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ORIGINAL RESEARCH

Prospective Analysis of Dry Eye Syndrome in Patients Undergoing Cataract Surgery with Phacoemulsification

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ABSTRACT

Background: Dry Eye Syndrome (DES) is a common postoperative complication of cataract surgery, particularly phacoemulsification, potentially impacting patient comfort and satisfaction. Although often transient, its incidence and severity may be influenced by surgical factors and systemic comorbidities. **Aim:** To prospectively evaluate the incidence, severity, and progression of Dry Eye Syndrome in patients undergoing phacoemulsification cataract surgery, and to assess the influence of systemic comorbidities on postoperative DES. **Material and Methods:** This prospective observational study included 110 patients aged ≥50 years undergoing phacoemulsification for senile cataract. Patients with pre-existing ocular surface disorders or autoimmune conditions were excluded. All participants underwent standardized preoperative assessments, including Schirmer's Test I, Tear Film Break-Up Time (TBUT), Ocular Surface Disease Index (OSDI), and fluorescein staining. Postoperative evaluations were conducted on Day 7, Day 30, and Day 90. Data were analyzed using paired t-test and chi-square test, with $p < 0.05$ considered statistically significant. **Results:** The mean preoperative Schirmer's value was 17.8 ± 5.1 mm and TBUT was 12.6 ± 3.4 seconds. Postoperatively, Schirmer's and TBUT dropped significantly at Day 7 (10.4 ± 3.2 mm; 6.2 ± 1.9 sec), with gradual recovery by Day 90 (15.1 ± 4.3 mm; 10.9 ± 3.2 sec). OSDI scores increased from 13.5 ± 5.9 preoperatively to 28.6 ± 7.3 on Day 7, declining to 15.7 ± 5.8 by Day 90. Based on DEWS II criteria, 74.55% had DES on Day 7, decreasing to 36.36% by Day 90. Hypertension and diabetes were significantly associated with higher DES incidence ($p = 0.031$ and $p = 0.021$, respectively). **Conclusion:** Phacoemulsification cataract surgery leads to a transient but significant increase in dry eye symptoms, peaking in the first week postoperatively and resolving over three months. Systemic comorbidities such as hypertension and diabetes markedly elevate the risk. Early recognition and appropriate management of DES can enhance postoperative outcomes.

Keywords: Dry Eye Syndrome, Cataract Surgery, Phacoemulsification, Schirmer's Test, Tear Film Break-Up Time

INTRODUCTION

Dry Eye Syndrome (DES) is a multifactorial ocular surface disease characterized by a loss of homeostasis of the tear film, accompanied by ocular symptoms such as burning, irritation, foreign body sensation, and visual disturbance. It is one of the most prevalent conditions encountered in ophthalmic practice and poses a significant burden on patients' quality of life and visual function[1]. The global prevalence of DES varies widely across populations due to differing diagnostic criteria and geographic factors, but it is generally reported to affect a substantial proportion of the aging population[2]. As age advances, changes in lacrimal gland function, reduced blink rate, hormonal imbalance, and increased ocular surface exposure contribute to the development and exacerbation of dry eye symptoms.

Cataract, being an age-related condition, commonly coexists with DES in elderly individuals. Cataract surgery, particularly the modern technique of phacoemulsification, is among the most frequently performed ophthalmic procedures worldwide. While the surgery significantly improves visual acuity and patient satisfaction, it is increasingly recognized that it can induce or exacerbate dry eye symptoms in the postoperative period[3]. This phenomenon is attributed to multiple mechanisms including disruption of the corneal nerves, use of ocular surface-irritating antiseptics and antibiotics, exposure to operative light, and inflammatory mediators triggered by surgical trauma[4].

Numerous studies have attempted to characterize the nature and extent of DES following cataract surgery. However, results remain variable due to differences in study populations, assessment timelines, tear film

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parameters used, and inclusion of comorbid conditions such as diabetes. Some studies have reported a transient worsening of dry eye symptoms within the first week after surgery, which gradually returns to baseline within a few months[5]. Others suggest that certain subgroups of patients, such as those with pre-existing ocular surface disorders or systemic comorbidities, may experience prolonged or persistent DES[6]. Therefore, understanding the time course and risk factors associated with post-phacoemulsification DES is essential for improving patient care and satisfaction.

Tear film stability and function are typically assessed through objective tests such as Schirmer's Test I, Tear Film Break-Up Time (TBUT), fluorescein staining, and patient-reported symptom scores such as the Ocular Surface Disease Index (OSDI). Postoperative changes in these parameters provide critical insights into the pathophysiology of surgical-induced dry eye. Among these, TBUT and Schirmer's Test I are widely used to evaluate tear film instability and aqueous deficiency, respectively. Several prospective and comparative studies have demonstrated that phacoemulsification is associated with a temporary reduction in TBUT and Schirmer's values, particularly within the first 30 days[7]. The subsequent recovery trend is often seen by the end of the third postoperative month, although interindividual variability exists depending on ocular surface resilience and patient characteristics.

The choice of surgical technique has also been identified as an influencing factor in the development of DES. While both manual small incision cataract surgery (MSICS) and phacoemulsification are considered safe and effective, the latter has been associated with slightly lower incidence and severity of postoperative dry eye in some comparative analyses[8]. Phacoemulsification typically involves a smaller corneal incision and less conjunctival manipulation, which may account for better postoperative tear film stability. However, the use of topical medications post-surgery, including corticosteroids and antibiotics, can induce ocular surface toxicity or exacerbate inflammation, thereby impacting tear film parameters.

More recent investigations have focused on how preoperative evaluation and early intervention can mitigate the impact of cataract surgery on the ocular surface. Identifying patients at risk of developing postoperative DES, especially those with borderline preoperative tear metrics, is crucial. Early administration of artificial tears or anti-inflammatory agents may reduce symptom severity and facilitate faster recovery[9]. In addition, preoperative counseling about the possibility of transient dry eye symptoms may improve patient compliance with postoperative care and enhance overall satisfaction with surgical outcomes.

Despite the growing body of literature, there remains a need for well-structured, prospective studies that comprehensively evaluate the onset, severity, and resolution pattern of DES following phacoemulsification, especially in patients with no prior diagnosis of dry eye. Furthermore, standardization in diagnostic criteria, timing of evaluations, and use of both subjective and objective parameters will facilitate better comparisons across studies and enable evidence-based improvements in clinical protocols. With advancements in surgical techniques and heightened patient expectations, addressing even transient postoperative discomfort such as DES becomes imperative[10].

MATERIAL AND METHODS

This **prospective observational study** was conducted in the Department of Ophthalmology at a tertiary care teaching hospital, following approval from the Institutional Ethics Committee (IEC). The study aimed to evaluate the incidence, severity, and clinical profile of Dry Eye Syndrome (DES) in patients undergoing cataract surgery using the phacoemulsification technique.A total of **110 patients** diagnosed with senile cataract and scheduled for phacoemulsification were enrolled consecutively from the outpatient department after obtaining written informed consent.

Inclusion Criteria

- Patients aged **50 years and above**
- Diagnosed with **senile cataract** in one or both eyes
- Willing to undergo **phacoemulsification**
- Provided **written informed consent** for participation

Exclusion Criteria

- Pre-existing **Dry Eye Disease**
- History of **ocular surface disorders**, **blepharitis**, or **chronic conjunctivitis**
- Patients with **autoimmune diseases** (e.g., Sjögren's syndrome, rheumatoid arthritis)
- History of **ocular surgery or trauma**
- Use of **topical ocular medications** other than lubricants within 6 months
- Contact lens wearers

Preoperative Evaluation

All enrolled patients underwent a detailed preoperative ophthalmic assessment to ensure baseline comparability and exclude confounding ocular conditions. This included visual acuity testing, slit-lamp biomicroscopy for anterior segment examination, and intraocular pressure (IOP) measurement using Goldmann applanation tonometry. A dilated fundus examination was also performed to evaluate the posterior segment status. In addition to the routine ophthalmological evaluation, specific tests for dry eye assessment were conducted one week prior to surgery. These included Schirmer's Test I (performed without anesthesia) to assess basic tear

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secretion, Tear Film Break-Up Time (TBUT) to evaluate tear film stability, and administration of the Ocular Surface Disease Index (OSDI) questionnaire to quantify subjective symptoms. Corneal integrity and staining patterns were assessed using fluorescein dye to identify ocular surface damage.

Surgical Procedure

All patients underwent phacoemulsification performed by a single experienced surgeon to maintain consistency in surgical technique. The procedure was carried out under topical anesthesia using a standard protocol. A 2.8 mm clear corneal incision was made, followed by creation of a continuous curvilinear capsulorhexis. Nucleus emulsification was performed using the divide-and-conquer technique, followed by cortical aspiration. A foldable posterior chamber intraocular lens (PCIOL) was implanted in the capsular bag. Throughout the procedure, Balanced Salt Solution (BSS) was used for ocular irrigation. The same surgical instruments and operating microscope settings were maintained for all cases to minimize variability. Postoperatively, all patients received a standardized regimen comprising topical moxifloxacin 0.5% four times daily for one week, topical prednisolone acetate 1% tapered over four weeks, and lubricating eye drops containing carboxymethylcellulose 0.5% four times daily for one month.

Postoperative Evaluation

Postoperative follow-up was conducted on Day 7, Day 30, and Day 90 after surgery. At each visit, dry eye assessments were repeated to evaluate changes in tear film parameters and ocular surface health. These included Schirmer's Test I, TBUT, OSDI scoring, and corneal fluorescein staining. The severity of postoperative Dry Eye Syndrome (DES) was assessed according to the Dry Eye Workshop II (DEWS II) classification, which integrates both subjective symptoms and objective clinical signs. The serial evaluations allowed monitoring of both the short-term and longer-term effects of phacoemulsification on tear film dynamics and ocular surface condition.

Statistical Analysis

Data were compiled using Microsoft Excel and analyzed using SPSS version 26.0. Quantitative variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. Comparison of preoperative and postoperative dry eye parameters was done using paired t-test or Wilcoxon signed-rank test, depending on data normality. A p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Baseline Characteristics (Table 1)

The study included a total of 110 patients undergoing cataract surgery via phacoemulsification, with a mean age of 64.25 ± 8.72 years, indicating an elderly population consistent with the typical age group affected by senile cataract. The gender distribution was relatively balanced, with 58 males (52.73%) and 52 females (47.27%), and the difference was statistically non-significant ($p = 0.481$), suggesting no gender bias in patient selection.Regarding the laterality of surgery, the majority of patients (95, 86.36%) underwent unilateral procedures, while only 15 patients (13.64%) had bilateral cataract surgery during the study period. The mean preoperative best corrected visual acuity (BCVA) was 0.82 ± 0.21 LogMAR, reflecting moderate visual impairment pre-surgery. A significant portion of the study population had systemic comorbidities, with hypertension present in 45 patients (40.91%) and diabetes mellitus in 34 patients (30.91%), underscoring the need to explore systemic influences on ocular surface health.

Preoperative Dry Eye Parameters (Table 2)

Preoperative assessment of dry eye parameters showed a mean Schirmer's Test I value of 17.8 ± 5.1 mm, indicating generally adequate baseline tear secretion. The tear film break-up time (TBUT) averaged 12.6 ± 3.4 seconds, which is within the normal range, and the mean OSDI (Ocular Surface Disease Index) score was 13.5 ± 5.9, suggesting mild to borderline dry eye symptoms in some patients prior to surgery.

Fluorescein staining revealed that 91.82% of eyes (101 patients) had no corneal staining (Grade 0), while 8.18% (9 patients) showed mild staining (Grade I). These results confirm that the majority of the study population did not have significant dry eye disease preoperatively, and any subsequent development of DES can be more confidently attributed to surgical influence.

Postoperative Dry Eye Parameters Over Time (Table 3)

There was a statistically significant change ($p < 0.001$) in all dry eye parameters across the three postoperative time points (Day 7, Day 30, and Day 90). The mean Schirmer's Test I value dropped to 10.4 ± 3.2 mm at Day 7, reflecting a transient reduction in tear production immediately after surgery. However, it gradually improved to 12.6 ± 3.7 mm by Day 30 and 15.1 ± 4.3 mm by Day 90, indicating partial recovery of tear secretion over time.

Similarly, the TBUT decreased sharply to 6.2 ± 1.9 seconds on Day 7, reflecting early postoperative tear film instability. By Day 30 and Day 90, it improved to 8.4 ± 2.6 seconds and 10.9 ± 3.2 seconds, respectively. The OSDI score, which represents patient-reported symptoms, was highest on Day 7

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(28.6 ± 7.3), indicating symptomatic discomfort, but showed significant improvement by Day 30 (21.3 ± 6.5) and further by Day 90 (15.7 ± 5.8). These findings show a clear trend of postoperative dry eye symptoms peaking in the first week and gradually resolving over three months.

Incidence and Severity of Postoperative Dry Eye (Table 4)

Based on the DEWS II classification, the severity of postoperative DES was highest on Day 7, with 82 patients (74.55%) experiencing varying degrees of dry eye—mild in 40 (36.36%), moderate in 30 (27.27%), and severe in 12 (10.91%). The proportion of patients with no dry eye symptoms was only 25.45% at this stage.

By Day 30, the incidence of severe dry eye dropped sharply to 2.73%, while moderate cases also decreased to 18.18%, and mild cases remained the most common (40.91%). At Day 90, most patients (70, 63.64%) had no signs of DES, and only 2 patients (1.82%) continued to experience severe symptoms, reflecting significant spontaneous resolution or response to lubricating therapy. The differences in severity across time points were statistically significant ($p < 0.001$), indicating that postoperative DES is often transient and improves over time.

Correlation with Systemic Comorbidities (Table 5)

Among the 82 patients who developed DES at Day 7, 39 (86.67%) had hypertension, compared to only 6 patients (13.33%) without DES, yielding a statistically significant association ($p = 0.031$). Similarly, 30 of 34 diabetic patients (88.24%) developed DES compared to just 4 (11.76%) without symptoms, also showing a significant correlation ($p = 0.021$). These findings suggest that systemic comorbidities like hypertension and diabetes mellitus significantly increase the risk of postoperative DES, possibly due to microvascular and inflammatory changes affecting the ocular surface.

Table 1: Demographic and Baseline Clinical Characteristics of Study Population (n = 110)

Parameter	Category	Number (n)	Percentage (%)	p-value
Age (years)	Mean ± SD	—	64.25 ± 8.72	—
Gender	Male	58	52.73	0.481
	Female	52	47.27	
Laterality of Surgery	Unilateral	95	86.36	—
	Bilateral	15	13.64	
Preoperative BCVA (LogMAR)	Mean ± SD	—	0.82 ± 0.21	—
Systemic Disease - Hypertension	Present	45	40.91	—
	Absent	65	59.09	
Systemic Disease - Diabetes	Present	34	30.91	—
	Absent	76	69.09	

Table 2: Preoperative Dry Eye Parameters

Parameter	Category	Number (n)	Percentage (%)	Mean ± SD
Schirmer's Test I (mm/5 min)	—	—	—	17.8 ± 5.1
TBUT (seconds)	—	—	—	12.6 ± 3.4
OSDI Score	—	—	—	13.5 ± 5.9
Corneal Fluorescein Staining	Grade 0	101	91.82	—
	Grade I	9	8.18	—

Table 3: Postoperative Dry Eye Parameters at Different Time Points

Parameter	Day 7	Day 30	Day 90	p-value
Schirmer's Test I (mm)	10.4 ± 3.2	12.6 ± 3.7	15.1 ± 4.3	< 0.001
TBUT (seconds)	6.2 ± 1.9	8.4 ± 2.6	10.9 ± 3.2	< 0.001
OSDI Score	28.6 ± 7.3	21.3 ± 6.5	15.7 ± 5.8	< 0.001

Table 4: Incidence and Severity of Postoperative Dry Eye Syndrome Based on DEWS II Classification

Severity Grade	Day 7 (n, %)	Day 30 (n, %)	Day 90 (n, %)	p-value
No Dry Eye	28 (25.45%)	42 (38.18%)	70 (63.64%)	< 0.001
Mild	40 (36.36%)	45 (40.91%)	28 (25.45%)	
Moderate	30 (27.27%)	20 (18.18%)	10 (9.09%)	
Severe	12 (10.91%)	3 (2.73%)	2 (1.82%)	

Table 5: Correlation of Postoperative DES with Systemic Comorbidities (at Day 7)

Comorbidity	Patients with DES (n = 82)	Patients without DES (n = 28)	p-value
Hypertension (n = 45)	39 (86.67%)	6 (13.33%)	0.031*
Diabetes Mellitus (n = 34)	30 (88.24%)	4 (11.76%)	0.021*

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DISCUSSION

The demographic profile of patients in the present study revealed a mean age of 64.25 ± 8.72 years, aligning with the known epidemiology of senile cataract, which predominantly affects the elderly. The gender distribution was nearly equal, showing no significant sex predilection for cataract formation or phacoemulsification outcomes. Similar demographic trends have been documented by Sahu et al. (2020)[11], who studied 150 cataract patients and reported a comparable age range and gender distribution, reinforcing that senile cataract is a common, age-related pathology with no strong gender bias.

The preoperative dry eye evaluation in this study demonstrated that most patients had normal tear secretion and stable tear film, with Schirmer's Test I averaging 17.8 ± 5.1 mm and TBUT of 12.6 ± 3.4 seconds. Only 8.18% exhibited mild fluorescein staining, and the mean OSDI score was 13.5 ± 5.9, indicating a relatively healthy ocular surface before surgery. These findings are consistent with those of Li et al. (2016)[12], who evaluated 120 patients and found that fewer than 10% had pre-existing dry eye signs prior to cataract surgery, confirming that DES postoperatively is likely attributable to surgical insult rather than baseline pathology.

Postoperative dry eye parameters showed a significant transient decline, with Schirmer's values falling to 10.4 ± 3.2 mm and TBUT to 6.2 ± 1.9 seconds on Day 7, before recovering toward baseline by Day 90. OSDI scores followed a similar pattern. These findings reflect the acute disruption of ocular surface homeostasis and lacrimal gland reflex arc caused by surgery. Ram et al. (2021)[13] reported similar postoperative changes, with TBUT reducing to 5.8 seconds on Day 7 and improving by 12 weeks, supporting the hypothesis that phacoemulsification induces temporary ocular surface dysfunction which is largely reversible with time and supportive therapy.

The progression of DES severity across time points revealed that 74.55% of patients had DES on Day 7, reducing to 36.36% by Day 90, with most cases being mild. The spontaneous resolution trend aligns with the findings of Kasetsuwan et al. (2013)[14], who documented DES in 66.7% of eyes one week after phacoemulsification, which declined to 22.2% by the third postoperative month. This supports the conclusion that phacoemulsification-associated dry eye is usually transient, likely due to surgical trauma, inflammation, and postoperative topical medications, all of which affect tear dynamics temporarily.

The presence of systemic diseases like hypertension and diabetes showed significant correlation with postoperative DES in this study, with 86.67% of hypertensive and 88.24% of diabetic patients developing symptoms ($p = 0.031$ and 0.021, respectively). This finding is consistent with the study by Chao et al. (2018)[15], who observed that patients with diabetes had significantly lower tear film stability and increased inflammatory marker expression post-cataract surgery, suggesting a systemic component to tear dysfunction that may exacerbate surgical effects on the ocular surface.

Finally, the pattern of gradual improvement in both objective (Schirmer's, TBUT) and subjective (OSDI) dry eye scores over 90 days emphasizes the importance of early diagnosis and management. Kohli et al. (2019)[16] observed similar patterns of resolution and advocated for routine prophylactic lubrication in all cataract patients, especially those with comorbidities, to prevent long-term complications and enhance postoperative comfort.

CONCLUSION

This study demonstrates that phacoemulsification cataract surgery is associated with a transient increase in dry eye symptoms, peaking in the first postoperative week and gradually resolving by the third month. Significant reductions in Schirmer's test, TBUT, and increased OSDI scores highlight temporary tear film instability. Systemic comorbidities like diabetes and hypertension were found to significantly increase the risk of postoperative DES. Early identification and timely management can improve patient comfort and surgical satisfaction.

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