Original Research Article

Ocular Surface Alterations Related to Cataract Surgery

Abstract

Background: Dry eye syndrome is a multifactorial disease of pre-corneal tear film that results in ocular discomfort, visual disturbance and tear film instability, with potential damage to the ocular surface. The aim of the work was to evaluate the ocular surface alterations related to cataract surgery either phacoemulsification or extracapsular cataract extraction surgeries.

Methods: This prospective observational study included 60 patients with cataract. Patients were divided into 2 equal groups: Group1 included patients who had scheduled for phacoemulsification. Group 2 included patients who had scheduled for extracapsular cataract extraction surgery. All patients were subjected to full history taking, complete ophthalmic evaluation, OSDI score test, Schirmer tests, invasive break up time tests (IBUT), and non-invasive break up time tests (NIBUT).

Results: Postoperative BCVA test in both groups was significantly better compared to preoperative tests after 1 week, 1 month, and 3 months while postoperative Schirmer test, IBUTT test, non IBUTT test, and OSDI test were significantly worse compared to preoperative in both groups after 1 week, 1month and 3 months (P value = 0.05).

Conclusions: Patients who had scheduled for phacoemulsification showed a significantly better BCVA test, OSDI test, Schirmer test, IBUTT test, and non IBUTT test after 1 week, 1month and 3 months compared to extracapsular cataract extraction group.

Keywords: Ocular Surface Alterations, Dry Eye Syndrome, Cataract Surgery.

Introduction:

Ocular pain, visual distortion, and tear film instability are all symptoms of dry eye syndrome, a multifactorial illness of the pre-corneal tear film that may cause permanent damage to the ocular surface. [1]

Dry eyes may be brought on by a number of different things including: female gender, aging, diabetes mellitus, connective tissue diseases, contact lens usage, systemic hypertension, drugs like anticholinergics, drops containing preservatives, antihistamines, oral contraceptives, antidepressants and topical eye and ocular diseases like meibominitis, chronic conjunctivitis, blepharitis, and pterygium. [2-4]

In ophthalmic facilities, cataract surgery is performed more often than any other procedure, and many patients have reported experiencing dry eye symptoms afterwards. These symptoms can include irritation, burning, a foreign body sensation, drooping eyelids, redness, reflex lacrimation, ocular pain, and fatigue [29,30].

It may cause persistent epithelial defect, punctate keratitis, superior limbic keratopathy, filamentary keratopathy, reduced visual acuity postoperatively and superior limbic keratoconjunctivitis. [5, 6]

Dry eye symptoms may be temporary, but they have a significant negative impact on the patient's standard of living; Studies reveal that in at least the first two months following cataract surgery, dry eye symptoms worsen in patients with preexisting dry eye and are induced in individuals without preexisting dry eye. [7-9]

Several causes contribute to the onset of dry eye symptoms after cataract surgery. The most important of them are decrease tear film break-up time due to surface irregularity at the site of the incision, prolonged use of antibiotic-steroid eye drops, poor tear film production and stability due to surgically induced ocular inflammation, decrease corneal sensation due to

surgical incision which disrupts the cornea-lacrimal gland loop leading to reduced tear secretion, and exposure to light from the operating microscope. [5, 9, 10]

Various measurements are used to assess the incidence and severity pattern of dry eye syndrome among patients who have undergone phacoemulsification and extracapsular cataract extraction; such as: Schirmer tests, Invasive break up time test (IBUT) using fluorescein stain,

and non-invasive break up time test (NIBUT) measured through video-keratography. [11, 12]

This study set out to compare the effects of phacoemulsification and extracapsular cataract extraction on the ocular surface.

Meterials and Methods:

This prospective observational study 60 patients with cataract. The study was done in the department of ophthalmology, Tanta university hospital over a period of one year from October 2020 to October 2021.

Inclusion criteria were all cases who had scheduled for cataract extraction surgery either phacoemulsification or extracapsular cataract extraction during the first 3 months of follow up period. **Exclusion Criteria** were corneal and conjunctiva diseases, chronic ocular disease or systemic disease as chronic glaucoma, ocular surgery other than cataract surgery, systemic disease as collagen vascular disease or endocrine disease e.g., thyroid disease and dry eyes.

Accordingly, 60 patients were equally divided into two groups as follows: **Group 1** included patients who had scheduled for phacoemulsification. **Group 2** included patients who had scheduled for extracapsular cataract extraction surgery.

All patients were subjected to the followings:

Preoperative data that include: Complete ophthalmic evaluation, full history taking including (Personal history age, sex, occupation, Past history of systemic and ocular diseases:

SLE, rheumatoid arthritis, Sjogren and other collagen diseases or thyroid diseases, Past history of using any topical medications and Past history of taking medications that can cause dry eyes as antihistamines, antidepressant, having laser eye surgery, undergoing radiation therapy such as that used to treat cancer aimed at the eyes). Symptoms (Burning, Itching, blurred vision, foreign body sensation, photophobia, headache, eye strain or tired eye). Complete ophthalmic examination for who produced positive data questionnaire [Uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA), Examination of the eyelid, blink rate, lid closure and lagophthalmos and Slit lamp examination of eyelids for blepharitis, ectropion, entropion, trichiasis, and for punctual patency and position].

Special examination: Using TBUT, Ocular Surface Disease Index (OSDI) score, and Schirmer tests, we evaluated tear film function.

Ocular surface disease index: Patients who showed signs of dry eyes were identified by a symptom-based survey and removed from the trial. The OSDI score is determined by how patient answers a questionnaire of twelve questions. Pose the following 12 questions to the patients, and have them circle the box number that best describes their response. **The final score is calculated as following:** The score ranges from 0 to 12 indicate normal. The score ranges from 13 to 22 indicate mild dry eye disease. The score ranges from 23 to 33 indicate moderate dry eye disease. The score ranges more than 33 indicate sever dry eye disease.

Schirmer 1, 2 tests: Schirmer's test, which measures the amount of tears made up of water, was done once. It aids in the evaluation of individuals showing symptoms of dry eye by establishing whether or not the dryness of the eye's surface is the result of a deficiency in tear production from the lacrimal glands (e.g., blepharitis, meibomitis, exposure). For a Schirmer's test, you'll need some special (no. 41 Whatman) filter paper that's 5mm wide and 35mm long. The test can be done with anesthetic (Schirmer 1) or without anesthetic (Schirmer 2). From a theoretical standpoint, a Schirmer 1 for basal secretion, whereas a

Schirmer 2 (without anaesthesia) for basal secretion with reflex secretion. **The test is performed as follows:** Tears are softly wiped away from the eye. If a local anaesthetic drops are administered (Schirmer 1), any surplus should be wiped away from the eye prior to testing. Most filter papers include a notched line 5 mm from one end to indicate where to fold them. Care must be taken to avoid touching the cornea or lashes when the folded tip is placed into the conjuctival sac of the lower lid, which is found at the juncture of the middle and outer thirds of the lower lid. The patient is instructed to shut their eyes during the examination. After waiting 5 minutes, we measure the quantity of wetness from the fold after removing the filter paper. **The Schirmer Test is interpreted as follows:** Measuring > 15 mm after 5 minutes is consistent with a normal amount of aqueous tears being produced. 10- to 15-millimeter mild dryness. Mild drought, between 5 and 10 millimetres. Severe dryness between 0 and 5 mm.

Invasive break up time tests (IBUT) and Non-invasive break up time tests (NIBUT): Tear break-up time (TBUT) also known as tear film break-up time (TFBUT) is the time it takes for the first dry patch to develop on cornea after a full blink. TFBUT is a quick and simple test for determining the stability of the tear film. In dry eye clinics, this test is performed routinely as a diagnostic tool. Production of tears, drainage via the lacrimal channels, and evaporation all contribute to the total volume of tears in the eye. Factors like decreased tear production, increased evaporation rate, tear film instability, tear hyperosmolarity, inflammations, ocular surface damages etc. can cause dryness to the eyes.

Invasive break up time tests (IBUT): Many worldwide diagnostic criteria, including those for dry eye, utilise the IBUT as their gold standard. In IBUT, reflex tearing is induced and tear stability is reduced with the use of a sodium fluorescein dye. **The test is performed as follows:** Once the sodium fluorescein dye has been injected into the eye, the tear film may be

examined under a slit lamp to look for signs of dryness. Observed using slit lamp under a broad beam of cobalt blue illumination.

Invasive break up time test (IBUT) is interpreted as follows: In general, responses taking more than 10 seconds are regarded to be average, those taking between 5 and 10 seconds to be marginal, and those taking less than 5 seconds to be low. The stability of a tear film is proportional to how long it takes for tears to break up, hence a quick break-up time is an indicator of a compromised tear film. **Non-invasive break up time tests (NIBUT):** NIBUT measurements were conducted by **CSO Sirius®** Pentacam device designed by C.S.O Italia, Florence. **The test is performed as follow:** When measuring tear breakup time noninvasively, a grid or concentric ring pattern is placed onto the cornea and the patient is instructed to blink. When the cornea dries out, the rings will seem distorted. NIBUT is calculated as the time elapsed from the last blink to the appearance of the distorted ring pattern.

Postoperative work-up: All patients were subjected to the previous mentioned examinations one week, one month, and three months following surgery.

Statistical analysis

SPSS v26 was used for the statistical analysis (IBM Inc., Chicago, IL, USA). The unpaired Student's t-test was used to compare the two groups' means and standard deviations (SDs) for quantitative variables. The Chi-square test or Fisher's exact test was used to determine statistical significance for qualitative variables provided as frequencies and percentages. Statistical significance was assumed at a two-tailed P value of less than 0.05.

Results:

Age and sex were insignificantly different between both groups. Preoperative BCVA test was insignificantly different between both groups. Postoperative BCVA test after one week, one month and three months was significantly better in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). Postoperative BCVA

test after one week, one month and three months was significantly better compared to prior to surgery BCVA test in phacoemulsification group (P value <0.05), postoperative BCVA test after one week, one month was significantly lower and after 3 months was significantly better compared to preoperative BCVA test in extracapsular cataract extraction group (P value <0.05). Preoperative OSDI values were insignificantly different between both groups. Postoperative OSDI values after one week, one month and three months were significantly lower in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). In phacoemulsification group, postoperative OSDI values after one week and one month were significantly higher compared to preoperative OSDI test values, however this difference became insignificant after three months compared to preoperative test. In extracapsular cataract extraction group, postoperative OSDI values after one week, one month and three months were significantly higher compared to prior to surgery OSDI test (P value <0.05).

Table 1: Demographic data, BCVA LogMAR and OSDI test test of the studied groups:

		Phacoemulsification group (n=30)	Extracapsular cataract extraction group (n=30)	P value
Age (years)	**Mean ± SD**	65.63 ± 6.98	66.87 ± 4	0.404
	Range	52 - 79	55 - 72	
Sex	**Male**	19 (63%)	17 (57%)	0.598
	Female	11 (37%)	13 (43%)	

BCVA LogMAR		Pre	1 week	1 month	3 months
Phacoemulsification group (n=30)	Mean ± SD	0.90 ± 0.27	0.47 ± 0.12	0.36 ± 0.14	0.31 ± 0.11
P1			<0.001*	<0.001*	<0.001*
Extracapsular cataract extraction group (n=30)	Mean ± SD	0.62 ± 0.69	0.67 ± 0.22	0.64 ± 0.25	0.45 ± 0.16
P2			0.46	0.31	0.28
P value		0.051	<0.001*	<0.001*	<0.001*
OSDI test		Pre	1 week	1 month	3 months
Phacoemulsification group (n=30)	Mean ± SD	14.90 ± 5.04	67.83 ± 11.83	42.43 ± 16.78	18.37 ± 11.23
P1			<0.001*	<0.001*	0.076
Extracapsular cataract extraction group (n=30)	Mean ± SD	13.87 ± 3.81	79.53 ± 9.01	55.03 ± 17.01	35.40 ± 16.81
P2			<0.001*	<0.001*	<0.001*
P value		0.374	<0.001*	0.005*	0.014*

OSDI: Ocular Surface Disease Index, *: significant as P value ≤ 0.05, P1: P value of postoperative compared to preoperative tests in phacoemulsification group, P2: P value of postoperative compared to preoperative tests in extracapsular cataract extraction group.

The severity of dry eye after one week, one month and three months was significantly lower in phacoemulsification group compared to extracapsular cataract extraction group (P

value <0.05). In phacoemulsification group, the percentage of mild, moderate and severe dry eye after one week and one month was significantly higher compared to preoperative OSDI test (P value<0.001), Nonetheless, the OSDI levels indicated improvement three months following surgery. In extracapsular cataract extraction group, the percentage of mild, moderate and severe dry eye after one week, one month and three months was significantly higher compared to prior to surgery OSDI score (P value<0.001). The severity of dry eye after one week, one month and three months was significantly lower in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). In phacoemulsification group, the prevalence of mild and moderate dry eye after one week and one month was significantly higher compared to preoperative as regard to Schirmer test (P value<0.001), however the test values showed improvement in the Schirmer test after three months postoperatively. In extracapsular cataract extraction group, the percentage of mild and moderate dry eye after one week, one month and three months was significantly higher compared to prior to surgery as regard to Schirmer test (P value<0.001).

Table 2: Percentage of dry eye pre and postoperative OSDI test and Schirmer test:

OSDI test		Pre	1 week	1 month	3 months
Phaco group (n=30)	Normal	30 (100%)	0 (0%)	0 (0%)	13 (43.3%)
	Mild	0 (0%)	0 (0%)	15 (50%)	15 (50%)
	Moderate	0 (0%)	12 (40%)	13 (43.3%)	2 (6.7%)
	Severe	0 (0%)	18 (60%)	2 (6.7%)	0 (0%)
P1			<0.001*	<0.001*	0.262
Extracapsular group (n=30)	Normal	30 (100%)	0 (0%)	0 (0%)	4 (13.3%)
	Mild	0 (0%)	0 (0%)	9 (30%)	11 (36.7%)
	Moderate	0 (0%)	0 (0%)	11 (36.7%)	15 (50%)
	Severe	0 (0%)	30 (100%)	10 (33.3%)	0 (0%)
P2			<0.001*	<0.001*	<0.001*
P value		----	0.024*	0.03*	<0.001*
Schirmer test		Pre	1 week	1 month	3 months
phaco group (n=30)	Normal	30 (100%)	3 (10%)	12 (40%)	29 (96.7%)
	Mild	0 (0%)	20 (66.7%)	16 (53.3%)	1 (3.3%)
	Moderate	0 (0%)	7 (23.3%)	2 (6.7%)	0 (0%)
	Severe	0 (0%)	0 (0%)	0 (0%)	0 (0%)
P1			<0.001*	<0.001*	0.312
extracapsular group (n=30)	Normal	30 (100%)	0 (0%)	2 (6.7%)	14 (46.7%)
	Mild	0 (0%)	13 (43.3%)	22 (73.3%)	16 (53.3%)
	Moderate	0 (0%)	17 (56.7%)	6 (20%)	0 (0%)
	Severe	0 (0%)	0 (0%)	0 (0%)	0 (0%)
P2			<0.001*	<0.001*	<0.001*
P value		---	0.013*	0.006*	<0.001*

*: significant as P value ≤ 0.05

Preoperative Schirmer values were insignificantly different between both groups. Postoperative Schirmer values after one week, one month and three months were

significantly higher in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). In phacoemulsification group, postoperative Schirmer values after one week and one month were significantly lower compared to preoperative Schirmer values, however this difference became insignificant after 3 months compared to preoperative test. In extracapsular cataract extraction group, postoperative Schirmer values after one week, one month and three months were significantly lower compared to prior to surgery Schirmer test (P value <0.05).

Table 3: Schirmer test of the studied groups:

		Pre	1 week	1 month	3 months
Phacoemulsification group (n=30)	Mean ± SD	18.30 ± 3.14	11.42 ± 2.56	13.93 ± 2.66	17.70 ± 1.79
P1			<0.001*	<0.001*	0.068
Extracapsular cataract extraction group (n=30)	Mean ± SD	19.03 ± 2.92	8.97 ± 1.92	11.18 ± 2.06	14.27 ± 1.71
P2			<0.001*	<0.001*	<0.001*
P value		0.353	<0.001*	<0.001*	0.010*

*: significant as P value ≤ 0.05, P1: P value of postoperative compared to preoperative tests in phacoemulsification group, P2: P value of postoperative compared to preoperative tests in extracapsular cataract extraction group.

Preoperative IBUTT values were insignificantly different between both groups. Postoperative IBUTT values after one week, one month and three months were significantly improved in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). In phacoemulsification group, postoperative IBUTT values after one week and one month were significantly lower compared to preoperative IBUTT values, however this difference became insignificant after three months compared to preoperative test. In extracapsular cataract extraction group, postoperative IBUTT test after one week, one month and three months was significantly lower compared to prior to surgery IBUTT test (P value <0.05).

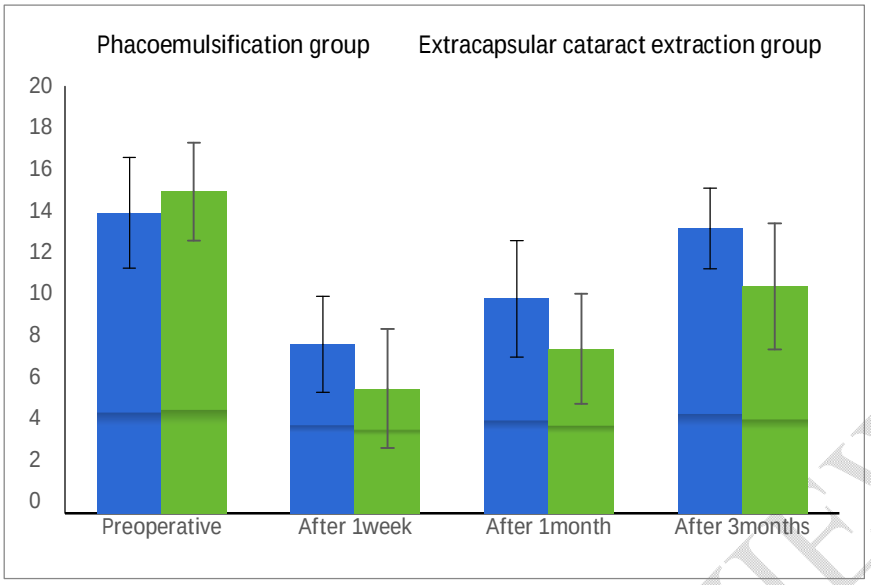

Figure 1: IBUTT test of the studied groups.

Preoperative non IBUTT values were insignificantly different between both groups. Postoperative non IBUTT values after 1 week, 1month and 3 months were significantly improved in phacoemulsification group compared to extracapsular cataract extraction group (P value <0.05). In phacoemulsification group, postoperative non IBUTT values after one week and one month were significantly lower compared to preoperative non IBUTT values, however this difference became insignificant after three months compared to preoperative test. In extracapsular cataract extraction group, postoperative non IBUTT test after one week, one month and three months was significantly lower compared to prior to surgery non IBUTT test (P value <0.05).

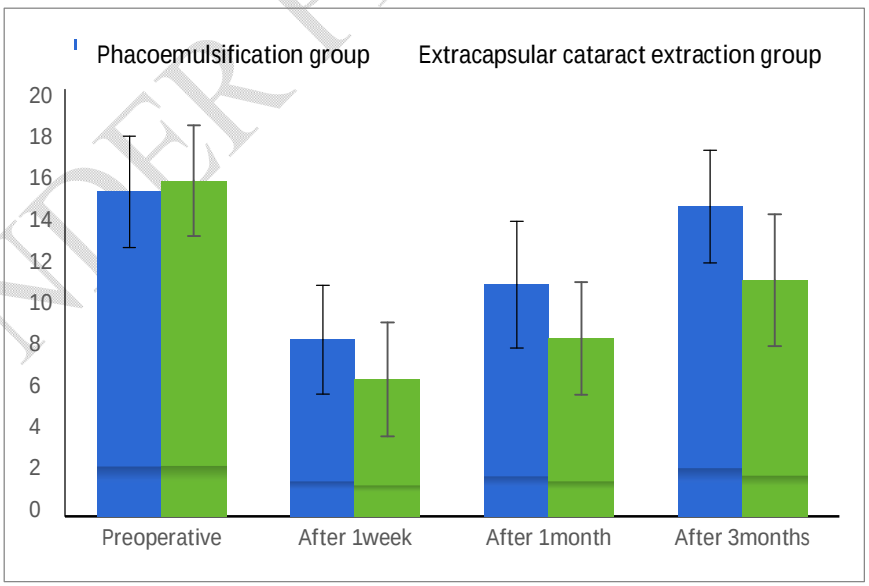

Figure 2: Non IBUTT test of the studied groups.

Discussion

Ocular pain and other symptoms are common in those who suffer from dry eye syndrome (DES), a disease of the periocular tear film that leads to ocular surface damage. [13] Its prevalence around the world varies from 5% to 34%.

In our study, it was found that postoperative best corrected visual acuity "BCVA" test after 1 week, 1 month and 3 months was significantly better in phacoemulsification group compared to extracapsular cataract extraction group (ECCE). In line with our results, **Thevi et al.** [14] performed a retrospective analysis of phacoemulsification and ECCE patients' medical data. Statistical analysis indicated that phacoemulsification patients had a significant better visual prognosis than ECCE patients by a margin of 80.1% to 48.5% ($p = 0.001$).

This was in line with NED data from 2002-2011, which showed that 91.5% of phacoemulsification patients had excellent vision of 6/12 or better, compared to 83.5% of ECCE patients. [15]

This was similar to the findings where Osita et al. [16] conducted a retrospective study to measure post-operative outcome of visual acuity, astigmatism with the keratometric values of the patients, after ECCE and surgical procedures were considered. The results showed that about 91.7% of patients had a good visual outcome in phacoemulsification surgery compared to ECCE.

Also, Minassian et al. [17] compared visual acuity, refractive error, and complication rates between 232 patients with age-related cataract who had ECCE and 244 patients who underwent phacoemulsification in two randomized trials. When comparing the phacoemulsification group to the ECCE group, it was observed that the phacoemulsification group had a considerably larger percentage of patients reaching 6/9 or better with spectacle correction (69%) In comparison to ECCE group (57%).

In our study, it was found that postoperative Schirmer test after one week, one month and three months was significantly higher in phacoemulsification group in comparison to ECCE while postoperative Schirmer was lower compared to preoperative Schirmer test in phacoemulsification and ECCE groups. In line with our results, **Singh et al.** [18] single-center, prospective descriptive research including 65 individuals who had clear cornea phacoemulsification for age-related cataracts without preexisting dry eye. The primary measures were fluorescein tear break-up time (FTBUT), and Schirmer tests without anesthesia. They were evaluated prior to surgery and one week after surgery. The results showed that Schirmer's test value decreased compared to preoperative value ($P < 0.001$). However, **MY et al.** [19] showed that when comparing TF-BUT, corneal fluorescein staining, and the Schirmer test, neither group showed statistically significant differences. This contradiction between both studies can be justified by small sample size and difference in both techniques.

In our study, it was found that postoperative Ocular Surface Disease Index (OSDI) after 1 week, 1month and 3 months was significantly lower in phacoemulsification group compared ECCE group while postoperative OSDI was significantly higher compared to preoperative OSDI test in phacoemulsification and ECCE groups. In agreement with our results, **Cetinkaya et al.** [20] included 192 eyes of 96 patients with chronic DES and cataract. In the first week after surgery, OSDI scores were higher than they had been before: in 15 (16%) of cases, it was below 25, in 33 (34%) it was between 25 and 30, in 21 (22%) it was between 30 and 40, and in 27 (28%) it was between 40 and 50. One month after the surgery, it was under 25 in 30 (31 %) patients, and ranged from 25 to 30 in 39 (41 %) patients and ranged from 30 to 40 in 27 (28 %) patients. In the third month after surgery, it was less than 25 in 84 (88%) patients and between 25 and 30 in 12 (12%) individuals Parallel to our results, Sinha et al. [21] conducted a prospective, randomized study conducted on sixty-nine patients to evaluate dry

eye disease. The results showed that OSDI after one week, one month and three months was significantly lower in phacoemulsification group compared to SICS group. Also, Kasetsuwan et al. [22] showed that was a significant increase in OSDI till 3 months after operation compared to preoperative values. On the contrary, Yuwanda et al. [23] recruited 62 individuals with 80 eyes with cataracts who had routine phacoemulsification. The results showed that none of the variables before and one day after phacoemulsification surgery were significantly different from one another (OSDI, p=0.149) , either before phacoemulsification surgery or one week after it. However, there was a significant decrease in OSDI after month (p<0.001). The contradiction between both studies after 1-day post operation may be because they were under anaesthesia effect and OSDI is non-parametric test where it depends on patient's sensation that may vary from one person to other.

In our study, it was found that postoperative IBUTT after 1 week, 1 month and 3 months was significantly higher in phacoemulsification group compared to ECCE while postoperative IBUTT was lower compared to preoperative IBUTT in phacoemulsification and ECCE groups (P value <0.05). In agreement with our results, **Cetinkaya et al.** [20] highlighted that postoperatively IBUTT was lower than preoperative compared to postoperative 3rd month. Further, **Kasetsuwan et al.** [22] highlighted that postoperatively IBUTT was lower than preoperative till 3 months. Parallel to our results, **Singh et al.** [18] highlighted that postoperative IBUTT was decreased after 1 week compared to preoperative IBUTT (P<0.001).

In our study, it was found that postoperative NIBUTT after one week, one month and three months was significantly higher in phacoemulsification group compared to ECCE while postoperative NIBUTT was lower compared to preoperative NIBUTT in phacoemulsification and ECCE groups (P < 0.05). In agreement with our findings, Kim et al. [24] showed that the mean postoperative 1 week and 1-month NITBUT first values were significantly lower than

preoperative values ($p < 0.05$). Also, Jin-song et al. [25] showed that 14 days postoperatively, mean NIBUT reduced significantly compared to preoperative value ($P = 0.05$).

Statistical analysis showed a significant negative correlation between OSDI and tear break up time; the higher or worse the OSDI score, the lower or worse the tear break up time was. [26] The OSDI is restricted in its evaluation of dry eye symptoms since it only takes into account light sensitivity, grittiness, and pain. Tearing and foreign body feeling are not among the symptoms evaluated by the questionnaire. [27]

Studies reveal that in the first two months after cataract surgery, dry eye symptoms intensify in individuals with prior DED and are induced in patients without previous DES. [9]

Research comparing the tear film characteristics of eyes with and without a history of surgery has shown no variations in tear film parameters in eyes where cataract surgery was performed more than 3 months after the procedure. [28]

Conclusions:

Patients who had scheduled for phacoemulsification showed a significantly better BCVA test, OSDI test, Schirmer test, IBUTT test, and non IBUTT test after one week, one month and three months compared to extracapsular cataract extraction group. Postoperative BCVA test in both groups was significantly better compared to preoperative tests after one week, one month and three months while postoperative Schirmer test, IBUTT test, non IBUTT test, and OSDI test were significantly worse compared to preoperative in both groups after one week, one month and three months.

Ethical Approval and Consent:

The Institutional ethical committee, Tanta university approved the study and informed written consent was obtained from all patients included.

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