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Pre and Postoperative Comparative Evaluation of Tear Film Stability and Conjunctival Impression Cytology After Phacoemulsification Using Clear Corneal Temporal Incision

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Abstract

Introduction: Development of significant dry eye symptoms and visual disturbances after successful cataract surgery remains the common and unsatisfying experience for ophthalmologists. Corneal incision site and surgical technique contribute in ocular surface damage after cataract surgery. To assess the pre and post-operative conjunctival impression cytology and tear film stability after phacoemulsification by clear corneal temporal incision.

Methodology: This prospective interventional study was conducted in department of ophthalmology at tertiary care teaching hospital. 72 patients were enrolled and the dry eye assessment was done considering the Schirmer's test, tear meniscus height, tear breakup time and conjunctival impression cytology; preoperatively and then at 1 week and 4 weeks postoperatively. ANOVA and Post Hoc test were used for statistical analysis and p value of <0.05 was considered significant.

Results: Mean age of the patients was 59.86±9.56 years and most of the males were employed while females were mostly homemakers. The overall trend for dry eye tests showed significant (P<0.0001 on ANOVA) increase at 1st week postoperatively, while the significant recovery was achieved by 4th week postoperatively. There was a significant decline (p<0.0001) in goblet cell density (GCD) at 1st week, which was reversed by the 4th week postoperatively.

Conclusion: The transient dry eye was seen in the patient's undergoing phacoemulsification by 1st week postoperatively, which resolved spontaneously but partially with routine postoperative care by the 4th week follow up.

Introduction

Cataract remains the leading cause of reversible blindness globally, characterized by the opacification of the normal transparent crystalline lens.[1] Nevertheless, after cataract surgery a notable subgroup of patients encounters the ocular pain, which is characterized by symptoms including dryness, foreign body sensation, ocular fatigue and vision abnormalities. These symptoms are collectively referred to as postoperative dry eye symptoms.[2] There have been studies indicating that both small incision cataract surgery (SICS) and phacoemulsification (phaco) surgery can potentially cause or worsen dry eye symptoms and impact the results of dry eye tests for up to three months after the operation.[3, 4]

SICS incision causes a loss of nerve supply to a significant portion of the cornea, whereas in phacoemulsification there is a decrease in corneal nerve damage and a decrease in manipulation of goblet cells. SICS patients may experience more severe symptoms of dry eyes with the foreign body sensations and accumulation of mucus and debris within the incision site as compared to phacoemulsification procedure which involves making a clear corneal incision (CCI).[5,6]

Tear film stability is the primary indicator of dry eye as the diminished tear film stability, together with tear osmolarity, are characteristic features of all types of dry eye, as highlighted by the Tear Film and Ocular Surface Society (TFOS).[7] Taehoon Oh concluded that the symptom score, corneal sensitivity, tear film stability, and average density of goblet cells showed the most significant decrease one day after the operation and also a direct relationship exists between symptoms of dry eye and reduced stability of the tear film and average density of goblet cells (GCD), when cytology samples were taken from the temporal area of the bulbar conjunctiva.[8]

Need of Study

The present study was aimed to address the lacuna, specifically concerning the choice of surgical procedure, in terms of incision technique, by analyzing the dry eye incidence and ocular surface changes following phacoemulsification with clear corneal temporal incision, thereby providing valuable insights into optimizing surgical outcomes and patient satisfaction.

Materials and Methods

This Prospective interventional study was conducted in the department of ophthalmology of a tertiary care teaching hospital after obtaining the approval from institutional ethical committee (IEC/2022/4027, dated 21/12/2022). Informed written consent was obtained from each enrolled patient.

Inclusion criteria:

- Age more than 45 years.
- All the patients admitted in department of ophthalmology having unilateral or bilateral age-related cataract without any existing dry eye symptoms.

Exclusion criteria:

- Age less than 45 years.
- Cataract caused by an etiology other than age, e.g., trauma, uveitis, drug induced, chemical or radiation corneal injuries.
- Pre-existing ocular diseases such as glaucoma, disorders of lids, conjunctiva, cornea, and sclera.
- Use of contact lens or who have undergone corneal refractive surgery.
- Patients who had ocular allergies, pterygium, or blepharitis.

Slit-lamp microscope examination, Schirmer's test 1 (ST-1), tear film breakup time (TBUT), tear meniscus height (TMH) and impression cytology were carried out in this specific order for every patient at the baseline/pre operatively and postoperatively on 1st week and 4th week follow up,.

Schirmer's test-1 (ST-1)

ST-I performed simultaneously in both the eyes without the use of corneal anaesthesia to assess the tear production by using the Schirmer's paper strips (Tear Touch) for 5-minute period. The quantity of

dampened surface was quantified in millimetres and wetting of <10 mm suggested a lack of tear production.

Tear meniscus height (TMH)

TMH was used to evaluate the amount of tear production and patients were directed to blink in a regular manner and then to stop blinking while keeping their eyes looking straight ahead. The height of the tear meniscus (TMH) was measured as the distance between the reflections of the upper and lower edges of the tear meniscus, immediately after the last blink using a horizontal slit lamp with medium-intensity light and 40 X magnifications. The measurement was conducted thrice in succession without employing fluorescein and mean data was used for calculations.

Tear Film Breakup Time (TBUT)

The stability of the tear film was evaluated by tear film breakup time (TBUT), where a sterile strip soaked in non-preserved saline solution containing fluorescein was inserted into the lower fornix, and the patients were instructed to blink multiple times. On slit lamp microscopy under a cobalt blue filter was used to examine the duration between a complete blink and the initial occurrence of black spot in tear film. TBUT test was repeated thrice, the value of <10 seconds was considered as abnormal and the mean value was computed for analysis.

Conjunctival impression cytology (CIC)

CIC was used to assess the status of GCD hence evaluate the amount of mucin production, which affects the tear film stability. 0.5% xylocaine drop instilled as topical anesthesia, any surplus tear fluid was removed and anesthesia was allowed one minute to take effect. Cellulose acetate filter paper with pore size 0.22µm was applied to the infero-nasal bulbar conjunctiva for 5 minutes and then the filter paper was extracted by grasping its tip as a 'peeling' action from the surface of the eye. Subsequently this filter paper was placed on slide which were appropriately identified and sequentially numbered and were stored at the ambient temperature.

The slides were dyed using the Periodic acid-Schiff (PAS) technique and then counterstained with hematoxylin and eosin. The mounted slides were inspected using a microscope at a magnification of 10 X the low power field. The cells were initially localized and subsequently inspected using a 40 X high-power field magnification. A minimum of 10 high-power fields HPF were analyzed to assess the presence of goblet cells and epithelial cells. The cytology was graded using Nelson's grading where grade 0 and /or 1 were considered as normal and grade 2 and /or 3 as abnormal cytology.

Nelson's grading:

Grade 0: The epithelial cells are small and round. The nuclei are large. The goblet cells are abundant, plump and oval.

Grade 1: The epithelial cells are slightly larger and more polygonal. The nuclei are smaller. The goblet cells are decreased in number; however, they still maintain their plump and oval shape.

Grade 2: The epithelial cells are larger, more polygonal and occasionally multinucleated. The nuclei are small. The goblet cells are markedly decreased in number and are smaller with well-defined cellular borders.

Grade 3: The epithelial cells are large and more polygonal with the nuclei small and pyknotic. The gob-

let cells are completely absent.

Statistical analysis was done using the software programs MS Excel (R) office 365, Graph Pad prism 8.4.2, and SPSS version 25. The Fisher Exact test or Chi square test was employed to compare proportions between categorical variables. The Mann-Whitney test or Student's t-test was used to analyse continuous variables and the multigroup comparisons were conducted using a Repeated Measures Analysis of Variance (RM-ANOVA). The Dunn post hoc analysis was employed to conduct intergroup comparisons after the initial analysis. A significance level of < 0.05 was used to determine statistical significance.

Results

The mean±SD age of the patients was 59.86±9.56 years with a range of 45-75 years, where most of the patients belonged to the age group of less than 70 years, there was a slight male preponderance (52.78%) and most of the males were employed in the study while females were mostly homemakers. The mean±SD preoperative baseline value for ST-1 was 17.75±1.62 mm, TMH was 0.41±0.08 mm and TBUT was 14.92±1.77 seconds. In all the 72 study patients CIC was grade 0 or grade 1, suggestive of no dry eye. [Figure 1]

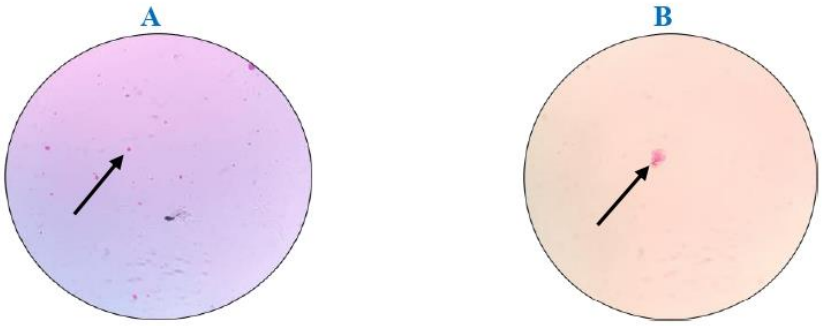

Figure 1: Microscopic picture (40X High power field)
A. Pre-op showing goblet cells in eosin stain [Nelson grade-0]
B. Post-op showing polygonal squamous cells in PAS stain [Nelson grade-3]

Postoperative results at 1st week

The mean±SD ST-1 was 11.76±1.38 mm, TMH was 0.26±0.06 mm and TBUT was 11.24±1.14 seconds. In about one fourth (23%) patients the CIC was found to be of grade 0-1, however in remaining three fourth (77%) patients the CIC was grade 2 or grade 3.

Postoperative results at 4th week

The mean±SD values for ST-1, TMH and TBUT at 4th week post-op was 15.69±1.37 mm, 0.34±0.07 mm and 12.38±1.36 seconds, respectively. The CIC showed grade 0 or grade 1 in 80% patients and remaining 20% patients had grade 2, cytology. [Figure 2]

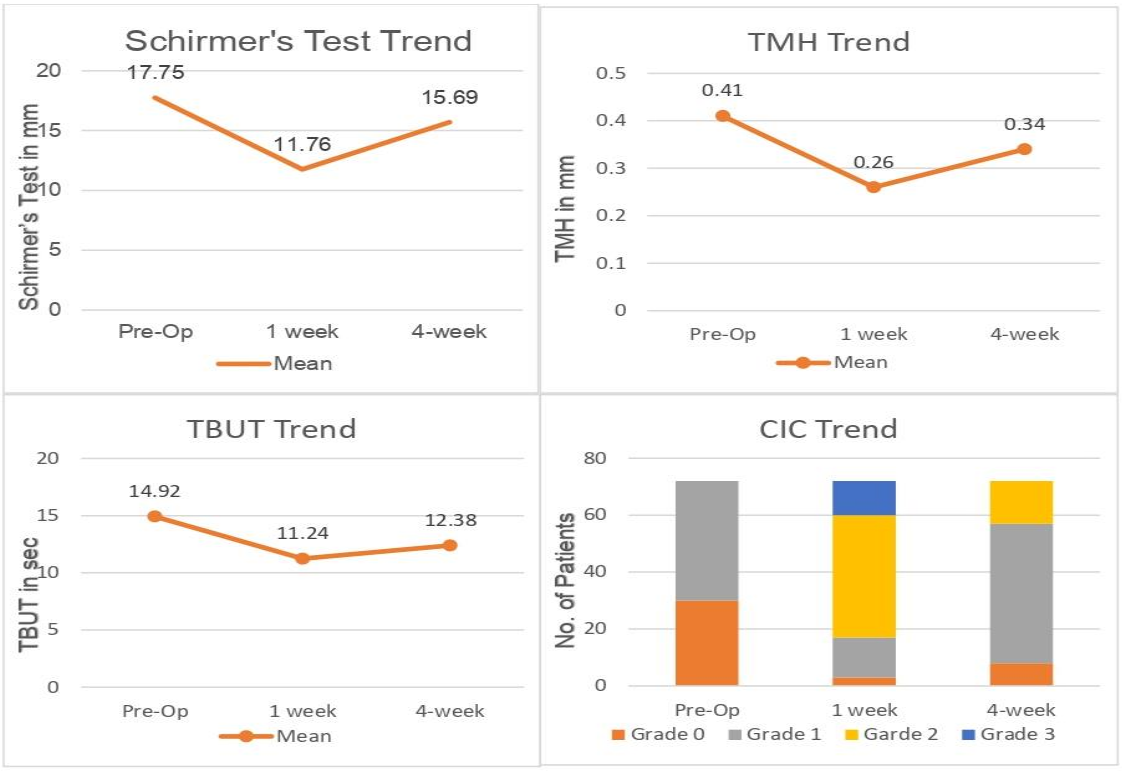

Figure 2: Pre and post-op ST-1, TMH, TBUT and CIC trends

The data from the ANOVA test analysis indicated a significant overall trend (P<0.0001) in ST-1, TMH, TBUT and CIC, suggesting a rise in dry eye symptoms during the 1st week postoperatively, however, by the 4th week there was a considerable rebound towards the preoperative baseline level. [Table 1]

Table 1: Dry eye evaluation parameters trend in the pre-op and post-op period

Dry eye Tests	Parameters	Pre-Op values (n =72)	Post-op values (n = 72)	
			1st week	4th weeks
Schirmer's Test-1 (mm)	Mean ± SD	17.75 ± 1.62	11.76 ± 1.38	15.69 ± 1.37
	Range	16-22	10-15	14-19
TMH(mm)	Mean ± SD	0.41 ± 0.08	0.26 ± 0.06	0.34 ± 0.07
	Range	0.24-0.55	0.15-0.40	0.20-0.46
TBUT(sec)	Mean ± SD	14.92 ± 1.77	11.24 ± 1.14	12.38 ± 1.36
	Range	12-19	9-14	10-15

CIC Nelson Grade	Pre operative (n= 72)	Post operative (n= 72)	
		1st week	4th week
0	30 (41.67%)	3 (4.17%)	8 (11.11%)
1	42 (58.33%)	14 (19.44%)	49 (68.05%)
2	0 (0.00%)	43 (59.72%)	15 (20.83%)
3	0 (0.00%)	12 (16.67%)	0 (0.00%)

Discussion

Our study showed a steep decline (p value <0.0001) in the mean ST-1, TMH and TBUT values at 1st week postoperative period, however this steep decline reversed back to almost preoperative baseline values at 4th week postoperative follow-up, although the p value still remained significant, when the preoperative and 4th week postoperative data was statistically compared. The CIC preoperatively was of grade 0 or grade 1 in all the 72 study patients, suggestive of normal GCD with no dry eye. Postoperatively at 1st week 76% patients had grade 2 or 3 cytology findings and at 4th week only 20% patients remained with grade 2 cytology findings, whereas nil (0%) patients showed grade 3, suggestive of recovery in most of the patients.

Kasetsuwan showed similar trends with notable increase in the intensity of dry eye symptoms after seven days, following phacoemulsification surgery; however there was a steady reduction in symptoms within thirty days and three months postoperatively. Nevertheless, the cytology assessment, which was also an important part of our study, showed that almost 50% of the patients had grade 2 or grade 3 cytology findings indicating dry eye. These findings mostly improved by the 4th week postoperative period. This phenomenon is attributed to the potential interference with the neurogenic response of the ocular surface and subsequent decrease in tear secretion.[9]

Proposed mechanisms by Al Aqaba suggested that their observations of dry eye following phacoemulsification may stem from the recovery process of corneal nerves. A recent study in 2022 by Hamed showed that the most important factor leading to dry eye post-phacoemulsification was the cornea's desensitization caused by the incision. Some potential factors contributing to postoperative complications include the use of antibiotic-steroid eye drops or ointment, irregularities in the corneal surface at the incision site, a decrease in the number of goblet cells near the incision, diminished corneal sensation due to the surgical incision disrupting the cornea-lacrimal gland loop, surgically induced ocular inflammation impacting tear production, and exposure to light from the surgical microscope. [10,11]

Saba Ishrat and Pragati Garg demonstrated that the occurrence of dry eye was significant after phacoemulsification surgery, with patterns resembling those found in our study. Furthermore, they highlighted the transient nature of dryness post-cataract surgery, with tendencies towards normalization within one month.[6,12]

Conclusions

The study was able to conclude that transient dry eye was seen in the patient's undergoing phacoemulsification by 1st week post-op period which was seen to resolve gradually with the routine postoperative treatment by the 4th week follow up.

Phacoemulsification is linked to temporary dry eye symptoms that typically resolve within one month after surgery. Understanding this pattern will enable physicians to effectively counsel and manage patients during the postoperative period.

In lieu of our study findings we recommend that the temporal clear corneal incision for phacoemulsification may produces minimal dry eye postoperatively, without much change in tear film stability or conjunctival cytology, and hence can be used in all types of cataract. However findings of this study need to be validated with larger studies from a more multicentric setting.

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