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Ocular Surface Changes after Phacoemulsification

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ABSTRACT

Background: Dry eye is a risk factor for cataract surgery with phacoemulsification.

Objective: To evaluate the ocular surface changes after phacoemulsification surgery.

Patients and Methods: This was a prospective study that included 50 patients; conducted at the Department of Ophthalmology, Menoufia University Hospital, and Tiba Ophthalmic Center during the study period from June 2023 to February 2024.

Results: There was a significant difference between pre-and postoperative regarding Ocular Surface Disease Index (OSDI) and Tear Breakup Time (TBUT) (P<0.001), and there was no significant difference between pre-and postoperative regarding the Schirmer test (P=0.065). Also, the mean change of OSDI, Schirmer test, and TBUT was (-6.52±1.89, 1.10±2.15, and 3.12±2.51), respectively, with significant differences among pre- and postoperative (P<0.05). Additionally, there was no significant relation between age categories and preoperative levels of OSDI, Schirmer test, and TBUT (P>0.05). Moreover, there was no significant relation between age categories and postoperative levels of OSDI, Schirmer test, and TBUT (P>0.05). There was no significant relation between age categories and median values of preoperative scores of OSDI, Schirmer test, and TBUT and postoperative scores of OSDI, Schirmer test, and TBUT (P>0.05).

Conclusion: Phacoemulsification cataract surgery relates to the risk of dry eye. There was a significant change in the ocular surface postoperatively compared to preoperative status in patients who underwent phacoemulsification. Also, a statistical difference between pre-and postoperative regarding TBUT and OSDI was proven.

Keywords: Phacoemulsification, Ocular surface, OSDI, TBUT.

INTRODUCTION

Approximately 17–25% of outpatient visits in ophthalmology clinics are related to dry eye, making it one of the most frequently reported symptoms. Between 6% and 34% of people have dry eye disease (DED) [1].

Ocular surface dryness brought on by insufficient tears and excessive evaporation is the hallmark of the multifactorial condition known as dry eye syndrome [2]. Age, gender, connective tissue diseases, DM, systemic hypertension, contact lens wearers, medications such as antihistamines, anticholinergics, antidepressants, oral contraceptives, and topical eye drops with preservatives, as well as ocular conditions like blepharitis, chronic conjunctivitis, meibomitis, and pterygium, are among the numerous causes and factors that contribute to dry eye [3].

Dryness, irritation, burning, feeling of a foreign body, heaviness of the eyelids, redness, reflex lacrimation, ocular discomfort, and weariness are some of the symptoms of dry eye syndrome. Reduced visual acuity, filamentary keratopathy, superior limbic keratoconjunctivitis, punctate keratitis, and persistent epithelial defect are possible side effects [4].

Certain anterior segment surgical procedures, like PRK, LASIK, and cataract surgery, can exacerbate the symptoms of pre-existing dry eye and produce new cases of the condition [5]. One of the major things influencing the quality of life is dry eyes. It affects visual function and interferes with daily tasks, including computer use, driving, and reading [6].

These days, the most common method for doing cataract surgery is the contemporary phacoemulsification procedure. In individuals with cataracts arising from any source, it aids in vision restoration [7]. A recent technique for cataract surgery called phacoemulsification involves using an ultrasonic handpiece to emulsify the interior lens of the eye and then aspirating it out. To keep the anterior chamber intact, aspirated fluids are restored with irrigation of a balanced salt solution [8].

The question of whether cataract surgery increases the chance of developing DED is still up for debate, even though there are several possible intraoperative and postoperative risk factors [1]. According to some research, patients experience prolonged dissatisfaction and disturbance following surgery [9], while other studies believe that DED following cataract surgery is a temporary impairment of the ocular surface that resolves in 1-3 months [10].

According to other research, better ocular surface results from cataract surgery, and these outcomes are associated with postoperative eye drop usage, less rubbing of the eyes, and sufficient blinking [9]. In addition to being a significant contributing factor to the development of DED, meibomian gland dysfunction (MGD) causes dry eye and postoperative ocular pain [1]. Thus, our study aimed to evaluate the ocular surface change after phacoemulsification surgery.

PATIENTS AND METHODS

This was a prospective study that included 50 patients conducted at the Department of

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Ophthalmology, Menoufia University Hospital, and Tiba Ophthalmic Center during the study period from June 2023 to February 2024.

Criteria of patient selection:

All cases scheduled for cataract extraction (phacoemulsification) were followed six weeks after the surgery. However, we excluded any patients with pre-existing dry eyes, patients suffering from eye surface diseases and abnormalities in their eyelids; patients receiving systemic or ocular medications that disrupt the production and stability of tears (e.g., preservative-containing topical eye drops, antihistaminic drugs, anticholinergic drugs, contraceptive pills); patients suffering from ocular hypertension; patients with rheumatoid arthritis; patients who have had prior ocular surgeries that disrupt the production or instability of tears (e.g., refractive surgery, keratoplasty, eyelid surgeries, pterygium excision), and patients with a history of trauma, chemical burns, and excessive contact lens use (resulting in damage to the conjunctiva and goblet cells and decreased sensitivity of the cornea).

All patients were subjected to the following:

Preoperative data that included complete ophthalmic evaluation, full history taking including (Personal history as age, sex, occupation, history of systemic and ocular diseases as SLE, rheumatoid arthritis, Sjogren, and other collagen or thyroid diseases and history of taking medications that can cause dry eyes, such as antihistamines and antidepressants, having refractive surgery, and undergoing radiation therapy, such as that used to treat cancer), symptoms as burning, itching, blurred vision, foreign body sensation, photophobia, headache, eye strain, or tired eye, complete ophthalmic examination for those who produced positive data questionnaire (uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA)**,** examine the eyelid, blink rate, lid closure, and lagophthalmos and slit lamp examination of eyelids for blepharitis. Ectropion, entropion, trichiasis, and lacrimal punctual patency and position.

Tear film function was evaluated using the Schirmer tests, TBUT, OSDI score, and ocular symptoms.

Ocular surface disease index: The OSDI score is based on the response to a questionnaire with 12 items[11]. The score ranges from 0 to 12, indicating normal, and the score ranges from 13 to 22, indicating mild DED, the score ranges from 23 to 33, indicating moderate DED and the score ranges from more than 33, indicating severe DED.

Schirmer 1, 2 tests: A unique filter paper (no. 41 Whatman) measuring 5 mm broad by 35 mm long is needed to perform a Schirmer's test. The test can be done with or without anesthesia (Schirmer 2). In theory, Schirmer 1 examines baseline secretion, while Schirmer 2 (without anesthesia) measures baseline plus reflex secretion. A wet-area length of less than 10 to 15 mm on the Schirmer strip without anesthesia suggests dry eyes. Schirmer, test I results are interpreted as 0 to 5 mm (extremely dry eyes), 5 to 10 mm (moderately dry eyes), 10 to 15 mm (possible dry eyes), and longer than 15 mm (normal tear function) [12].

Tear break-up time (TBUT), to assess tear film's stability. It is a standard diagnostic procedure in dry eye clinics [13].

Invasive break-up time tests (IBUT): The IBUT has been routinely utilized for dry eye diagnosis and is a standard in several international diagnostic standards. IBUT is interpreted as follows: generally, >10 seconds is considered normal, 5-10 seconds is minor, whereas <5 seconds is considered low. A short TBUT indicates a weak tear film; the longer it takes, the more stable the tear film.

Non-invasive breakup time tests (NIBUT): NIBUT measurements were conducted by CSO Sirius@ Pentacam device designed by C.S.O Italia, Florence.

Operative data

All patients underwent uneventful phacoemulsification with the same surgeon using Alcon Centurion which is manufactured by Alcon.

Postoperative treatment: all previous examinations and measurements were investigated again after six weeks of the surgery. All patients had the same protocol of treatment which consisted of moxiflox 0.3% 4 times daily for one week after the surgery, prednisolone acetate 1% eye drops for 5 weeks after the surgery, 5 times daily in the 1st, week, times daily in 2nd, 3rd, 4th week, and once daily in 5th week. Also, no use of lubricants until 6 weeks at the time of post-operative follow-up.

Ethics approval:

Menoufia University Faculty of Medicine's local Ethics Committee gave the project approval. Every patient provided written informed permission, and the study was conducted in agreement with the guidelines outlined in the Declaration of Helsinki.

Statistical analysis

Microsoft Excel 2019 and SPSS v. 25.0 were used to tabulate and statistically analyze the data on a personal computer. Quantitative data were presented as mean ± standard deviation (SD), range, median, and interquartile range (IQR) and were compared by student's t-test, and Mann-Whitney test (U). Qualitative data were presented as frequency and percentage and were compared by X^2-test. P-values < 0.05 showed statistical significance.

RESULTS

A flowchart of the study population is shown in Figure 1. Of the 71 patients evaluated, the ocular surface changed after phacoemulsification surgery at Menoufia University Hospital, 21 patients were excluded from the study and 50 were willing to participate **(Figure 1).**

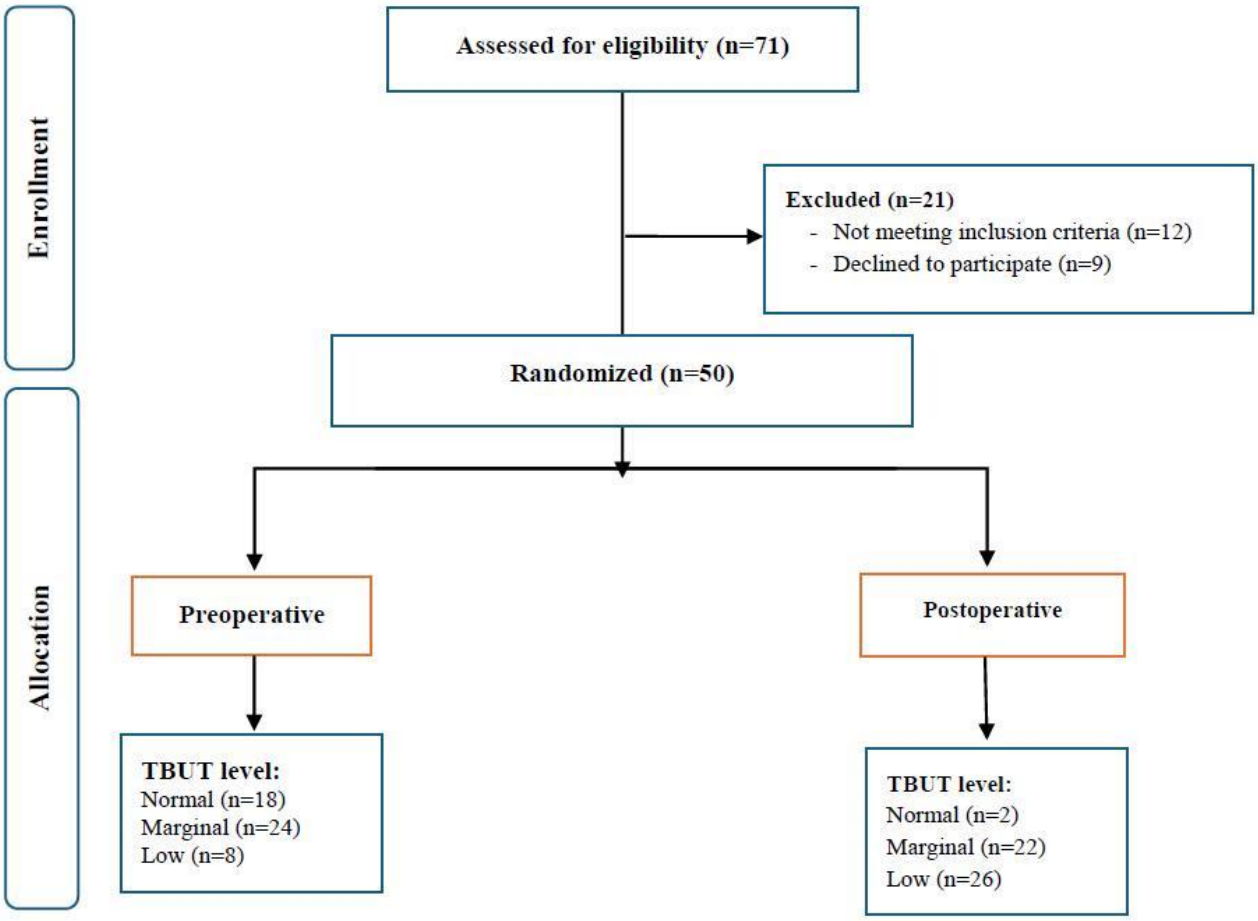

Figure (1): Flowchart of the studied patients.

Among 50 cases, the mean age was (61.34±4.06). 25 (50.0%) of cases were males. 25 (50.0%) cases were workers. Among 50 cases, all cases were without systemic diseases and ocular diseases and were not using medications **(Table 1).**

Table (1): Demographic data among the studied cases.

Variable	The studied cases (n=50)	
	Mean± SD	Range
	N	%
Age/year	61.34±4.06	55.0-70.0
Sex		
Male	25	50.0
Female	25	50.0
Occupation		
Working	25	50.0
Not working	25	50.0
Systemic diseases		
Negative	50	100.0
Ocular diseases		
Negative	50	100.0
Medications		
Negative	50	100.0

Table (2) showed TBUT and pre- and postoperative OSDI differed significantly, however, there was no significant difference in either measure when it came to the Schirmer test.

Table (2): Comparison between pre- and postoperative regarding OSDI, Schirmer, and TBUT scores among the studied cases (n=50).

	Preoperative		Postoperative		X^2	P value
	N	%	N	%		
OSDI						
Normal	17	34.0	3	6.0		
Mild	17	34.0	14	28.0	17.825	**<0.001***
Moderate	13	26.0	20	40.0		
Severe	3	6.0	13	26.0		
Schirmer						
Normal	13	26.0	12	24.0		
Mild	13	26.0	5	10.0	7.235	0.065
Moderate	12	24.0	23	46.0		
Severe	12	24.0	10	20.0		
TBUT						
Normal	18	36.0	2	4.0	22.416	**<0.001***
Marginal	24	48.0	22	44.0		
Low	8	16.0	26	52.0		

X^2: Chi square, *Significant

The mean change of OSDI, Schirmer test, and TBUT was (-6.52±1.89, 1.10±2.15, and 3.12±2.51), respectively, with significant differences among pre- and postoperative values **(Table 3).**

Table (3): Mean change of OSDI, Schirmer, and TBUT scores pre- and postoperative among the studied cases (n=50).

	Paired Differences			t	P value
	Mean± SD diff	95% CI			
		Lower	Upper		
OSDI preoperative - after 6 weeks score	-6.52±1.89	-7.06	-5.98	24.432	**<0.001***
Schirmer 1 preoperative - after 6 weeks score	1.10±2.15	0.49	1.71	3.618	**0.001***
TBUT preoperative - after 6 weeks score	3.12±2.51	2.41	3.83	8.796	**<0.001***

CI: Confidence Interval, t: Paired t-test, *Significant

Additionally, there was no significant relation between age categories and preoperative levels of OSDI, Schirmer, and TBUT **(Table 4).**

Table (4): Preoperative OSDI, Schirmer, and TBUT levels among age categories of the studied cases (n=50).

Preoperative	<60 years (n=18)		≥60 years (n=32)		X^2	P value
	N	%	N	%		
OSDI						
Normal	4	22.2	13	40.6		
Mild	9	50.0	8	25.0	4.987	0.173
Moderate	5	27.8	8	25.0		
Severe	0	0.0	3	9.4		
Schirmer						
Normal	5	27.8	8	25.0		
Mild	5	27.8	8	25.0	0.866	0.834
Moderate	3	16.7	9	28.1		
Severe	5	27.8	7	21.9		
TBUT						
Normal	8	44.4	10	31.3	2.498	0.287
Marginal	6	33.3	18	56.3		
Low	4	22.2	4	12.5		

X^2: Chi square

Moreover, there was no significant relation between age categories and postoperative levels of OSDI, Schirmer, and TBUT **(Table 5).**

Table (5): Postoperative OSDI, Schirmer and TBUT levels among age categories of the studied cases (n=50).

Postoperative	<60 years (n=18)		≥60 years (n=32)		X^2	P value
	N	%	N	%		
OSDI						
Normal	0	0.0	3	9.4		
Mild	4	22.2	10	31.3	3.879	0.275
Moderate	10	55.6	10	31.3		
Severe	4	22.2	9	28.1		
Schirmer						
Normal	5	27.8	7	21.9		
Mild	1	5.6	4	12.5	0.977	0.807
Moderate	9	50.0	14	43.8		
Severe	3	16.7	7	21.9		
TBUT						
Normal	1	5.6	1	3.1	0.193	0.908
Marginal	8	44.4	14	43.8		
low	9	50.0	17	53.1		

X^2: Chi square

In addition, there was no significant relation between age categories with median values of preoperative scores of OSDI, Schirmer, and TBUT **(Table 6).**

Table (6): Median values of preoperative OSDI, Schirmer, and TBUT scores among age categories of the studied cases (n=50).

Preoperative	<60 years (n=18)	≥60 years (n=32)	U	P value
	Median (IQR)	Median (IQR)		
OSDI	19.0 (9.0-33.0)	19.0 (5.0-38.0)	285.500	0.959
Schirmer	11.5 (1.0-32.0)	10.5 (1.0-30.0)	287.000	0.984
TBUT	9.0 (3.0-15.0)	7.5 (3.0-15.0)	262.500	0.605

U: Mann Whitney u test

Also, there was no significant relation between age categories and postoperative scores of OSDI, Schirmer, and TBUT **(Table 7).**

Table (7): Mean value for postoperative OSDI, Schirmer, and TBUT scores among age categories of the studied cases (n=50).

Postoperative	<60 years (n=18)	≥60 years (n=32)	U	P value
	Median (IQR)	Median (IQR)		
OSDI	26.0 (15.00-40.00)	26.0 (12.0-40.0)	285.500	0.959
Schirmer	9.0 (3.00-32.00)	8.0 (2.00-30.00)	265.500	0.646
TBUT	4.5 (2.50-11.00)	4.0 (2.50-11.00)	282.500	0.911

U: Mann Whitney test

In case 1, a male patient aged 55 years, had no DM, HTN, or immunological diseases that affect the ocular surface and no use of lubricants or artificial tears. The patient had a cataract in his left eye and underwent left phacoemulsification, **(Figure 2a, b).** However, in case 2, a female patient aged 66 years, had no DM, HTN, or immunological diseases that affect the ocular surface and no use of lubricants or artificial tears. The patient had a cataract in her left eye and visual acuity of 2/60 and underwent left phacoemulsification, **(Figure 3a, b).**

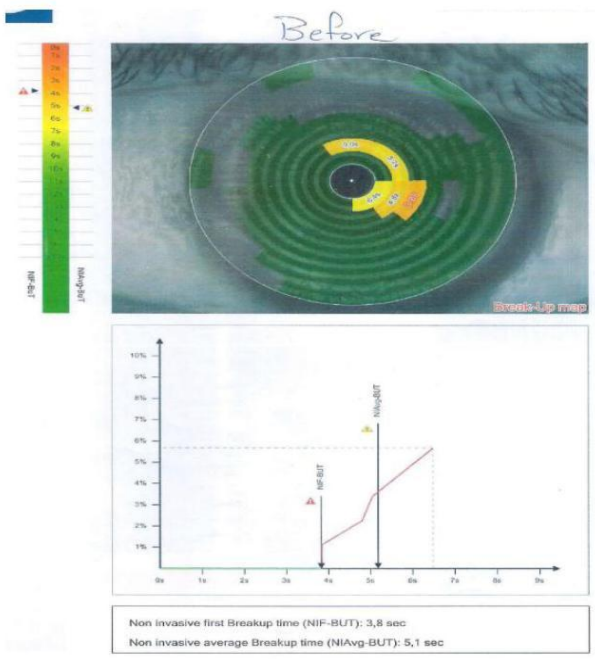

Figure 2a. Preoperative.

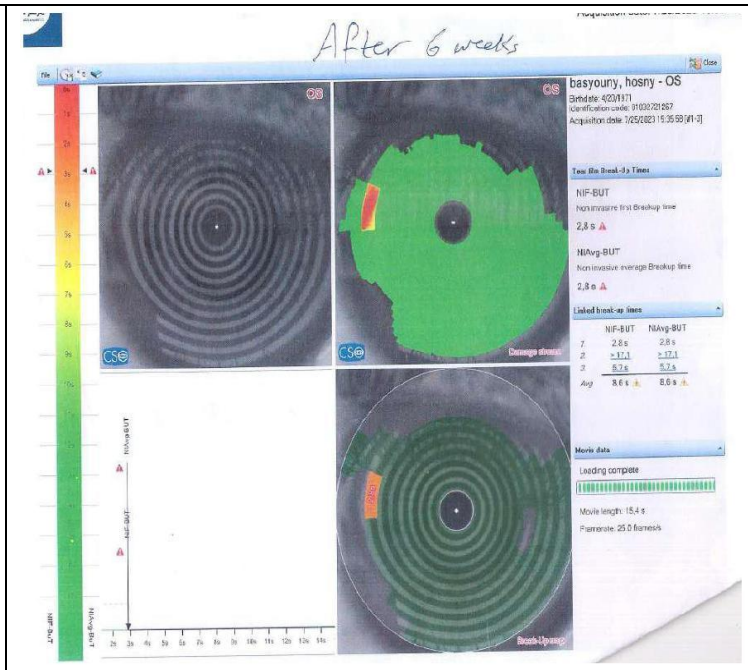

Figure 2b. After 6 weeks postoperative.

Figure (2a, b): A male patient aged 55 years had a cataract in his left eye and underwent left phacoemulsification.

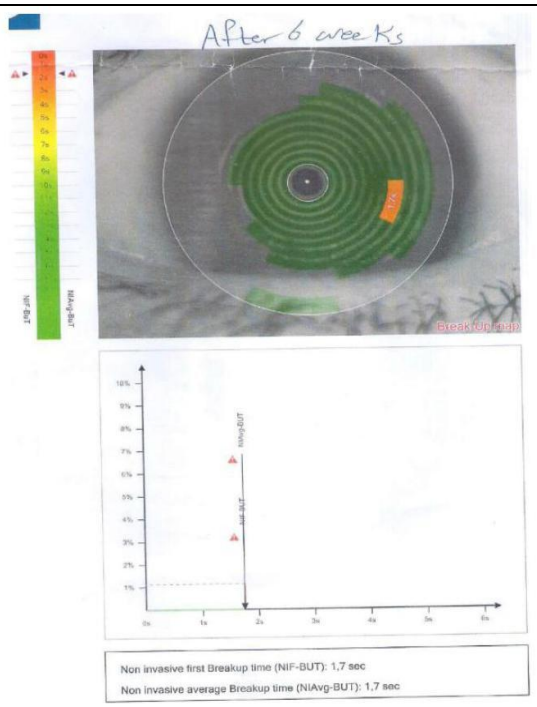

Figure 3b. After 6 weeks postoperative.

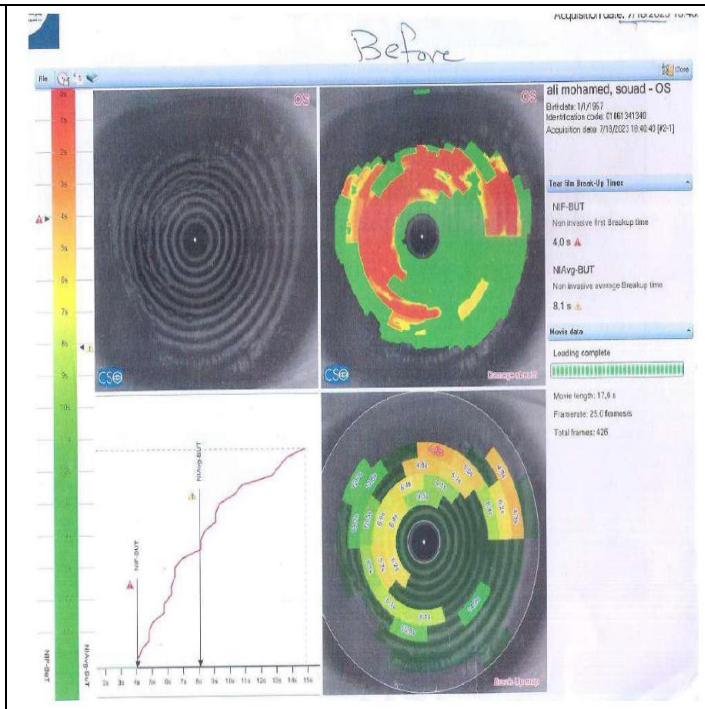

Figure 3a. Preoperative.

Figure (3a, b): A female patient aged 66 years had a cataract in her left eye and visual acuity of 2/60 and underwent left phacoemulsification.

DISCUSSION

In ocular surgery, phacoemulsification is the most common procedure. Even when the patients' full vision is restored, it is more likely that the operation will result in ocular abnormalities because of reduced tear production, unstable ocular surfaces, and increased resistance to damage. As a result, it's critical to consider the potential for dry eyes after surgery and to provide prompt, accurate diagnosis and treatment [14].

The question of whether cataract surgery is a risk factor for DED remains unresolved, even though several variables may cause DED both during and after surgery. In addition to being a significant etiological factor for DED, MGD also causes dry eyes and pain in the eyes after surgery. So, our study aimed to evaluate the ocular surface change after phacoemulsification surgery [15]. To elucidate our aim, this was a prospective study that included 50 patients conducted at the Department of Ophthalmology, Menoufia University Hospital, and Tiba Ophthalmic Center.

Our study showed TBUT and pre-and postoperative OSDI differed significantly, however, there was no significant difference in either measure when it came to Schirmer test. According to reports, the time of the tear layer should be more than 10 seconds under normal conditions; if it is less than 10 seconds, the tear layer is unstable.

Andryani *et al.* [16] found that before surgery, the average TBUT value of patients with cataracts was around 10.5 seconds, indicating that the patients' tear layer was stable. 34 individuals, or 85% of the total, had aberrant TBUT levels in their cataract cases. Following cataract surgery, the TBUT value dropped to around 9.29 seconds one month following the procedure, and 38 patients (95%) had aberrant TBUT readings. This is reported by **Abd-EL Moez *et al.*** [17], who found that TBUT decreased after phacoemulsification surgery by 68.4%. In contrast, the study of **Shirwadkar *et al.*** [18] obtained the same TBUT measurement time in preoperative and 1-month postoperative phacoemulsification.

In the **Andryani *et al.*** [16] study, before surgery, the average Schirmer test value of cataract patients was 14.3 mm, indicating that they had enough aquatic layers. Just six individuals (15%) had aberrant Schirmer I scores about their cataracts. After one month after surgery, the value of Schirmer test I did, however, gradually declined to about 11.5 mm, and the number of patients with an aberrant Schirmer test value rose to 15 patients (37.5%). Similarly, **Andryani *et al.*** [16] and **Li *et al.*** [19] showed that A total of 15 postoperative cataract patients (37.5%) and 38 aberrant TBUT values (95%), had abnormal Schirmer test results. The results of diagnostic tests based on normal values show that the sensitivity is 39.5% and the specificity is 100%. This indicates that the abnormal Schirmer test value has a limited capacity to identify abnormal TBUT values, whereas the normal Schirmer test I value has a 100% capacity to identify normal TBUT values.

Another study by **Balakrishnan *et al.*** [20] found that when measured postoperatively on day 7, the preoperative mean values of the TBUT and Schirmer test were lower; nonetheless, a gradually increasing trend was observed until the most recent follow-up, which was two months later. Additionally, **Tangpagasit and Srivanich** [21] demonstrated the progression of dry eye and the scores obtained upon phacoemulsification from TBUT and ST. **Balakrishnan *et al.*** [20] also noted a considerably lower value of the TBUT and Schirmer test after cataract surgery, which is consistent with our research. Additionally, a substantial decline in the TBUT values, Schirmer test values, and OSDI scores was seen in the early postoperative period by **Ishrat *et al.*** [22]. When the patients' dry eye test results were evaluated after surgery, the test levels did, however, gradually improved.

In the present study, the mean change of OSDI, Schirmer test, and TBUT was (-6.52±1.89, 1.10±2.15, and 3.12±2.51), respectively, with significant differences among pre- and postoperative values. In this concern, **Miura *et al.*** [23] found that during the first 2 months following cataract surgery, alterations in several ocular surface parameters and instability of the tear film improved, but they eventually reverted to levels similar to those before the procedure, which is similar to **Zhao *et al.*** [24] who reported that dry eye following cataract surgery is self-limiting and may resume normality after 1-3 months. This is by **Deneska and Susilo** [25] who reported that the Schirmer test showed significant rises on the 1st day and 7th day after surgery compared to pre-surgery, which decreased to preoperative level on the 30th day after surgery. Similar findings were found in research by **Abd-EL Moez *et al.*** [17]. They found that it can occur because the irritation and inflammation that started immediately after the operation boosted the production of tears on the first day following the procedure.

Furthermore, it was discovered by **Hamed *et al.*** [6] that the TBUT had returned to its preoperative level 30 days following surgery. It was similar to research by **Khanal *et al.*** [26], while the findings of **Shirwadkar *et al.*** [18] were different, indicating that TBUT before and after phacoemulsification did not alter significantly. Besides, **Trpenoski and Mitrova** [27] who found that the TBUT of all the subjects was abnormal, which means there was already an abnormality in their tear film, which meant that they were at a high risk of tear film disturbance.

In our study, there was no significant relation between age categories and postoperative levels of OSDI, Schirmer test, and TBUT. In line with our study, **Trattler *et al.*** [28] and **Kohli *et al.*** [29] discovered that while the elder patients' OSDI scores were less than 33, they did occasionally exhibit dry eye symptoms.

Additionally, they discovered that following phacoemulsification, individuals who were younger than 60 years old but did not exhibit any dry eye symptoms were more likely to experience atypical dry eye symptoms. However, **Park *et al.* [30]** discovered that elderly people had a greater incidence of dry eyes. Similarly, following phacoemulsification, **Abd-El Moez *et al.* [17]** found a statistically significant positive connection between aging and alterations in the tear film.

According to **Abd-EL Moez *et al.* [17]**, 20 patients (40%) and 30 patients (60.0%) respectively were 60 years of age or older in their prospective investigation. At the second postoperative week, 45% and 50% of patients under 60 had Schirmer-T scores of less than 10 mm and TBUT of less than 10 seconds, respectively. Conversely, at the second postoperative week, 76.7% and 93.3% of patients over 60 had Schirmer-T scores of less than 10 mm and TBUT times of less than 10 seconds, respectively. Consistent with earlier research, **Dodia *et al.* [31] and Hambali and Mustafa [32]** assessed 272 patients who had undergone phacoemulsification surgery prospectively and found that becoming older is an additional risk factor for dry eye following phacoemulsification surgery.

CONCLUSIONS

Phacoemulsification cataract surgery is associated with a risk of dry eye. There is a significant change in the ocular surface postoperatively compared to preoperative status in patients who underwent phacoemulsification. Also, a statistical difference between pre and postoperative regarding TBUT and OSDI was proven.

Limitations of the study

There are several limitations on our research due to the small sample size of our patients; thus, we recommend further multicenter studies should be conducted over distinctive years to evaluate the ocular surface change after phacoemulsification surgery over a larger scale and additional studies with a large sample size will be needed to prove our results. We recommend wearing corneal contact lenses to confirm the effect of relieving dry eye symptoms better.

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