of dry eye (Schirmer I test) showed non-significant positive correlation ($r = 0.1241$, $p = 0.071$). **As shown in figures (1, 2).**

Table (1): Demographic distribution among the two studied groups

	Range		**Mean ±SD**	
Age (years)	55 – 77		68.9 ± 7.13	
Gender	**Males**		**Females**	
	No.	**%**	**No.**	**%**
Total (N = 30)	12	40.0	18	60.0

SD: standard deviation.

Table (2): Assessment of tear film preoperatively and at the follow-up period.

Test	Mean ±SD		Significance		
Schirmer I score (mm)	**(n = 28)**	**Change**	**P1**	**P2**	**P3**
• Preoperative	12.36 ± 3.10				
• 1 week postoperative	10.23 ± 2.05	2.16	<0.001		
• 1 month postoperative	8.61 ± 1.72	3.61	<0.001	0.024	
• 3 months postoperative	11.1 ± 1.93	1.26	0.038	0.019	0.011
Tear break up time (sec)		**Change**	**P1**	**P2**	**P3**
• Preoperative	11.57 ± 2.12				
• 1 week postoperative	8.26 ± 1.95	3.31	<0.001		
• 1 month postoperative	8.49 ± 2.14	3.08	<0.001	0.167	
• 3 months postoperative	10.05 ± 1.98	1.52	0.012	0.042	0.046
Tear meniscus height (µm)		**Change**	**P1**	**P2**	**P3**
• Preoperative	336.2 ± 67.5				
• 1 week postoperative	321.8 ± 60.9	14.4	0.029		
• 1 month postoperative	312.1 ± 59.8	24.1	0.010	0.048	
• 3 months postoperative	327.3 ± 63.5	8.9	0.069	0.127	0.045

P <0.05: significant, p > 0.05: non-significant. P1: comparison in relation to preoperative value, P2: comparison in relation to 1 week post-operative value, P3: comparison in relation to 1 month postoperative value.

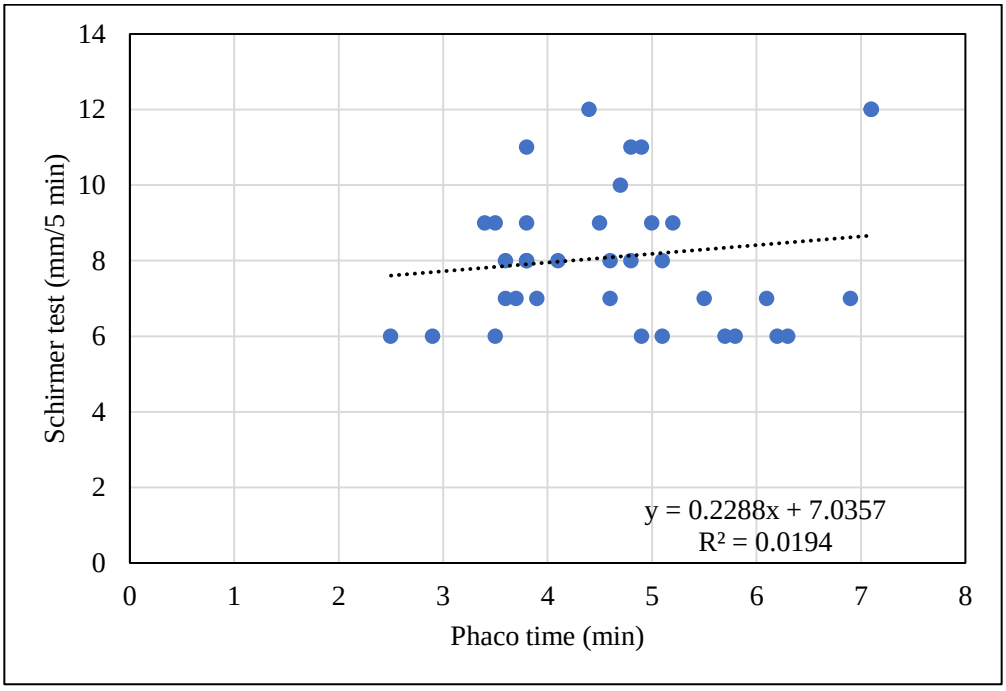

Fig. (1): Correction coefficient between phaco times and occurrence of dry eye (Schirmer test) showed non-significant positive correlation (r = 0.1393, p = 0.065).

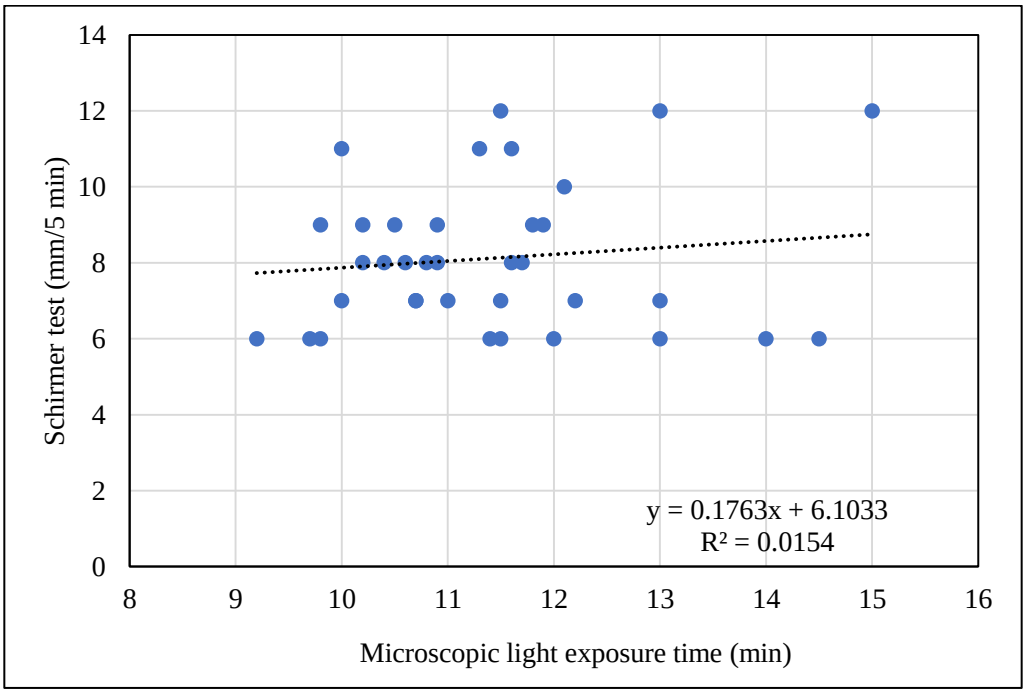

Fig. (2): Correction coefficient between microscopic light exposure times and occurrence of dry eye (Schirmer test) showed non-significant positive correlation (r = 0.1241, p = 0.071).

DISCUSSION

Because of early refractive stabilisation, decreased astigmatism, and lower postoperative inflammation, phacoemulsification is being used more frequently in the management of cataracts **[2].** Both patients and surgeons may frequently and unhappily experience alterations in the tear film following cataract surgery **[6].** Patients who are affected may have red or watery eyes and a persistent feeling of a foreign body. The cornea may have lesions such epithelial defects and superficial punctate keratitis **[3].**

The aim of this study is to evaluate changes in the tear film functions in patients after phacoemulsification by slit lamp (SL) examination and anterior segment OCT (AS-OCT). The study included 30 eyes of 30 adults who underwent uncomplicated phacoemulsification surgery for cataract removal. The mean age of the cases in the study was 68.9 ± 7.13 years. Among the included cases there were 12 males (40%) and 18 females (60%).

The mean preoperative Schirmer's I test values of the studied cases were 12.36 ± 3.1 mm. These values decreased to 10.23 ± 2.05 mm at the first postoperative week, 8.61 ± 1.72 mm at the first postoperative month. Then increased again at 3 postoperative months to 11.1 ± 1.93 mm. There was a statistically significant reduction of the score at 1 week, 1 month and 3 months postoperatively as compared to the preoperative value, but the final score (after 3 months) showed elevation (11.1 mm), but still lower than the pre-operative value.

This was in line with the findings of **Shrivastava et al. [7],** who examined cataract patients who underwent phacoemulsification. Schirmer's I test results were significantly different preoperatively from day 7 and day 21 postoperatively ($P \leq 0.05$). However, there was no discernible difference between the results at 90 days postoperatively and the preoperative levels ($P>0.05$). In the same context, **Liu et al. [8]** discovered that patients' Schirmer's I test scores significantly decreased on the first postoperative day following phacoemulsification. Schirmer's I test returned to normal in their research on the seventh postoperative day, and the tear film stabilised on the thirty-first postoperative day. According to **Xi et al. [9],** postoperative Schirmer's test levels were statistically significantly lower than preoperative values. After 180 days, readings were gradually brought back to their preoperative levels before being restored to normal. In this study, the mean **TBUT** of our patients before surgery was 11.57 ± 2.12 seconds (s). The score decreased to

8.26 ± 1.95 s after 1 week from the surgery, 8.49 ± 2.14 s after 1 month from surgery. The score increased again after 3 months postoperatively to 10.05 ± 1.98s. There was a statistically significant reduction of the score at 1 week, 1 month and 3 months after the surgery as compared with the preoperative value, but the score showed elevation after 3 months but did not reach the preoperative values.

This was in line with the findings of **Oh et al. [10],** who discovered that patients who had undergone phacoemulsification surgery showed a substantial reduction in TBUT in the early postoperative period. Additionally, the scientists observed that TBUT readings improved at 1 and 3 months postoperatively even though they remained below the baseline. In accordance with the current results, **Ishrat et al. [11]** reported that there was a significant reduction in the TBUT values in the early postoperative period at one week as compared to preoperative findings (8.7 ± 0.48 sec vs. 15.8 ± 0.31 seconds $p < 0.001$). The significant difference was also noticeable at 1 month follow-up (11.2 ± 0.39 seconds versus (vs.) 15.8 ± 0.31 seconds, $p < 0.001$). However, this difference became non- significant at 3 months as further improvement in TBUT occurred – 4.3 ± 0.37 sec vs. 15.8 ± 0.31 sec $p = 0.089$.

According to **Cho and Kim [12],** after cataract surgery, the severity of dry eye symptoms and the results of diagnostic tests increased in comparison to preoperative data. They reached the same conclusion as the current study, which is that the immediate postoperative period following cataract surgery has an impact on both TBUT and the barrier function of the corneal epithelium.

In this study, the mean preoperative TMH values of the studied eyes that were measured by AS-OCT were 336.2 ± 67.5 μm. These values decreased to 321.8 ± 60.9μm 1 week postoperative, 312.1 ± 59.8μm 1 month postoperative. Then increased again 3 months postoperatively to 327.3 ± 63.5 μm. There was a statistically significant reduction of the score at 1 week and 1 month postoperatively as compared with the preoperative value, but after 3 months, it was elevated but did not reach significance compared to preoperative value ($p > 0.05$).

This came in accordance with **Sahu et al. [13]** who showed a decreasing trend in TMH values up to 1-month post-surgery and then acquired a rising trend. **Cho and Kim [12]** included TMH in their study which was conducted on patients after phacoemulsification and noticed a decline in test values, on a follow-up of 3 months.

In the current study, the different scores for assessment of dry eye showed transient reduction up to 1 month postoperatively and started to show elevation again at 3 months after the surgery.

This was in consistent with the known principal that the symptoms of dry eye may be temporary and return to normal state after variable duration following the cataract surgery. However, this period of affection is associated with impairment of the quality of life of the patients and affection of his satisfaction **[10]**.

Microscopic ocular surface damage during cataract surgery appears to be one of the pathogenic factors that cause ocular discomfort and DED after cataract surgery, according to **Oh et al.'s [10]** reported that the decrease in goblet cell density, which was correlated with operation time, had not recovered at 3 months after cataract surgery.

Other potential causes of dryness following cataract surgery include exposure to microscopic light, vigorous intraoperative irrigation of the tear film, inflammatory components in the tear film as a result of irritation of the ocular surface, manipulation of the ocular surface, and use of topical eye drops with preservatives **[14].**

In most cases the tear film changes occur after the surgery don't reach the cut-off point to be diagnosed as dry eye; however, the patients expressed the same symptoms.

Conclusion

In conclusion, based on the results of our study, it could be included that the tear film changes may occur frequently after phacoemulsification, however, they are mostly temporary and tend to return to normal levels within 3 months

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Availability of data and materials: The data-sets generated and analyzed during the current study are not available due to the protection of data security (the original data contains a lot of specifically demographic characteristics information and will be used again in the future follow-up study) but are available from the corresponding author on reasonable request.

Declarations, Ethics approval and consent to participate: This study was approved by the research ethical committee and the Institutional Review Board (IRB) of the Faculty of Medicine, Zagazig University, Zagazig, Egypt and met the ethical code of the World Medical Association for human experimentation, as stated in the Helsinki Declaration. Written informed consent was obtained from all study participants.

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