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Research Article

ASSESSMENT OF CHANGES IN CORNEAL SENSITIVITY AND TEAR FILM PHYSIOLOGY AFTER PHACOEMULSIFCATION CATARACT SURGERY

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A B S T R A C T

Introduction: Dry eye syndrome following cataract surgery is of concern recently. Dry eye produces ocular discomfort and may reduce vision if the tear film becomes chronically unstable and repeatedly breaks up into dry eye spots between the blinks, exposing the corneal and conjunctival epithelium to evaporation. This study aims to assess changes in tear film physiology and corneal sensitivity following phacoemulsification cataract surgery and to see it's consequences on these two parameters.

Methods: Study was conducted on 110 patients who underwent phacoemulsification cataract surgery for senile cataract. Pre-validated, pretested, semi-structured questionnaire was used as data collection tool. Study subjects were examined for changes in the corneal sensitivity and tear film physiology one day prior to their surgery and on post-operative days 1, 7, 15, 30 and 90.

Results: Most of our study subjects were females. The mean age was 60.52 ±9.1 years. 12 (10.90%) patients had moderate dryness on POD 7 & POD 15 which improved with time to have only 6 (5.45%) patients with moderate dryness on POD 90. 10 (9.09%) patients developed abnormal TBUT on POD 7 while remaining 100 (90.90%) patients maintained normal TBUT values. 101(91.81%) patients had reduced corneal sensitivity at POD 1 and POD 7. Amongst them, 87 (79.09%) patients regained sensitivity by POD 15, all others regained sensitivity by POD 90.

Conclusion: Dry Eye Syndrome was observed in few patients only in the early post-operative period. There was reduction in corneal sensitivity for initial two weeks of post-operative period which normalized by the end of three months for most of the patients.

INTRODUCTION

Phacoemulsification is a modern cataract surgery in which the cataractous lens is emulsified with an ultrasonic hand-piece and aspirated from the eye.[1] Cataract is an eye pathology that develops gradually, causing diminution of vision, and blindness if left untreated.[2] The only permanent cure to it is surgery, Most surgical procedures of the anterior segment of the eye disrupt the normal corneal innervation.[3] The ophthalmic branch of the fifth cranial nerve carries sensory fibers for the cornea.[4] As dennervation of the cornea increases epithelial permeability, impairs epithelial wound healing, decreases epithelial metabolic activity and causes loss of cytoskeletal structures associated with cellular adhesion, it is necessary to identify factors that determine the extent of neural regeneration.

Dry eye syndrome following cataract surgery has been of concern recently.[5] Symptoms include a burning sensation and blurred vision, and bio-microscopic signs like decreased tear film break up time, corneal fluorescein staining, and lid-parallel conjunctival folds.

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Temporal corneal incisions made during phacoemulsification can reduce the corneal sensations in the surgical area and other areas far from the incision site. The damage to corneal nerves may increase when longer phacoemulsification time is needed to break up a mature cataract.[6]In addition, epithelial ingrowth, interface scarring, and surgically induced astigmatism were common due to the manual resection.

Dry eye can develop or worsen after cataract surgery if not treated in time.[7] Indiscriminate use of topical antibiotics causes histological and ultra-structural changes in conjunctiva leading to decreased tear film break-up time and dry eye state. It is important to maintain the stability of ocular surface for good recovery of visual acuity after cataract surgery.

The tear film is a complex biochemical mixture consisting of water, electrolytes, immunoglobulins, lysozymes, growth factors, mucins, polar and non-polar hydrophobic lipids[8] and is held on to the corneal surface by the numerous micropliacae of the corneal epithelium and protects it from harmful action by the anti-bacterial enzymes as well as by washing out debris which may have settled on the ocular surface from surrounding environment.[9]The average volume of tear production is 1.2

ul/min.(range of 6-8 µl/min) in unstimulated state while the turnover rate of tears is around 30%.

A dry eye produces ocular discomfort and reduces vision when the tear film becomes chronically unstable and repeatedly breaks up into dry eye spots between the blinks, exposing the corneal and conjunctival epithelium to evaporation.

This study aims to assess the changes in tear film physiology and corneal sensitivity after phacoemulsification and to study it's consequences on these two parameters.

Objective

To study the changes in corneal sensitivity and tear film physiology in patients who have undergone phacoemulsification cataract surgery.

MATERIALS AND METHODS

The protocol of our longitudinal observational study was approved by Institutional Ethical committee of our medical college. Written and informed consent was taken from all study subjects before collection of data.

Study was conducted on 110 patients fulfilling the inclusion and exclusion criteria, after taking written and informed consent, in department of ophthalmology at a tertiary care hospital in Maharashtra. Study duration was 18 months. Inclusion criteria included all patients who underwent phacoemulsification surgery for senile cataract. Exclusion criteria was patients with corneal abnormalitiessuch as keratoconjunctivitis sicca, keratitis, corneal dystrophies and degenerations**.**lid abnormalities like entropion, ectropion, lid lag, lagophthalmos**; c**onnective tissue disorders**, v**itamin A deficiency**,** ocular trauma, previous ocular surgery**,** patients with contact lenses, pregnant women**, s**mokers, patients on drugs like anti-histaminics, diuretics, oral contraceptives, antidepressants and diabetes.

Considering the prevalence of dry eye syndrome following phacoemulsification surgery to be 15.4% [8], with 90% confidence interval and 5% absolute precision, the minimum sample size came out to be 141 with Open EPI version 3.01
Pre-validated, pretested, semi-structured questionnaire was used as data collection tool .All study subjects underwent a biplanar, supero -temporal, 2.8mm clear corneal phacoemulsification cataract surgery using standard technique, done by a single surgeon. All surgeries were uneventful without any intra-operative or post-operative complications. Study subjects were examined for changes in the corneal sensitivity and tear film physiology one day prior to their phacoemulsification surgery and on post-operative day 1, 7, 15, 30 and 90. On the day of admission; CBC (complete blood count), FBS (Fasting blood sugar), PPBS (Post prandial blood sugar), HIV, HBsAg, Blood Urea, Serum Creatinine of all the patients was done

Method of measurement

Following tests were performed on the patients on each follow-up visit:

Schirmer I test*[9]*

The patient was made to sit comfortably in a dimmed room. A standard Schirmer strip of 5x35mm Whatman-41 filter paper that is folded 5mm from one end, was inserted at the junction of medial two-third and lateral one third in the lower conjunctival fornix. The patient was asked to look up. The paper was then removed after 5 minutes and amount of wetting was measured from the fold.[9] Inferences were drawn on following criteria:

- Normal value : >15mm wetting of the paper after 5 minutes
- Moderate dry eye: 5-15 mm wetting of the paper after 5 minutes
- Severe dry eye: <5 mm wetting of the paper after 5 minutes

Tear film break up time (TBUT)

In this test, sterile filter paper strip impregnated with sodium fluorescein dye was used to stain the patient's tear film. The patient was instructed not to blink while the tear film was observed under a beam of cobalt blue illumination using slit-lamp bio-microscope. TBUT was recorded as number of seconds that elapse between the last blink and the appearance of first randomly distributed dry spot on the cornea. TBUT > 10 seconds is normal while TBUT ≤ 10 seconds is considered abnormal for this study. [9]

Measurement of corneal sensitivity by qualitative method

A wisp of cotton- tipped applicator was used to compare corneal sensation in each eye. All the four quadrants were tested. Sensation in each location was recorded as normal, reduced or absent. [9]

Data was entered in MS-EXCEL and analyzed SPSS (Statistical Packaging for Social Studies) software version 20. Descriptive statistics were represented with percentages, mean with SD. Independent t-test, repeated ANOVA were applied to find significance. P <0.05 was considered significant.

RESULTS

In the present longitudinal study 110 patients underwent phacoemulsification cataract surgery and followed up as per schedule at department of ophthalmology at tertiary health care center.

Table 1 gives the baseline characteristics of study population. Majority of the study subjects i.e. 68 (61.82%) were females whereas 42(38.18%) were males. The mean age was 60.52 ±9.1 yrs. Out of which, 95(86.36%) study subjects were ≥ 50 years while 15(13.64%) were < 50 years. In the present study, 107(97.27%) patients had immature senile cataract and 3(2.73%) patients had mature senile cataract. The number of phacoemulsification surgeries performed in the present study had distribution of 55(50%) on right eye while 55(50%) on left eye.

Table 1 Distribution of study subjects according to some baseline categories

Baseline Category	Subcategory	Frequency	Percentage
Age	<50	15	13.64
	≥50	95	86.36
Gender	Male	42	38.18
	Female	68	61.82
Type of Cataract	ISC	107	97.27
	MSC	3	2.73
Laterality	Left eye	55	50
	Right eye	55	50

ISC = immature senile cataract, MSC= mature senile cataract

In the present study; pre-operatively, 106 (96.36%) out of total 110 study subjects had normal Schirmer I test while 4 (3.64%) had moderate dryness. This number increased to 16 (14.54%) patients on POD 1. On follow-up, 12 (10.90%) patients had moderate dryness on POD 7 & POD 15 which gradually improved with time to have only 6 (5.45%) patients with moderate dryness on POD 90. None of the patients reported a severe disturbance at any point of time. (Table 2)

Table 2 Schirmer I test observations

Grading	PRE-OP	POD 1	POD 7	POD 15	POD 30	POD 90
Normal >15 mm	106	94	98	98	101	104
Moderate 5-15 mm	4	16	12	12	9	6
Severe <5 mm	0	0	0	0	0	0

PRE-OP= pre-operavtive, POD= post-operative day

Pre-operatively, 110 patients had normal TBUT out of which 10 (9.09%) patients developed abnormal TBUT on POD 7 while remaining 100 (90.90%) patients maintained normal TBUT values. The disturbance persisted with 2 (1.81%) patients having abnormal TBUT at POD 15. By POD 30, all 110 patients had regained normal TBUT values. (Table 3)

Table 3 Distribution of Tear film break up time in study population

TBUT	PRE-OP	POD 1	POD 7	POD 15	POD 30	POD 90
Normal >10 seconds	110	100	100	108	110	110
Abnormal <=10 seconds	0	10	10	2	0	0

PRE-OP= Pre-operative, POD=post-operative day

In the present study, every patient had normal corneal sensitivity pre-operatively. The corneal sensations were found to be reduced only in superior and/or temporal quadrant.101(91.81%) patients had reduced sensitivity at POD 1 and POD 7. Amongst them, 87 (79.09%) patients regained corneal sensitivity by POD 15, while all others regained sensitivity by POD 90. At the end of 3 months, all the patients had normal corneal sensitivity. (Table 4)

Table 4 Distribution of corneal sensitivity in study population

Corneal sensitivity	PRE-OP	POD 1	POD 7	POD 15	POD 30	POD 90
Normal	110	9	9	23	97	110
Reduced	0	101	101	87	13	0

PRE-OP= pre-operative, POD= post-operative day

DISCUSSION

Dry eye syndrome is common after eye surgeries. The most common eye surgery done in India is that for cataract. This study was planned to see the actual occurrence of dry eye after phacoemulsification cataract surgery. In the present study, majority were females. This finding is consistent with Kasetsuwan N *et al*[11]who reported Sixty-six percent of the patients were women. However Gonzales Mesa A *et al*[12] reported 28 men and 24 women. Garg P *et al*[13] reported most were men (n=73, 60.83%). The preponderance of more women for the development of cataract is unknown but may be due to hormonal disturbances after menopause.

The mean age in our study was 60.52 years. 86.36% had age greater than 50 years. Kasetsuwan N *et al* [11] reported a mean age of 67.22±8.26 years. Garg P *et al* [13] reported mean age of the patients was 59.25+9.77 years. Cataract is part of ageing process, so naturally the age group was on higher side in most of the studies.

96% patients in our study had immature senile cataract. Pre-operatively, 106 patients had normal Schirmer I test. On post-operative day1, it reduced to 94,which gradually improved with time to 104 patients at POD 90 with 6 patients having moderate disturbance. Similar findings were reported by Li *et al*.[14]], Ishrat S *et al* .[15] and Cho and Kim.[16] According to dry eye diagnosis standard published by the Asian Dry Eye Association in 2017, they found the prevalence of DED to be15% at 1 week and 45% at 1 month post-operatively. Dhawan M *et al* [17] reported incidence of dry eye to be 11% seven days after phacoemulsification.

In the present study, pre-operatively, 110 patients had normal TBUT out of which 10 (9.09%) patients developed abnormal TBUT on POD 7 while remaining 100 (90.90%) patients' maintained normal TBUT values. The disturbance persisted with 2 (1.81%) patients having abnormal TBUT at POD 15. By POD 30, all 110 patients had regained normal TBUT values. On comparing our findings with other studies, it is seen that Liu *et al*.[17] also reported significant worsening of the tear film pattern, height of the tear meniscus, and scores detected by the TBUT, Schirmer I test, after phacoemulsification. Barabino *et al*. reported that phacoemulsification induced dry eye-like signs and symptoms on days 1 and 7. In contrast, Ram *et al*.[18] reported no differences in dry eye between before and after phacoemulsification in 23 patients wherein TBUT and Schirmer II test with anesthesia were performed. This discrepancy might be due to its small sample size and retrospective study design.

In our study, every patient had normal corneal sensitivity pre-operatively. 101 patients had reduced sensitivity at post-operative day 1 and 7. By day 90, every patient had regained corneal sensitivity. Khanal S *et al*[19] reported deterioration in corneal sensitivity immediately after phacoemulsification. Corneal sensitivity did not return to preoperative levels until 3 months post-operatively.[19] Reductions in corneal sensitivity after ocular surface surgery are thought to be dependent on the extent of the corneal incision.[20]Micro incision procedures such as phacoemulsification would be expected to cause less reduction in corneal sensitivity in comparison with refractive surgeries and extra capsular cataract extraction.

Even though multiple previous studies have compared the preoperative and postoperative changes in dry eye symptoms and/or the dry eye test values that worsened significantly after cataract surgery.[21] this current study was first to report the incidence and pattern of dry eye after phacoemulsification using a combinations of tests over a period of three months. The dry eye pattern observed in the current study was due to the recovery process of the corneal nerves. Since the cornea is one of the highly innervated structures, with about 44 corneal nerve bundles entering the cornea around the limbus centripetally[22] 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,[23] it is vulnerable to any damage within that region. Temporal corneal incisions created during phacoemulsification can reduce the corneal sensitivity in the surgical area and other areas far from the incision site.[24] The damage to the corneal nerves may expand when longer phacoemulsification time is needed to

emulsify a dense nucleus.[25] Neurogenic inflammation also can develop after corneal incisions. Inflammatory mediators can change the action of the corneal nerves and reduce corneal sensitivity.[26] Disruption of the normal corneal innervation or lacrimal functional unit feedback can reduce the tear flow and blink rate and cause instability of the tear hyper-osmolarity and tear film.[26] With corneal healing post-operatively, new neurite cells emerge and after 25 days, neural growth factor is released to regenerate the sub-epithelial corneal axon.[26] Thus, the recovery of the corneal nerves may explain why dry eye was seen early after surgery and improved thereafter. Even though, in theory, neurogenic inflammation may affected by feedback loop to contralateral eye, we did check the other eye as in general as screening and did not find any significant dryness developed after surgery.

Apart from transection ofcorneal nerves and damage to corneal epithelial cells, exposure to microscopic light, vigorous intra-operative irrigation of the tear film, elevation of inflammatory factors in the tear film due to ocular surface irritation, use of topical anesthesia intra-operatively, and topical eye drops administered post-operatively and its preservatives can cause dry eye after phacoemulsification. Vigorous irrigation of the tear film and manipulation of the ocular surface intra-operatively may reduce the goblet cell density and result in decreased TBUT post-operatively. We believe that the use of light filters, decreased microscopic exposure time, appropriate irrigation, and gentle handling of the ocular surface tissue may decrease the post-operative complications.

CONCLUSION

This study shows that majority of the patients who underwent phacoemulsification did not develop dry eye after the surgery. However, moderate level of dryness was observed in few patients only in the early post-operative period. Also, there was a significant reduction in corneal sensitivity for initial two weeks of post-operative period which normalized by the end of three months.

Declaration

There was no source of funding in our study hence there were no conflicts of interest.

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