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The Incidence of Dry Eye Disease after Uncomplicated Phacoemulsification Surgery

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Abstract:

Background: Dry eye is described as a multifactorial disorder of the tear film that occurs due to excessive tear evaporation or tears insufficiency, and so leads to ocular discomfort sensation and ocular tissue damage with time. **Objectives:** The aim of this study was to assess the incidence of dry eye disease after uncomplicated phacoemulsification surgery at patients with no pre-existed dry eye. **Patients and Methods:** This hospital-based cross-sectional study was conducted to assess the incidence of dry eye at 50 eyes of 50 patients who underwent uncomplicated phacoemulsification surgery, with age more than 40 years old. It is measured by dry eye tests ST1, TBUT, and OSDI questionnaire. **Results:** This study showed that 22% of the patients who underwent uncomplicated phacoemulsification surgery suffered from dry eye with significant results at 1st week post-operative that improved over time. Also, it showed a significant association between microscopic light exposure time (during surgery) and increasing the incidence of dry eye postoperatively. **Conclusion:** There was a statistically significant drop in the results of the schirmer test1 and TBUT post phacoemulsification surgery, but with no clinical significance, as they still at the normal range. The tear film assessment results at 22% of the patients, at the 1st week post-operative, were out of the normal range at TBUT, OSDI tests and were borderline at ST1. These results improved over time to return to the normal values within 12 week postoperatively.

Keywords: Dry Eye Disease; Uncomplicated Phacoemulsification Surgery; Cataract Surgery

1. Introduction:

Dry eye is a disorder of the tear film, that occurs due to excessive tear evaporation or tears insufficiency, and so leads to ocular surface damage. It is accompanied by ocular discomfort, itching, burning, lacrimation, blurring of vision and foreign body sensation [1]**.** Dry eye is a multifactorial disease that has a high prevalence over the past few years due to overusing contact lens, computers and a greater number of laser surgeries. It is also associated with systemic diseases as 'diabetes mellitus, autoimmune diseases, and

hypertension..', ocular diseases and eyelid abnormalities, some drugs such as topical eye drops that contain preservatives, antihistaminic drugs, anticholinergic drugs, contraceptive pills [2-3]**.** Dry eye is one of the most essential factors that influence the quality of life. It interferes with everyday life activities, impacts on visual function especially, reading, driving, and using a computer. Sometimes it is associated with mood changes and a decrease in workplace productivity [4-5]**.**

The tear film is a thin fluid layer, which overlies the ocular surface and provides the interface between the ocular surface and the external environment. It consists of three layers (lipid, aqueous and mucous) which act together to protect the corneal and conjunctival tissues and keeping them healthy. The superficial lipid layer is secreted by meibomian glands and contains different species of lipids that have an important role to decrease tear film evaporation and maintain its stability. The Mucous layer is secreted by the goblet cells of the conjunctiva. It contains mucins that is very essential for lubrication, and wetting. The aqueous layer is secreted by lacrimal glands. It contains different components with various functions as: providing oxygen and nutrients to the avascular corneal tissue, washing away tissue debris, toxins, and foreign bodies, Also protecting the ocular surface from microbes [6-7]**.**

Phacoemulsification is the most recent cataract surgery at which a small incision is done then the ultrasonic power is used to fragment and emulsify the cataract [8]**.** It was first introduced by Dr. Charlies Kelman for cataract extraction. He used small incision to reduce the convalescent period, So patients could resume the daily activities soon after surgery [9]**.** Most surgeons prefer phacoemulsification surgery because of less postoperative astigmatism, faster stabilization of vision and refraction, and less postoperative inflammation [10-11]**.**

Cataract is the common cause of vision loss in the developing countries, also its rate of incidence increases with aging. So it is essential for those patients to undergo cataract surgeries to improve their vision and protect them from blindness [12]. Despite the importance of cataract surgeries for vision improvement, many patients still unsatisfied due to developing postoperative dry eye symptoms. This disorder occurs after extra-capsular cataract extraction surgery, due to its large incision which decreases corneal sensitivity and sometimes damages the cornea. Few reports discussed the incidence of dry eye after uncomplicated phaco-emulsifications in patients with no preexisting dry eye disease, so it will be discussed in our study [8]**.**

There are many tests that are used to estimate the dryness and its severity. These tests measure tears stability, tears production and presence of ocular surface disorder. In our study, we will use two of them (Schirmer’s test 1, Tears Break Up Time).

Schirmer's test:

This test is used to evaluate tears production and the severity of dry eye by estimating the amount of special filter paper wetting that is put in the lower fornix for 5 minutes. There are 2 types of Schirmer's test, Schirmer test 1 Schirmer test 2. It is considered abnormal if the amount of paper wetting is less than 10mm at type 1 or 6mm at type 2 [6].

Tears Break Up Time:

This test is important to evaluate the tear film stability and evaporation, by using fluorescein strip for staining the tears and ocular surface then we examine the tear film stability under slit lamp by broad beam cobalt blue filter for detection the appearance of first dry spots. The interval between the last blinking and dry spot appearance (BUT) of less than 10 seconds is suspicious [6,13].

2. Aim Of The Work:

The aim of our study is to evaluate the incidence of dry eye disease after uncomplicated phacoemulsification surgery in patients with no pre-existing dry eye.

3. Patients And Methods:

- **Type of the study:** this study is a prospective study.
- **Site of the study:** this study was conducted at International Eye Hospital in Luxor.
- **Date and period of the study:** this study was conducted between May 2019 through October 2019.
- **Study Objects :** this study included 50 cataract patients, with age above 40 years old who underwent uncomplicated phacoemulsification surgery.
- **Inclusion criteria:**
  - Cataract patients.
  - Cases within age > 40 years old.
- **Exclusion criteria:**

-Patients with pre-existing dry eye.

-Patients with ocular surface diseases and eyelid abnormality.

-Patients receive ocular or systemic medications, that interfere with tear film production and stability (e.g. topical eye drops that contain preservatives, antihistaminic drugs, anticholinergic drugs, contraceptive pills).

-Patients with systemic diseases like diabetes, HTN, rheumatoid arthritis.

- Patients underwent previous ocular surgeries that interfere with tears instability or production (e.g. refractive surgery, keratoplasty, eyelid surgeries, pterygium excision).

- Patients with a history of trauma, chemical burn, overusing contact lens (due to damaging the conjunctiva and the goblet cells, also corneal sensitivity reduction).

- **Methods:**

All patients were subjected for routine preoperative ophthalmological examination:

- Assessment of vision by snellen chart.
- Refraction.
- Measuring IOP.
- Slit lamp examination.
- Fundus examination by 90D lens.

- Tear film function was assessed at all cases preoperatively and at 1st week, 4th week and 12th week after the surgery , by Schirmer test-1 (ST-I), tear film break-up time (TBUT) and the dry eye symptoms by Ocular Surface Disease Index (OSDI) score.

❖ **Schirmer Test-1:** performed without using topical anesthesia, to assess the basic and reflex tear production. The filter paper was folded 5 mm from one end and inserted at the junction of the middle and outer third of the lower eyelid of the patient's eyes that had phacoemulsification, we took care not to touch the cornea or lashes. We asked patients to close their eyes gently and after 5 minutes we removed the filter paper and assessed how far the tears have traveled on the paper. It is considered abnormal when the level of wetting is less than 10mm. Depending upon the amount of wetting, severity of dry eye is assessed (**Fig.1)**.

Fig.1: Schirmer test I at right eye of female patient that showed value of less than 15mm at 1st week postoperative.

❖ **Tears break up time:** To measure it, fluorescein is instilled into the patient's tear film by using a fluorescein strip that is moistened with saline and applied to the inferior fornix. After several blinks, the patient is asked not to blink while the tear film is observed under a broad beam of cobalt blue illumination. The TBUT is measured as the number of seconds that elapse between the last blink and the appearance of the first dry spot in the tear film. TBUT is considered abnormal when it is under 10 seconds. Depending upon a time it was categorized as follows: (Normal >10 Seconds, Mild to moderate is 5 seconds – ≤10 seconds, Sever is < 5 seconds). The time interval between ST-1 and TBUT was at least 10 min **(Fig2)**.

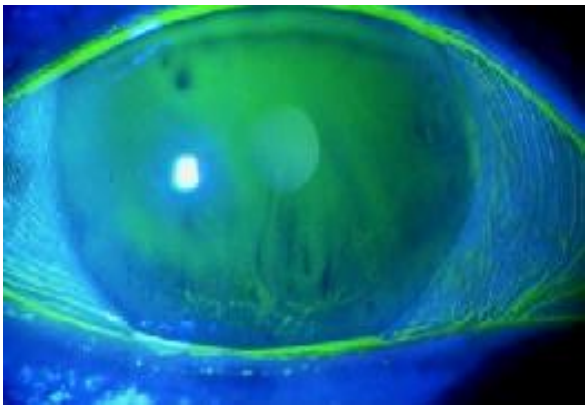

Fig.2: TBUT of right eye of male patient, that showed normal result more than 10 sec preoperative and abnormal result less than 10sec only at 1st week postoperative.

❖ **Ocular surface disease index(OSDI) questionnaire:**

- It's a questionnaire that includes 12 questions related to symptoms, environmental conditions which can cause dry eye & functional limitations. The score of OSDI is based upon the response to these questions, as each question has 5 type

response options, with score gradings from 0 (none of the time) to 4 (all of the time).

- The score of OSDI is calculated by this formula: **(Total points of all answered questions x 25/Total number of answered questions .**
- Higher scores represent more disability. Scores are matched with the graph with different color coding to detect the dryness and its severity **(Fig.3)**.
- The index demonstrates sensitivity and specificity in distinguishing between dry eye patients and normal subjects and is a valid and reliable instrument for measuring the severity of dry eye disease.

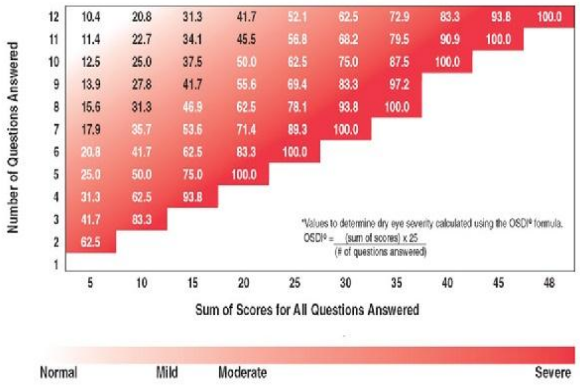

Fig. 3: Graph with different color coding to detect the dryness and its severity by matching OSDI scores with it.

❖ **Phacoemulsification surgery** with foldable PCIOL was done with a 2.4mm clear corneal incision. The patients who underwent uncomplicated surgery were only included in the study. The total duration of microscope light exposure during surgery was noted. Moxifloxacin (0.5%) eye drop four times a day was started one day prior to the surgery. Postoperatively moxifloxacin eye drop was continued along with prednisolone acetate (1%) eye drop six times a day for one week and then tapered every week over a month.

- **Data collection methods and entry:**

Data were collected, coded and entered into an Excel sheet.

- **Data analysis:**

Statistical analysis was done compatibly with a computer using software SPSSversion 20 for windows. Frequencies, descriptive statistics, correlation, X2 test, t-test, and regression analysis were done. The probability of less than 0.05 was used as a cut off point for all significant tests.

4. Results:

Table (1): Demographic data of the studied population; (N= 50):

	Descriptive Statistics
Age (years) ; N (%)	
<55	15 (30.00)
55-70	22 (44.00)
>70	13 (26.00)
Total	50 (100.00)
Mean ±SD	63.02 ±10.3
Range (Maximum – Minimum)	(80 – 45)
Gender; N (%)	
Female	23 (46.00)
Male	27 (54.00)

This present study was conducted on 50 eyes of 50 patients distributed as (27) males and (23) females, their ages were ranged from (45) to (80) with an average age of (63.02 ±10.3) years old. It is illustrated in **Table (1) .**

Microscopic Light Exposure Time was ranged from (8.25) to (17.25) minutes with an average time of (11.24 ±2.1) minutes. It is illustrated in **Table (2) .**

Table (2): Microscopic Light Exposure Time among studied population; (N= 50):

	Minimum	Maximum	Mean ±SD
Microscopic Light Exposure Time	8.25	17.25	11.24 ±2.1

Table (3): Pre-operative assessment of eye dryness:

	Test	**Minimum**	**Maximum**	**Mean ±SD**
1-	**Schirmer test I**	17.00	26.00	19.86 ±1.9
2-	**Tear film break-up time**	11.00	18.00	13.90 ±1.6
3-	**Ocular surface disease index questionnaire**	2.70	11.10	5.27 ±2.4

Dry eye was assessed Preoperatively by different tests and all of them show normal values as illustrated in **table (3)**. The mean of Schirmer test I was 19.86 with a standard deviation (SD) of ±1.9. The mean of Tear Film Break up Time scores was 13.90 with a standard deviation (SD) of ±1.6. The mean of Ocular Surface Disease Index scores was 5.27 with a standard deviation (SD) of ±2.4.

Table (4): Patients' Sequential Changes in dry Eye tests over time; (N= 50):

Test	Mean ±SD				*Overall P-value*
	Pre-operative	**1 week post-operative**	**4 weeks post-operative**	**12 weeks post-operative**	
Schirmer I test	19.86 ±1.9	15.44 ±3.4	17.30 ±2.5	18.54 ±1.9	<0.001
TBUT	13.90 ±1.6	10.84 ±2.4	12.04 ±1.5	12.78 ±1.5	<0.001
OSDI	5.27 ±2.4	12.21 ±5.3	9.15 ±3.0	7.53 ±2.3	<0.001

The mean value of ocular surface disease index questionnaire result on 1st week post-operative was 12.21 with a statistically significant difference from pre-operative assessment which was 5.27 (p-value= 0.001). On 4th week post-operative, the mean value was 9.15. On 12th week post-operative, the mean value was 7.53. Both 4th week, 12th week results have a statistically significant difference from pre-operative one, it is illustrated in **tables (4,5)**.

Table (5): Comparison of P-Values for Patients' Sequential Changes in dry Eye tests over time; (N= 50):

	Pre-operative	1 week	4 weeks	12 weeks
Schirmer test I				
Pre-operative				
1 week	0.001			
4 weeks	0.001	0.001		
12 weeks	0.010	0.001	0.016	
Tear film break-up time				
Pre-operative				
1 week	0.001			
4 weeks	0.001	0.001		
12 weeks	0.002	0.001	0.042	
Ocular surface disease index questionnaire				
Pre-operative				
1 week	0.001			
4 weeks	0.001	0.001		
12 weeks	0.001	0.001	0.022	

Table (6): Frequency of post-operative dry eye :

		Frequency	**Percent**
	Normal	39	78.0
	Dry Eye	11	22.0
	Total	50	100.0

Among the studied (50) eyes of 50 patients ; only (11) of them experienced mild to moderate post-operative dry eye at the 1st week, according to the results of the dry eye tests that were discussed previously. It is illustrated in **table (6)**.

Table (7): Association between gender and eye dryness:

		Gender		Total	p-value
		Female N= 23	Male N= 27		
Postoperative Eye Dryness	Normal	17 (73.9%)	22 (81.5%)	39 (78.0%)	0.780
	Dry Eye	6 (26.1%)	5 (18.5%)	11 (22.0%)	

Gender is considered an important factor that influences on the incidence of dry eye. In our study there was a statistically non-significant association between postoperative dry eye and patients' gender; (p-value >0.05). It is illustrated in **Table (7)**.

Table (8): Association of Age and postoperative Dry eye

Patients' Age		Normal eye	Dry eye	Total	Chi-square	P-value
<55	Count	14	1	15	6.66	0.036*
	%	35.9%	9.1%	30.0%		
55-70	Count	18	4	22		
	%	46.2%	36.4%	44.0%		
>70	Count	7	6	13		
	%	17.9%	54.5%	26.0%		
Total	Count	39	11	50		
	%	100.0%	100.0%	100.0%		

P-value< 0.05 is significant

Also, We found a statistically significant association between postoperative dry eye incidence and patients' age (p-value=0.036), as the incidence of dry eye increases with old age , it is illustrated in **table (8)**.

Table (9): Correlation between dry eye assessment and patients' age:

Test	Patients' Age	
	r	p-value
Schirmer I test	-0.452	0.001*
Tear film break-up time	-0.392	0.005*
ocular surface disease index questionnaire	0.413	0.003*

The Correlation between the patients' age and the dry eye assessment one week post-operative showed that; the Schirmer test I scores was moderately negative correlated with patients' age (r= -0.452, p-value= 0.001). The Tear film break-up time scores were slightly negative correlated with patients' age (r= -0.392, p-value= 0.005). The ocular surface disease index questionnaire scores were moderately positive correlated with patients' age (r= 0.413, p-value= 0.003). Results are shown in **Table (9).**

Table (10): Correlation between Microscopic Light Exposure Time and dry eye assessment one week post-operative

Test	Microscopic Light Exposure Time	
	r	p-value
Schirmer test I	-0.459	0.001*
Tear film break-up time	-0.679	0.001*
Ocular surface disease index questionnaire	0.843	0.001*

We studied the correlation between Microscopic Light Exposure Time and the dry eye assessment one week post-operative, and found that; the Schirmer test I scores was moderately negative correlated with Microscopic Light Exposure Time (r= -0.459, p-value= 0.001). The Tear film break-up time scores were moderately negative correlated with Microscopic Light Exposure Time (r= -0.679, p-value= 0.001). The ocular surface disease index questionnaire scores were strongly positive correlated with Microscopic Light Exposure Time (r= 0.843, p-value= 0.001). Results are shown in **Table (10).**

5. Discussion:

Dry eye can develop often after various types of ophthalmic surgeries such as photorefractive keratectomy and laser-assisted in situ keratomileuses (LASIK). After LASIK, dry eye can persist for up to 6 months or more with an incidence of 20% [2]**.**

Also, Cataract surgery has widely been seen to adversely affect the tear film status in the early postoperative period, hence leading to the development of the dry eye in various studies [8, 14]. Our study shows the incidence of dry eye after uncomplicated phacoemulsification at 22% of patients at 1st week postoperatively. We found in our study that the age had a significant association with the incidence of dry eyes post phacoemulsification. Also, In another study the post phacoemulsification cataract surgery results showed an association of dry eye with higher age (>65 yrs) [15]**.**

We did not find any significant difference in the occurrence of dry eyes post phacoemulsification between the two genders.This contrasts with other studies that have reported a higher prevalence of the dry

eye in females than in males in the general population [16-17].

But in another study the post phacoemulsification surgery results showed non-significant association of dry eye with Gender [18]**.** The values of St1, TBUT test and OSDI questionnaire in our study at the 1st week postoperatively showed a significant deterioration from preoperative normal values, indicating the incidence of eye dryness which was at its peak then improved with time . So that the values of the tests were normal at 12th week postoperatively with a little difference from the perioperative values. This pattern of postoperative dry eye in our study was consistent with the results of **Kasetsuwan et al.**, who noticed the incidence of signs and symptoms of dry eye on the 7th day after surgery with rapid improvement over time.

Various factors might affect the ocular surface environment and the dry eye incidence after cataract surgery. The Most important one is corneal desensitization that resulted from the incision[8]**.** The recovery process of the corneal nerves is a possible explanation for the dry eye pattern observed in the current study. It is known that the cornea is one of the most highly innervated organs, with more than 44 corneal nerve bundles entering the cornea around the limbus centripetally [19]**,** 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 [20].

Therefore, it is vulnerable to any damage within that region. The corneal incision that is created during phacoemulsification, even it was small, can reduce the corneal sensitivity in the surgical area and other areas far from the incision site. The damage to the corneal nerves may expand when longer phacoemulsification time is needed to break up a dense cataract [21]. Neurogenic inflammation also can develop after corneal incisions. Inflammatory mediators can change the action of the corneal nerves and reduce corneal sensitivity [22].

According to what was mentioned at **The 2007 report of the international dry eye work shop (DEWS)**, any disruption of the normal corneal innervation or lacrimal functional unit feedback can reduce the tear flow and blink rate and so cause instability, hyperosmolarity of tear film and dryness. During the postoperative corneal healing, new neurite cells emerge and after about 4 weeks, the neural growth factor is released to regenerate the sub epithelial corneal axon [22]**.** Thus, the recovery of the corneal nerves, that enhancing the feedback neural loop of the cornea and lacrimal gland, may explain why dry eye was seen early after surgery and improved thereafter as was observed in various tests ,specially ST1, which showed a trend towards improvement in all test scores over 12 weeks.

Another possible Explanation of the incidence of the dry eye early postoperatively and its pattern is the usage of topical anesthesia intra-operatively and topical eye drops administered

postoperatively and its preservatives that influence on tear film stability [23].

Benzalkonium chloride, one of the most commonly used preservatives in topical eye drops can induce tear film instability and decrease the number of mucin-expressing cells [24], that leading to incidence and aggravation of dry eye symptoms. So that stopping the usage of the preservative eye drops or using a preservative-free topical eye drops can decrease the dry eye symptoms as reported at other studies [25, 26].

Thus the scores of dry eye tests in the current study showed significant results that indicate the incidence of eye dryness early post phacoemulsification, then gradually improved to normal level after the 4^{th} week postoperatively which could be due to the discontinuation of topical medications at around this time.

During our study, we noticed that there was a significant correlation between the Microscopic light exposure time and the scores of dry eye tests at the 1st week postoperatively ,as with increasing microscopic light exposure time there was increasing in the incidence and severity of dry eye. There are studies that have reported a significant correlation between microscopic light exposure time and dry eye tests' values postoperatively, as well in our study [27, 28].

The possible explanation of this correlation is that, the microscopic light influences on tear film stability by reducing the goblet cell density. It was observed that the longer the microscopic light exposure time, the more the goblet cell density reduction, and the more the development of dry eye [29]. Other studies have also reported microscope light exposure as a contributory factor for dry eye after cataract surgery [30-31].

As this study was conducted in southern Egypt, increased sunlight exposure and high ambient temperature may increase the frequency of dry eye symptoms and so, It may explain the the relatively high scores of the OSDI test in our study. It was reported that low ambient temperature and high relative humidity are associated with more tear film stability than low relative humidity and high temperature [32], which applies to the geographical area where the study was conducted. This could be a contributory factor for the relatively high incidence of dry eye post phacoemulsification in our study, with a percentage of 22% ,and the aggravation of dry eye symptoms. The next studies may need to be done on a large sample size with certain age group and avoiding the geographic and drugs factors to get the most accurate results of the effect of the phacoemulsification on the incidence of the dry eye.

6. Conclusion:

There was a statistically significant drop in the results of the schirmer test1 and TBUT post phacoemulsification surgery, but with no clinical significance, as they still at the normal range.

The tear film assessment results at 22% of the patients, at the 1st week post-operative, were

out of the normal range at TBUT, OSDI tests and were borderline at ST1. These results improved over time to return to the normal values within 12 week postoperatively. So, before surgery, we must inform the patient about the possibility of early developing temporary symptoms of discomfort, dryness, and if indicated, artificial tears may be prescribed in the postoperative period.

There was a significant correlation between the microscopic light exposure time and the tear film assessment tests values at the 1st week post-operative, so that, the intra-operative exposure to the microscope light should be reduced by appropriate use of filters and shortening the exposure time.

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