A COMPARATIVE EVALUATION OF DRY EYE PARAMETERS IN PATIENTS UNDERGOING MANUAL SICS AND PHACOEMULSIFICATION IN A TERTIARY EYE CARE HOSPITAL

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ABSTRACT
BACKGROUND: Dry eye syndrome, a medical disorder characterised by inadequate tear production or heightened tear evaporation, results in eye irritation and discomfort. This disorder arises from alterations in the tear film layer. Following cataract surgery, many individuals have feelings of foreign objects, erythema, and symptoms of ocular dryness.
AIM: to compare dry eye parameters before and after manual small incision cataract surgery (SICS) and phacoemulsification inpatients undergoing cataract surgery.
METHODOLOGY: A prospective comparison study was conducted on 90 patients aged >50 years, undergoing elective cataract surgery at a tertiary eye-care hospital. Patients were randomised to manual small incision cataract surgery (SICS; n=45) or phacoemulsification (PHACO; n=45). Pre-operative and post-operative measurements of dry-eye parameters, including tear-film break-up time (TBUT), Schirmer I and II tests and tear-film meniscus height (TFMH) were recorded. Also examined were ocular surface findings, including abnormalities detected by slit-lamp biomicroscopy, corneal feeling and lid-margin alterations. Post surgery evaluations were done at 4,6 and 8 weeks postoperatively.
RESULTS: The mean age of 90 participants was 59.41 ± 5.61 years and 53.3% were males. Significant postoperative alterations in tear film characteristics were seen in both SICS and PHACO groups. TBUT, Schirmer I and tear-film meniscus height were substantially greater in PHACO group than SICS group at 4, 6 and 8 weeks ($p<0.001$ for all). Punctate epithelial erosions, decreased corneal feeling and lid margin abnormalities were similarly more common after SICS (57.8%, 35.6%, 33.3%) than PHACO (31.1%, 17.8%, 13.3%). The results suggest a superior healing of the postoperative ocular surface after phacoemulsification.
CONCLUSION: Although both manual SICS and phacoemulsification are effective methods for cataract extraction, manual SICS is linked to a higher risk and increased severity of postoperative dry eye disease in comparison to phacoemulsification

KEYWORDS: Cataract; Dry eye disease; Phacoemulsification; Small incision cataract surgery; Schirmer’s test.

1. INTRODUCTION

Dry eye is a complicated, multifaceted syndrome that impacts the tear film and ocular surface, resulting in symptoms like pain, visual impairments, and tear instability, potentially leading to harm to the ocular surface. The prevalence of dry eye illness is estimated to be 11.59% globally.1 This disorder is characterized by inadequate tear secretion or heightened tear evaporation, leading to eye pain, frequently associated with changes in the tear film.2,3

Elements contributing to the onset of dry eye following cataract procedures encompass prolonged utilization of antibiotic-steroid ocular drops, diminished tear film break-up time resulting from surface irregularities at the incision site, reduced mucin secretion from the conjunctiva as a consequence of incision positioning, impaired corneal sensation due to surgical incisions disrupting the cornea-lacrimal gland loop, leading to decreased tear production, and compromised tear film generation and stability due to surgically induced ocular inflammation and exposure to light from the operating microscope.4–6

Phacoemulsification continues to be the predominant technique employed for cataract surgery globally. Nonetheless, manual small incision cataract surgery (SICS) remains commonly executed owing to its benefits, including as reduced expenses, a shallower learning curve, and decreased operative time.7,8

The application of topical pharmaceuticals, such as non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and preservatives in eye drops, both before and after surgery, may induce epithelium toxicity and impede the recovery of the ocular surface post-cataract surgery. Cataract surgery is the most often executed operation in ophthalmology, and given that senile cataracts are the primary reason for such surgeries, recognizing and addressing ocular surface disease is essential.9–11

This study was attempted to compare dry eye parameters before and after manual small incision cataract surgery (SICS) and phacoemulsification inpatients undergoing cataract surgery.

OBJECTIVES:

1. To compare the preoperative and postoperative tear-film breakup time (TBUT), Schirmer I, Schirmer II and tear-film meniscus height (TFMH) in patients undergoing SICS and phacoemulsification to analyze the changes in the dry eye parameters after cataract surgery.
2. To compare the postoperative dry-eye parameters between SICS and phacoemulsification postoperatively regarding tear film stability, aqueous tear secretion and tear film volume.
3. To compare the post-operative ocular-surface results between SICS and phacoemulsification including slit-lamp abnormalities, corneal sensation and lid-margin changes. To evaluate whether the two surgical procedures differ in their influence on ocular-surface health.

MATERIALS AND METHODS:

This prospective comparative study was conducted in the Department of Ophthalmology, Sree Balaji Medical College and Hospital, Chennai. The study was conducted from October 2024 to April 2026. The study included patients aged >50 years attending the outpatient and inpatient services of the Department of Ophthalmology who were scheduled to undergo elective cataract surgery. Patients undergoing either manual small-incision cataract surgery (MSICS) or phacoemulsification were eligible for enrolment.

Sample Size:

The sample size was calculated using the formula $n = 4PQ/d^2$, where the prevalence of dry eye disease (32%), the confidence interval was 95%, the design effect was 1, and the allowable error was 10%. The calculated sample size was 87 participants. Including the potential dropouts, the final sample size was rounded to 90 participants.

Participants were categorized into two groups according to the type of cataract surgery performed.

Group A comprised 45 patients undergoing manual small-incision cataract surgery.

Group B comprised 45 patients undergoing phacoemulsification.

Inclusion Criteria

Patients were eligible for inclusion if they were aged >50 years

undergoing elective cataract surgery by either manual SICS or phacoemulsification.

Patients with systemic illnesses, including diabetes mellitus, hypertension, thyroid disorders, and hyperlipidemia

Exclusion Criteria

- Any pre-existing dry eye disease;
- cataract attributable to causes other than age, including trauma, uveitis, or drug-induced cataract; or pre-existing ocular disease involving the glaucoma, eyelids, conjunctiva, cornea, or sclera.
- ocular allergy,
- pterygium,
- blepharitis,
- chemical or radiation injury to the eye,
- contact lens use,
- chronic ocular medication use,
- previous ocular surgery including corneal refractive surgery, and autoimmune disorders.

Data Collection

Following acquisition of written informed consent, detailed demographic and clinical information was recorded using a predesigned data collection form. All participants underwent a comprehensive ophthalmic examination, including best-corrected visual acuity assessment, slit-lamp examination of the anterior segment, measurement of intraocular pressure, and fundus examination.

Dry eye status was evaluated both preoperatively and postoperatively using subjective and objective assessment methods. Subjective assessment was performed using a standardized dry-eye questionnaire. Objective assessment included Schirmer's test I and II for evaluation of tear secretion, tear-film breakup time (TBUT) for assessment of tear-film stability, tear-film meniscus height (TFMH) for assessment of tear volume, and ocular-surface staining with Rose Bengal to assess ocular-surface integrity. All assessments were performed in a standardized sequence.

Surgical Procedures

All cataract surgeries were performed under local anaesthesia using standard aseptic precautions by experienced surgeons.

Group A: Cataract surgery was conducted manually by making a sclero-corneal tunnel incision, extraction of the cataractous nucleus through the tunnel and implantation of a posterior chamber intraocular lens.

Group B: Phacoemulsification by a tiny clear corneal incision by ultrasonic emulsification of the nucleus and implantation of a posterior chamber intraocular lens.

Postoperative Care and Follow-up:
All participants received standard postoperative topical medications according to institutional protocol. Postoperative follow-up was performed at scheduled intervals. Dry-eye assessment was repeated postoperatively using the same standardized questionnaire and objective tests employed during the preoperative evaluation, thereby permitting comparison of dry-eye parameters before and after cataract surgery.

Ethical Considerations
Ethical clearance was obtained from the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants. Confidentiality of participant information was maintained throughout the study, and participants were informed of their right to withdraw from the study at any time.

STATISTICAL ANALYSIS:
Statistical analysis was done using SPSS 28.0. Continuous data are shown as mean ± standard deviation. Categorical variables are presented as frequencies and percentages. For comparisons of preoperative and postoperative parameters within the group, paired t-test or Wilcoxon signed-rank test was performed, as applicable. Between-group comparisons were performed with independent t-test or Mann–Whitney U test. Chi-square test was used to compare categorical variables. Effect sizes and percentage changes were calculated when appropriate. $p < 0.05$ (two sided) was regarded as statistically significant.

RESULTS:

Table 1: Descriptive statistics of continuous variables among study participants (n = 90)

Variable	Mean	Standard deviation	Minimum	Maximum
Age (years)	59.41	5.61	44.30	71.10
TBUT – preoperative (sec)	8.98	0.55	8.00	10.00
TBUT – postoperative (sec)	6.90	0.82	4.70	8.40
Schirmer I – preoperative (mm)	15.08	1.98	12.00	18.00
Schirmer I – postoperative (mm)	10.40	2.07	6.00	15.00
Schirmer II – preoperative (mm)	12.66	1.72	10.00	15.00
Schirmer II – postoperative (mm)	9.64	2.00	6.00	13.00
Tear Film Meniscus Height – preoperative (mm)	0.30	0.03	0.25	0.35
Tear Film Meniscus Height – postoperative (mm)	0.21	0.04	0.13	0.29

Table 1 presents the descriptive statistics for continuous variables of our study subjects. The mean age was 59.41 years. Postoperatively, TBUT, Schirmer I and II values and tear-film meniscus height were decreased from preoperative values. Out of 90 subjects 48 (53.3%) were males and 42 (46.7%) were females.

Table 2: Within-group comparison of pre- and postoperative dry-eye parameters

Parameter	Group	Test used	Test statistic	p-value
TBUT	SICS	Paired t-test	t = 41.05	<0.001
	PHACO	Wilcoxon signed-rank test	Z = 0.00	<0.001
Schirmer I	SICS	Wilcoxon signed-rank test	Z = 0.00	<0.001
	PHACO	Wilcoxon signed-rank test	Z = 0.00	<0.001
Schirmer II	SICS	Wilcoxon signed-rank test	Z = 0.00	<0.001
	PHACO	Wilcoxon signed-rank test	Z = 0.00	<0.001
Tear-film meniscus height	SICS	Paired t-test	t = 29.83	<0.001
	PHACO	Wilcoxon signed-rank test	Z = 0.00	<0.001

Within-group analysis showed significant differences in pre-operative versus post-operative dry eye parameters in both surgical groups. The change in TBUT was significant in SICS group and PHACO group. Similarly, both groups showed significant postoperative changes in Schirmer I and II test results. The tear-film meniscus height was also considerably different following surgery in both groups. The data demonstrate significant changes in tear film stability, aqueous tear secretion and tear film volume after cataract surgery regardless of surgical method.

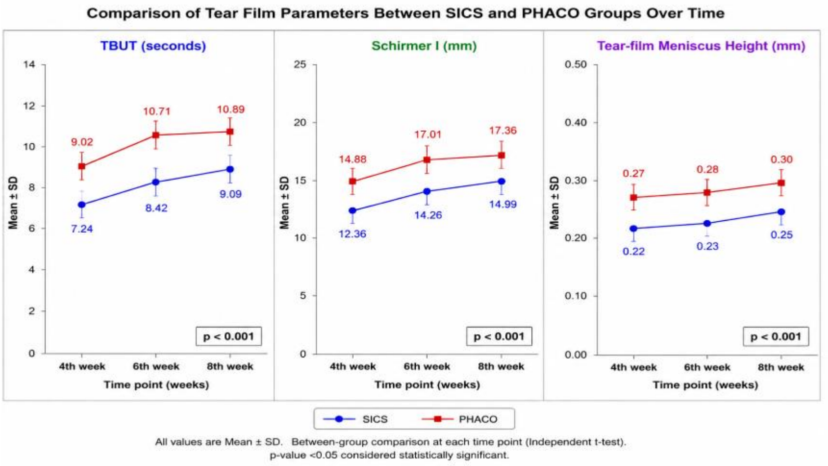

Figure 1: Group comparison of postoperative tear-film parameters

Between-group comparisons revealed that the postoperative TBUT, Schirmer I and tear film meniscus height values were substantially greater in the PHACO group than in the SICS group at the 4th, 6th and 8th weeks (p = <0.05). TBUT improved progressively in both groups during the follow-up. Schirmer I and tear-film meniscus height similarly improved with time. However, at all the assessment points the PHACO group had consistently higher results. These results demonstrate that phacoemulsification provides better postoperative tear film stability, aqueous tear secretion and tear volume than SICS.

Table 3: Comparison of ocular examination findings between surgical groups

Parameter	Finding	SICS, n (%)	PHACO, n (%)	Total, n (%)	p-value
Visual acuity	Normal	28 (62.2)	36 (80.0)	64 (71.1)	0.061
	Mildly reduced	17 (37.8)	9 (20.0)	26 (28.9)	
Slit-lamp biomicroscopy	Normal	19 (42.2)	31 (68.9)	50 (55.6)	0.013
	Punctate epithelial erosions	26 (57.8)	14 (31.1)	40 (44.4)	
Corneal sensation	Normal	29 (64.4)	37 (82.2)	66 (73.3)	0.049
	Reduced	16 (35.6)	8 (17.8)	24 (26.7)	
Lid margin/lash changes	Normal	30 (66.7)	39 (86.7)	69 (76.7)	0.040
	Lid margin changes	15 (33.3)	6 (13.3)	21 (23.3)	
Ocular movements	Normal	90 (100.0)	—	90 (100.0)	—
Anterior chamber	Normal	90 (100.0)	—	90 (100.0)	—

The distribution of visual acuity was not statistically significantly different between the two groups (p = 0.061). However, slit lamp abnormalities were substantially more common following SICS than PHACO (57.8% vs 31.1%; p=0.013). The SICS group also had a higher prevalence of reduced corneal sensation (35.6% vs 17.8%; p=0.049) and lid-margin alterations (33.3% vs 13.3%; p=0.040). Ocular movements and the anterior chamber results were normal in all subjects. The results show more ocular-surface anomalies after SICS than PHACO in total

DISCUSSION:

Cataract surgery is recognised for modifying both the qualitative and quantitative characteristics of the tear film and ocular surface. Manual SICS and phacoemulsification are two methods that vary in the site and profundity of the incision. In manual SICS, a linear incision is executed on the sclera superiorly, breaching the cornea at the

Schwalbe line, whereas in phacoemulsification, the incision occurs in the transparent cornea at the temporal location.12

The current investigation sought to deliver a thorough comparative assessment of dry eye parameters following manual SICS and phacoemulsification in a tertiary care environment, with a specific focus on tear film stability, tear secretion, ocular surface alterations, and related risk factors.

Demography and Clinical Profile:

The mean age of the study cohort was 59.41±5.61 years, indicative of the standard demographic receiving cataract surgery. The progression of age is a well-documented risk factor for dry eye illness, attributed to age-associated malfunction of the lacrimal glands, loss of meibomian glands, and diminished corneal sensitivity.13 The nearly balanced gender distribution guaranteed sufficient representation and reduced gender-related bias. Although dry eye disease is conventionally reported to be more prevalent in females, particularly in postmenopausal women, several studies based on cataract surgery have demonstrated comparable postoperative dry eye incidence between genders, aligning with our findings.14

All participants in the current study were diagnosed with diabetes mellitus and hypertension, establishing a uniform systemic profile. Diabetes is recognised for its detrimental effects on corneal innervation and its capacity to diminish reflex tear production, consequently predisposing individuals to postoperative dry eye.15

Changes in tear film stability:

The mean TBUT was lowered in general from 8.98 ± 0.55 seconds preoperatively to 6.90 ± 0.82 seconds postoperatively. Similarly, Schirmer I reduced from 15.08 ± 1.98 mm to 10.40 ± 2.07 mm, Schirmer II from 12.66 ± 1.72 mm to 9.64 ± 2.00 mm and tear-film meniscus height from 0.30 ± 0.03 mm to 0.21 ± 0.04 mm. Within-group analysis showed statistically significant postoperative change for all parameters in SICS and PHACO group. A notable decrease in TBUT was observed post-operatively in both SICs and phacoemulsification groups ($p < 0.001$), indicating a decline in tear film stability following cataract surgery. This discovery aligns with earlier research indicating that cataract surgery disrupts the tear film via corneal nerve transection, epithelial damage, and postoperative inflammation.4

TBUT decrease was significantly higher in the SICS group as seen by intergroup comparisons, effect size analyses, percentage changes and TBUT change ratings. The large Cohen's d values for both groups imply clinical significance; however, the larger drop in the SICS group suggests that this group is more affected by ocular surface damage. This discrepancy may be due to larger scleral-corneal incisions, more manipulation of ocular tissues and longer surgical exposure in SICS.16

These findings substantiate previous comparative study that indicating greater tear film instability after manual SICs in contrast to phacoemulsification.17

Tear Secretion Parameters: Schirmer I and II Tests:

In both groups, Schirmer I and Schirmer II tests showed significant decrease postoperatively in each group, indicating lower basal and reflex tear production. This loss of corneal sensitivity may be transient and subsequent to surgical trauma and corneal nerve injury of the lacrimal functional unit.18

However, there was no statistically significant intergroup difference in the postoperative Schirmer values. Thus, despite cataract surgery affects tear production in both directions, the severity of postoperative dry eye between SICS and phacoemulsification is mostly determined by the stability of tear film instead of aqueous shortage. Similar results have been reported in previous studies showing TBUT showed more sensitivity than Schirmer test in diagnosis of surgery induced dry eye.19

Tear Film Meniscus Height (TFMH):

Both groups showed a significant decrease in TFMH postoperatively which indicates a decrease in tear generation, there was no statistically significant difference between the groups. It implies that the both the procedures have a similar effect on tear volume and that variations in dry eye symptom intensity are more related to tear film quality and evaporation rates than volume alone.20

Ocular Surface and Visual Outcomes:

The slit lamp examination revealed significantly more punctate epithelial erosions in the SICS group ($P<0.001$). These findings imply a considerable degradation of the epithelium layer and ocular surface inflammation after to SICS. The SICS group had a significantly higher occurrence of reduced corneal sensation, which further supports the theory that larger incisions cause greater corneal nerve injury.21

Punctate epithelial erosions were more common in the SICS group than in the PHACO group (57.8% vs 31.1%; $p = 0.013$). There was also a higher rate of reduced corneal sensation after SICS (35.6% versus 17.8%; $p = 0.049$). Lid-margin abnormalities were present in 33.3% of SICS patients compared with 13.3% of PHACO patients ($p = 0.040$).

Damage to corneal nerves resulted in a reduced blink response and decreased tear output, therefore promoting tear film instability. In vivo confocal microscopy studies have shown a delay in corneal nerve regeneration after bigger incisions, consistent with our results.22

Lid margin abnormalities were markedly more common in the SICS group, indicating a heightened involvement of evaporative dry eye mechanisms. Surgical stress and postoperative inflammation may aggravate preexisting meibomian gland dysfunction, further destabilising the tear film.23

Although a larger percentage of patients in the SICS group displayed mildly diminished visual acuity, the disparity was not statistically significant. This underscores that visual acuity alone does not indicate ocular surface health.

Numerous studies have highlighted that instability in the tear film can lead to variable vision and patient dissatisfaction, even with satisfactory Snellen acuity.24

The current research offers a comparative assessment of dry eye parameters subsequent to manual SICS and phacoemulsification in a tertiary eye care environment. The results unequivocally indicate that cataract surgery is linked to a notable decline in postoperative tear film stability, tear production, and ocular surface integrity, regardless of the surgical technique utilized.

Intergroup comparison indicated that TBUT was the most sensitive parameter in distinguishing postoperative dry eye severity between the two techniques, with a markedly greater reduction noted in the SICS group. Ocular surface assessment revealed a heightened occurrence of punctate epithelial erosions, diminished corneal sensitivity, and lid margin irregularities in the SICS cohort, indicating increased ocular surface disruption and neurosensory impairment.

There are some limitations of this study. The relatively small sample size and single-centre design may restrict the generalisability of the findings. We only followed up for 8 weeks; thus, we could not analyse longer-term healing or permanence of surgical ocular-surface alterations. The study mostly used clinical tests for the assessment of tear film and ocular surface but did not include sophisticated investigations like tear osmolarity, meibography, inflammatory biomarkers or corneal nerve imaging.

CONCLUSION:

In conclusion, although both manual SICS and phacoemulsification are effective methods for cataract extraction, manual SICS is linked to a higher risk and increased severity of postoperative dry eye disease in comparison to phacoemulsification.

Preoperative identification of dry eye, especially in elderly diabetic patients, and early postoperative use of preservative-free lubricants may help mitigate these effects. Where feasible, phacoemulsification maybe preferred inpatients at high-risk for dry eye disease.

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