The Review Of
DIABETIC
STUDIES
OPEN ACCESS

Ocular Surface Changes After Cataract Surgery: Assessing Dry Eye Disease And Tear Film Instability

Haziel Rynjah[1*], Deepjyoti Baro[2], Indrajeet Mishra[3], Ibtesam Zaman[4], Syed Safikur Rahman[5], Nur Alom Choudhury[6]

[1*]*Assistant Professor, Department of Optometry, RSMAS, Royal Global University, Assam*
[2]*Optometrist, Department of Optometry, Sri Sankaradeva Nethralaya, Assam*
[3]*Optometrist, Department of Optometry, Kiran Netralaya Barauni, Bihar*
[4]*Faculty, Department of Optometry, Institute of Optometry and Paramedical Ophthalmic sciences, Sri Sankardeva Nethralaya, Assam*
[5]*Optometrist, Department of Optometry, Sri Sankardeva Nethralaya , Assam*
[6]*Optometrist, Department of Optometry, Mobile Medical Unit (NHM),Assam*

Abstract

Objective: To evaluate ocular surface changes and dry eye disease (DED) following cataract surgery, comparing outcomes between Small Incision Cataract Surgery (SICS) and Phacoemulsification(Phaco).
Methods: A prospective cohort study was conducted on 70 patients undergoing cataract surgery at Greater Siliguri Lions Eye Hospital from January to March 2024. Pre- and post-operative assessments included OSDI, TBUT, keratometry, and visual acuity.
Results: Significant postoperative improvements were observed in OSDI scores, BCVA, and near visual acuity
in both surgical groups. A mild but significant decline in TBUT was noted postoperatively in both SICS and Phaco groups. No significant intergroup differences were found in postoperative OSDI, TBUT, or visual acuity.
Conclusion: Both SICS and Phacoemulsification result in transient tear film instability but yield comparable visual and ocular surface outcomes. With proper management, cataract surgery does not significantly compromise long-term ocular surface health.

1. Introduction

Cataracts are a leading cause of visual impairment worldwide, characterized by the opacification of the eye's natural lens[1]. This condition primarily results from age-related degenerative changes but may also be influenced by systemic diseases such as diabetes mellitus, trauma, prolonged use of corticosteroids, poor nutrition, smoking, and excessive alcohol consumption[2]. As cataracts progress, they lead to reduced visual acuity, glare sensitivity, and impaired contrast sensitivity, ultimately affecting the quality of life[3]. The most effective treatment for cataracts is surgical intervention, including phacoemulsification and manual small incision cataract surgery (SICS), which aims to restore vision by replacing the opacified lens with an intraocular lens (IOL)[4]. Despite the benefits of cataract surgery, the procedure has been associated with the onset or exacerbation of dry eye disease (DED).

DED, also known as keratoconjunctivitis sicca[5], is a multifactorial condition characterized by the loss of homeostasis of the tear film and ocular surface[6]. The tear film comprises three layers: the outer lipid layer produced by the meibomian glands, the middle aqueous layer secreted by the lacrimal gland, and the inner mucin layer produced by goblet cells[7,8]. Any disruption in these layers can lead to ocular discomfort, inflammation, and visual disturbances[9]. Cataract surgery affects the tear film and ocular surface by causing corneal nerve damage, increased tear evaporation, and inflammatory responses, which can lead to symptoms of dry eye[10]. Additionally, factors such as ocular surface exposure during surgery, the use of topical anaesthetics and antiseptics, and post-operative anti-inflammatory medications can further contribute to dry eye development[11]. This study aims to investigate the relationship between cataract surgery and dry eye disease, focusing on the impact of surgical interventions on tear film stability, ocular surface changes, and postoperative discomfort.

2. Material and Methods

A prospective cohort study utilizing a questionnaire based on the Ocular Surface Disease Index (OSDI) was conducted at the Greater Siliguri Lions Eye Hospital, North Bengal, for 3 months, January 2024 to March 2024. The study included 68 patients who underwent cataract surgery, with data collected over three months. Statistical analysis was performed using SPSS version 22. Informed consent was obtained from all participants after explaining the study procedures and requirements.

Inclusion Criteria:
- Age group of 30-87 years
- Underwent cataract surgery
- Free from retinal disease

Exclusion Criteria:
- Contact lens wearer
- Thyroid eye disease
- Rheumatoid arthritis
- Nasolacrimal drainage blockage
- Corneal disease
- Moderate to severe dry eye disease (DED)
- Use of lubricating eye drops

2.1 Phase I: Vision Screening and Eye Examination

Patients visiting the hospital underwent a comprehensive eye examination, which included:
- A detailed medical and ocular history, including previous ocular and medical conditions.
- Visual acuity assessment for distance and near using a Log MAR chart.
- Slit-lamp examination to detect abnormalities in the anterior segment of the eye.
- Patients who met the exclusion criteria were referred for further treatment, while those meeting the inclusion criteria proceeded to the next phase.

2.2 Phase II: Pre- and Post-Cataract Surgery Ocular Assessment

This phase involves the evaluation of ocular parameters before and after cataract surgery. The following assessments were conducted:
1. Keratometry: Measurement of corneal curvature to assess astigmatism and aid in intraocular lens (IOL) power calculation.
2. Extraocular Muscle Function: Evaluation of eye movements and alignment using the Broad H test and cover test to rule out strabismus or muscle imbalance.
3. Cover Test: Assessment of ocular alignment and phoria at distance and near to detect any pre-existing or post-surgical deviations.
4. Dry Eye Disease (DED) Assessment:

Tear Film Break-Up Time (TBUT): This test was conducted to assess tear film stability under a slit lamp examination using a cobalt blue filter. Fluorescein dye was applied to the eye, and TBUT was measured. A normal TBUT was considered >10 seconds, mild to moderate DED ranged between 5-10 seconds, and severe DED was <5 seconds[12] .

Ocular Surface Disease Index (OSDI): The OSDI questionnaire, consisting of 12 questions, was used to assess dry eye symptoms. Scores were categorized as follows[14]
- Mild: 13-22%
- Moderate: 23-32%
- Severe: >33%

Patients with significant dry eye disease or other ocular abnormalities were managed accordingly before proceeding to cataract surgery.

2.3 Phase III: Post-Cataract Surgery Follow-Up and Dry Eye Reassessment

After cataract surgery, patients were followed up to reassess ocular parameters and dry eye disease. The following evaluations were performed:
1. Visual Acuity: Post-operative visual acuity was measured using a LogMAR chart.
2. Keratometry: Repeated to assess any changes in corneal curvature post-surgery.
3. Extraocular Muscle Function and Cover Test: Repeated to evaluate any changes in ocular alignment or muscle function.
4. Dry Eye Disease (DED) Reassessment:
• TBUT: Repeated to assess tear film stability.
• TMH: Re-evaluated to measure changes in tear meniscus height.
• OSDI: Re-administered to assess changes in dry eye symptoms.
• Eyelid Abnormality and Meibum Secretion Quality: Reassessed to monitor any improvements or worsening.

Results:
A total of 70 participants were included in the study. The age of the subjects ranged from 50 to 87 years, with a mean age of 62.25 ± 9.8 years. A study comprised 62.8% (n= 44) males and 37.1 % females (n=26). The SICS group comprised 47 patients, while the Phaco group included 23 patients.
A comparative analysis was performed between patients undergoing Small Incision Cataract Surgery (SICS) and those undergoing Phacoemulsification (Phaco) across various visual and ocular surface parameters as shown in table 1. Preoperative distance Visual Acuity (VA) in both eyes was comparable between the SICS and Phaco groups. The mean±SD of Pre-VA (OD) was 0.73 ± 0.359 in the SICS group and 0.64 ± 0.333 in the Phaco group (p = 0.332). Similarly, Pre-VA (OS) was 0.72 ± 0.355 in SICS and 0.67 ± 0.300 in Phaco (p = 0.559), indicating no statistically significant difference. Preoperative Near VA (OD) was higher (worse) in the SICS group (3.17 ± 1.179) compared to the Phaco group (2.59 ± 0.943, p = 0.033). Likewise, Near VA (OS) was significantly better in the Phaco group (2.64 ± 0.753) than in the SICS group (3.26 ± 1.099, p = 0.008). Preoperatively, Tear Break-Up Time (TBUT) was comparable between the groups, with values of 12.70 ± 0.765 seconds in the SICS group and 12.94 ± 1.358 seconds in the Phaco group (p = 0.433). Similarly, Tear Meniscus Height (TMH) and the presence of eyelid abnormalities did not differ significantly (p = 0.488 and p = 0.154, respectively). Postoperatively, TBUT remained statistically similar between the groups (11.13 ± 1.180 sec in SICS vs. 11.51 ± 1.755 sec in Phaco; p = 0.351), as did TMH and eyelid abnormalities, with unchanged p-values (p = 0.488 and p = 0.154). Corneal curvature (K values) also demonstrated no significant intergroup variation, with horizontal K values of 44.63 ± 1.611 (SICS) and 44.03 ± 3.465 (Phaco) (p = 0.431), and vertical K values of 44.70 ± 1.687 and 44.44 ± 1.296, respectively (p = 0.480). postoperative Ocular Surface Disease Index (OSDI) scores were statistically comparable (19.48 ± 2.333% in SICS vs. 19.96 ± 2.074% in Phaco; p = 0.387), indicating no significant difference in perceived ocular discomfort or dryness

Table 1: Comparison of Clinical Parameters Between Phacoemulsification and Small Incision Cataract Surgery.

Parameter's	SICS	Phaco	p-value (Sig.)
Pre VA (OD)	0.73 ± 0.359	0.64 ± 0.333	0.332
Pre VA (OS) log unit	0.72 ± 0.355	0.67 ± 0.300	0.559
Near VA (OD)	3.17 ± 1.179	2.59 ± 0.943	0.033
Near VA (OS)	3.26 ± 1.099	2.64 ± 0.753	0.008
Pre TBUT (sec)	12.70 ± 0.765	12.94 ± 1.358	0.433
Pre TMH Grade	0.00 ± 0.000	0.02 ± 0.146	0.488
Pre Eyelid Abnormality	0.04 ± 0.209	0.00 ± 0.000	0.154
K Horizontal	44.63 ± 1.611	44.03 ± 3.465	0.431
K Vertical	44.70 ± 1.687	44.44 ± 1.296	0.48
Post OSDI (%)	19.48 ± 2.333	19.96 ± 2.074	0.387
Post BCVA (log unit)	0.1174 ± 0.08766	0.1443 ± 0.07779	

Post TBUT (sec)	11.13 ± 1.180	11.51 ± 1.755	0.351
Post TMH	0.00 ± 0.000	0.02 ± 0.146	0.488
Post Eyelid Abnormality	0.04 ± 0.209	0.00 ± 0.000	0.154

A paired analysis of patients undergoing Small Incision Cataract Surgery (SICS) revealed statistically significant improvements across multiple clinical parameters, indicating positive postoperative outcomes shown in table 2. Ocular Surface Disease Index (OSDI) scores, decreasing from a preoperative mean of 40.40 ± 5.837% to 19.89 ± 2.494% postoperatively ($p < 0.001$), indicating a substantial improvement in patient-reported ocular surface comfort. Best-Corrected Visual Acuity (BCVA) significantly improved from 0.77 ± 0.229 logMAR preoperatively to 0.1238 ± 0.0848 logMAR postoperatively ($p < 0.001$), reflecting enhanced visual clarity. Similarly, Near Visual Acuity (M units) improved dramatically from 2.65 ± 0.873 to 0.75 ± 0.000 ($p < 0.001$), signifying restoration of functional near vision. Tear Break-Up Time (TBUT) showed a statistically significant decline from 12.89 ± 1.022 seconds preoperatively to 11.37 ± 1.416 seconds postoperatively ($p < 0.001$), suggesting some degree of postoperative tear film instability, though still within a clinically acceptable range. Corneal curvature measurements also showed minor but statistically significant changes. The horizontal keratometry (K horizontal) increased from 44.49 ± 1.31 to 44.98 ± 1.26 ($p < 0.001$), and vertical keratometry (K vertical) increased from 44.39 ± 1.42 to 44.74 ± 1.67 ($p = 0.05$), indicating subtle corneal steepening post-surgery.

Table 2: Pre- and Post-operative Changes in Clinical Parameters Following Small Incision Cataract Surgery.

Parameters	Pre-operative (Mean ± SD)	Post-operative (Mean ± SD)	p-value (Sig. 2-tailed)
OSDI (%)	40.40 ± 5.837	19.89 ± 2.494	0
BCVA (logMAR)	0.77 ± 0.229	0.1238 ± 0.0848	0
Near VA (M unit)	2.65 ± 0.873	0.75 ± 0.000	0
TBUT (sec)	12.89 ± 1.022	11.37 ± 1.416	0
K horizontal	44.49 ± 1.31	44.98 ± 1.26	0
K vertical	44.39 ± 1.42	44.74 ± 1.67	0.05
Average K	44.44 ± 1.31	44.85 ± 1.39	0

A paired analysis of patients undergoing Phacoemulsification demonstrated statistically significant improvements across multiple clinical parameters, indicating both functional and refractive benefits postoperatively. Ocular Surface Disease Index (OSDI) scores showed a substantial decrease from 40.17 ± 6.04% preoperatively to 20.17 ± 2.04% postoperatively ($p < 0.001$), reflecting a significant reduction in subjective symptoms of ocular discomfort and dry eye. Best-Corrected Visual Acuity (BCVA) improved markedly from 0.76 ± 0.23 logMAR to 0.15 ± 0.07 logMAR postoperatively ($p < 0.001$), indicating a significant gain in distance visual acuity. Near Visual Acuity (M unit) also showed a dramatic improvement, decreasing from 2.94 ± 1.01 preoperatively to 0.75 ± 0.00 postoperatively ($p < 0.001$), highlighting the effectiveness of the procedure in restoring near vision function. There was a significant decline in Tear Break-Up Time (TBUT) from 12.92 ± 1.14 seconds to 11.17 ± 1.83 seconds postoperatively ($p < 0.001$), suggesting a mild reduction in tear film stability, which is common after cataract surgery. Horizontal keratometry readings increased from 44.46 ± 1.17 to 44.97 ± 1.33 ($p < 0.001$),Vertical keratometry readings rose from 44.34 ± 1.18 to 44.49 ± 1.66 ($p = 0.05$), Average K values increased significantly from 44.40 ± 1.13 to 44.73 ± 1.36 ($p < 0.001$).

Table 2: Pre- and Post-operative Changes in Clinical Parameters Following Phacoemulsification.

Parameter	Pre Value (Mean ± SD)	Post Value (Mean ± SD)	p-value
OSDI (%)	40.17 ± 6.04	20.17 ± 2.04	0
BCVA (log unit)	0.76 ± 0.23	0.15 ± 0.07	0
Near VA (M unit)	2.94 ± 1.01	0.75 ± 0.00	0
TBUT (sec)	12.92 ± 1.14	11.17 ± 1.83	0
K horizontal reading	44.46 ± 1.17	44.97 ± 1.33	0
K vertical reading	44.34 ± 1.18	44.49 ± 1.66	0.05
Average K	44.40 ± 1.13	44.73 ± 1.36	0

Discussion:

This study aimed to evaluate and compare the impact of cataract surgery techniques—SICS and phacoemulsification—on various ocular surface parameters and visual acuity metrics. In our study, there was a significant postoperative reduction in OSDI scores in both surgical groups.

The OSDI decreased from 40.40% to 19.89% in the SICS group and from 40.17% to 20.17% in the Phaco group. This is consistent with Garg et al. (2020) who reported significant increases in OSDI immediately postoperatively, followed by recovery by one month, indicating transient dry eye symptoms following surgery.[15] Similarly, Nazm et al. (2022) found an initial rise in dry eye symptoms using OSDI scores, which subsided over a 4-week period, affirming the temporary nature of ocular surface disturbance after cataract procedures. [16]

A significant postoperative decrease in TBUT was noted in both groups: from 12.89 to 11.37 seconds in the SICS group and from 12.92 to 11.17 seconds in the Phaco group. This finding aligns with previous studies that also reported reduced TBUT post-surgery. Saba Ishrat et al. demonstrated a more pronounced reduction in the SICS group (mean TBUT 10.0 sec) than in the Phaco group (13.9 sec) at one-month follow-up.[16] Likewise, Cho and Kim and Puranik et al. observed significant reductions in TBUT, attributing this to corneal nerve damage, light exposure, and postoperative inflammation. [16-17]

Visual acuity outcomes were excellent in both groups, improving from 0.77 to 0.12 logMAR (SICS) and 0.76 to 0.15 logMAR (Phaco). This significant improvement is in line with studies such as Donthineni et al. (2020), who demonstrated a median improvement in BCVA from 1.1 to 0.1 logMAR after cataract surgery in patients with pre-existing dry eye disease. [18] These findings reinforce that dry eye symptoms do not impede the overall gain in visual acuity after cataract surgery when appropriate management is in place. [18]

Statistically significant but clinically minor increases were observed in both horizontal and vertical keratometry postoperatively. In SICS, K horizontal increased from 44.49 to 44.98 and K vertical from 44.39 to 44.74. This is comparable to findings by Baveja and Batra (2017), who also reported postoperative corneal steepening attributed to incision-induced biomechanical changes. [18]

Intergroup analysis in our study did not show statistically significant differences in postoperative TBUT, OSDI, or BCVA, suggesting both techniques yield comparable outcomes. However, the literature indicates that SICS may have a slightly more pronounced and prolonged impact on tear film parameters, likely due to the larger incision and longer surgical time. Nazm et al. and Garg et al. reported higher short-term dry eye prevalence and delayed TBUT normalization in SICS patients. [15,16]

Conclusion

Cataract surgery, whether performed via Small Incision Cataract Surgery (SICS) or Phacoemulsification (Phaco), is associated with significant improvements in visual acuity and patient-reported comfort as measured by OSDI scores. Although both surgical techniques led to a statistically significant reduction in Tear Break-Up Time (TBUT), indicating some postoperative tear film instability, these changes remained within a clinically acceptable range and were temporary. The absence of significant differences between the two surgical methods in terms of postoperative DED parameters suggests that both are comparably safe for the ocular surface when appropriate perioperative care is provided. However, SICS may show slightly more pronounced short-term effects on the tear film, likely due to its more invasive nature. Overall, with proper preoperative assessment and postoperative management, cataract surgery does not have a long-term adverse effect on ocular surface health.

Abbreviations

DED – Dry Eye Disease, **TBUT** – Tear Break-Up Time, **TMH** – Tear Meniscus Height, **OSDI** – Ocular Surface Disease Index, **DM** – Diabetes Mellitus, **HTN** – Hypertension, **ATD** – Aqueous Tear Deficiency, **SICS** – Small Incision Cataract Surgery, **LASIK** – Laser-Assisted In Situ Keratomileusis, **PRK** – Photorefractive Keratectomy, **LASEK** – Laser-Assisted Subepithelial Keratectomy, **Cat** – Cataract, **Pty** – Pterygium, **Cat Sx** – Cataract Surgery.

Reference

1. Moshirfar, M., Huynh, R., & Ellis, J. H. (2022). Cataract surgery and intraocular lens placement in patients with Fuchs corneal dystrophy: A review of the current literature. Current Opinion in Ophthalmology, 33(1), 21-27.
2. Nizami, A. A., Gulani, A. C., & Redmond, S. B. (2021). Cataract (Nursing).
3. Day, A. C., Burr, J. M., Bennett, K., Bunce, C., Doré, C. J., Rubin, G. S., ... & Yang, Y. (2020). Femtosecond laser-assisted cataract surgery versus phacoemulsification cataract surgery (FACT): a randomized noninferiority trial. Ophthalmology, 127(8), 1012-1019.
4. Venkatesh, R., Tan, C. S., Sengupta, S., Ravindran, R. D., Krishnan, K. T., & Chang, D. F. (2010). Phacoemulsification versus manual small-incision cataract surgery for white cataract. Journal of Cataract & Refractive Surgery, 36(11), 1849-1854.
5. Nelson, J. D. (1994). Diagnosis of keratoconjunctivitis sicca. International ophthalmology clinics, 34(1), 37-56.
6. Craig JP, Nichols KK, Akpek EK, Caffery B, Dua HS, Joo CK, Liu Z, Nelson JD, Nichols JJ, Tsubota K, Stapleton F. TFOS DEWS II definition and classification report. The ocular surface. 15(3):276-83
7. Szczotka-Flynn, L. B., Maguire, M. G., Ying, G. S., Lin, M. C., Bunya, V. Y., Dana, R., & Asbell, P. A. (2019). Impact of dry eye on visual acuity and contrast sensitivity: dry eye assessment and management study. Optometry and Vision Science, 96(6), 387-396.
8. Singh, T., & Ichhpujani, P. (2023). Assessing the Quality, Reliability, and Readability of Online Information on Dry Eye Disease. Cornea, 42(3), e5.
9. Zoukhri, D. (2006). Effect of inflammation on lacrimal gland function. Experimental eye research, 82(5), 885-898.
10. HARDTEN, D. R. (2008). Case Study: Managing Dry Eye. Ophthalmology
11. Nguyen, A., Kolluru, A., & Beglarian, T. (2023). Dry eye disease: A review of anti-inflammatory therapies. Taiwan Journal of Ophthalmology, 13(1), 3-12.
12. Hwang, H. B., Ku, Y. H., Kim, E. C., Kim, H. S., Kim, M. S., & Hwang, H. S. (2020). Easy and effective test to evaluate tear-film stability for self-diagnosis of dry eye syndrome: blinking tolerance time (BTT). BMC ophthalmology, 20, 1-7.
13. Doughty, M. J., Laiquzzaman, M., Oblak, E., & Button, N. (2002). The tear (lacrimal) meniscus height in human eyes: a useful clinical measure or an unusable variable sign? Contact Lens and Anterior Eye, 25(2), 57-65.
14. Li, J., Ma, J., Hu, M., Yu, J., & Zhao, Y. (2020). Assessment of tear film lipid layer thickness in patients with Meibomian gland dysfunction at different ages. BMC Ophthalmology, 20, 1-7.
15. Garg, P., Gupta, A., Tandon, N., & Raj, P. (2020). Dry eye disease after cataract surgery: study of its determinants and risk factors. Turkish journal of ophthalmology, 50(3), 133.
16. Nazm, N., Pisudde, P., Mukherjee, S., & Kadhane, A. Analysis of ocular surface and tear film abnormalities post cataract surgery-small incision cataract surgery V/S phacoemulsification. International journal of health sciences, 6(S6), 10368-10380.
17. Baveja, A., & Batra, N. (2017). A comparative study of tear film parameters before and after small incision cataract surgery and phacoemulsification. J Evid Based Med, 4(26), 1510-1513.
18. Donthineni, P. R., Das, A. V., Shanbhag, S. S., & Basu, S. (2020). Cataract surgery in dry eye disease: visual outcomes and complications. Frontiers in Medicine, 7, 575834.