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Original Research Article

OCULAR SURFACE CHANGES AND VISUAL OUTCOMES IN CAMP CATARACT PATIENTS WITH COEXISTING DRY EYE DISEASE FOLLOWING CATARACT SURGERY: A SUBTYPE ANALYSIS

Shefali Mazumdar[1], Anil Kumar[2], Kartik Dhaker[2], Krishnendu Mazumdar[3]

[1]Associate Professor, Department of Ophthalmology, Sarojini Naidu Medical College, Agra, Uttar Pradesh, India
[2]Junior Resident, Department of Ophthalmology, Sarojini Naidu Medical College, Agra, Uttar Pradesh, India
[3]MBBS First Year Student, Sharda School of Medical Sciences and Research, Greater Noida, Uttar Pradesh, India

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Corresponding Author:
Dr. Shefali Mazumdar,
Associate Professor, Department of Ophthalmology, Sarojini Naidu Medical College, Agra, Uttar Pradesh, India
Email: shefalimazumdar@gmail.com

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ABSTRACT

Purpose: To evaluate ocular surface changes and visual outcomes in dry eye disease (DED) among camp patients undergoing cataract surgery, with a subtype-wise analysis.
Materials and Methods: This prospective, non-randomised interventional study was conducted from December 2024 to December 2025 at the SNMC Ophthalmology Department in Agra. During outreach cataract camps held in this period, patients with cataracts were screened for coexisting dry eye disease (DED) at the campsites. DED diagnosis was based on symptoms, clinical signs, tear film break-up time (TBUT), and Schirmer's test. Patients were then classified into aqueous-deficient, evaporative, or mixed subtypes. These patients with both cataracts and DED received preoperative ocular surface optimisation for 2-4 weeks, followed by manual small-incision cataract surgery (MSICS). Follow-up continued for 6 weeks postoperatively.
Results: Between December 2024 and December 2025, 24 outreach camps were held, and 1,200 cataract patients were admitted through these camps, of whom 205 (17.1%) were diagnosed with coexisting DED. Most patients were aged 61–70 years (40.3%), with a female majority of 109 (53.2%). The most common subtype was mixed DED (143 patients; 69.7%), followed by evaporative and aqueous-deficient types. MSICS achieved success in 201 out of 205 patients (98%), with only 4 patients (2%) experiencing minor intraoperative complications. Postoperative issues included grade 1–2 anterior chamber reactions in 8 patients (3.9%) and mild corneal oedema in 25 patients (12%), both of which were managed conservatively. Early follow-up showed transient worsening of dry eye parameters in 41 patients (20%) at 1 week, but all parameters improved significantly by 6 weeks, exceeding baseline levels across all subtypes ($p < 0.05$). Visual acuity improved markedly in all subtypes, with continued enhancement in best-corrected visual acuity from baseline to 6 weeks ($p < 0.05$).
Conclusion: The study emphasises the importance of detecting and treating DED during outreach cataract programs, despite time constraints. This approach not only educates patients but also leads to better visual outcomes and overall improvements in dry eye parameters after cataract surgery.
Keywords: Dry eye disease(DED), cataract surgery, Manual Small Incision Cataract Surgery(MSICS), ocular surface, outreach camps.

INTRODUCTION

Cataract remains the leading cause of avoidable blindness in India, contributing significantly to visual impairment, particularly among the elderly.[1,2] Despite advances in surgical care, access to timely treatment is still limited in many rural and underserved areas. To address this, a camp-based outreach cataract screening approach has been implemented under the National Programme for Control of Blindness and Visual Impairment (NPCBVI).[3] These initiatives focus on timely detection and intervention, helping to bridge gaps in accessibility and affordability, particularly for socioeconomically disadvantaged populations, thereby reducing the burden of preventable cataract-related blindness in the country.[4]

Although the primary aim of these camps is cataract screening, they can also be utilised to screen for other common conditions, such as Dry Eye Disease (DED), which is prevalent in rural regions due to environmental influences, malnutrition, or ageing. DED can affect both preoperative evaluations and postoperative visual outcomes.[5] Additionally, cataract surgery may exacerbate dry eye symptoms through mechanisms such as corneal nerve damage, postoperative inflammation, and tear film instability.[6,7] Despite the large number of cataract surgeries carried out via outreach cataract screening camps, limited data exist on the prevalence of DED and its influence on postoperative outcomes in these populations.[8] Therefore, this study was conducted to examine dry eye disease among camp patients undergoing cataract surgery. The primary objective was to assess the effect of manual small-incision cataract surgery (MSICS) on dry eye by analyzing changes in ocular surface parameters. The secondary objectives included evaluating the role of preoperative optimisation on postoperative visual outcomes and dry eye metrics, as well as determining the prevalence and subtypes of dry eye disease in these populations.

MATERIALS AND METHODS

This prospective, non-randomised interventional study was conducted from December 2024 to December 2025, after obtaining institutional ethical approval and in accordance with the Declaration of Helsinki. It included patients aged 40 years and older who were screened at outreach cataract camps for cataract and mild-to-moderate dry eye disease (DED) and were scheduled for manual small-incision cataract surgery (MSICS). Each patient underwent a comprehensive ophthalmic assessment, including best-corrected visual acuity (BCVA), slit-lamp examination, intraocular pressure measurement, fundus evaluation, and routine preoperative tests and investigations. In addition, DED was diagnosed according to the criteria in the TFOS DEWS II Report. [10] Tear film break-up time (TBUT) was measured using fluorescein dye, recording the time from the last blink to the appearance of the first dry spot. Three measurements were averaged, and values under 10 seconds were considered abnormal. Schirmer's test without anaesthesia was performed using standardised strips placed in the lower fornix for five minutes; wetting under 10 mm indicated decreased tear production. Patients with cataract and coexisting DED were further classified into three subtypes: aqueous-deficient DED (Schirmer's <10 mm with relatively preserved TBUT), evaporative DED (TBUT <10 seconds with normal Schirmer's values and clinical signs of meibomian gland dysfunction), and mixed DED (features of both aqueous deficiency and evaporative issues). Although advanced diagnostic tools recommended by the Tear Film and Ocular Surface Society were unavailable in the outreach setting, a practical clinical approach was adopted to reflect real-world practice. Participants provided written informed consent and agreed to a 6-week postoperative follow-up. Exclusion criteria included severe dry eye disease, a history of ocular surgery or trauma within the last 6 months, active ocular infection or inflammation, and significant ocular surface disorders. Patients with complicated cataracts, ocular comorbidities likely to affect visual outcomes, or long-term use of topical medications that influence the tear film were also excluded. Additionally, individuals with uncontrolled systemic conditions that could impair tear production, as well as those unlikely to comply with follow-up, were not included. Only uncomplicated cases were selected to minimise confounding variables and ensure reliable outcomes.

Sample size: Previous studies reported a postoperative dry eye prevalence of 33.0% after cataract surgery. To determine the sample size, the formula $n = (Z^2 \times p \times q) / d^2$ was used, with $Z = 1.96$ (95% confidence level), $p = 0.33$, $q = 0.67$, and $d = 0.07$.[11] This calculation yielded a sample size of 173. To allow for a 20% attrition rate, the final sample size was set at 205 patients.

All patients received preoperative care to optimise the ocular surface, including lubricants, lid hygiene, and subtype-specific therapy (cyclosporine, azithromycin, or doxycycline as needed) for 2–4 weeks. This was followed by MSICS with intraocular lens implantation in our department. For patients with mature cataracts (n=61), surgery could not be postponed; therefore, individual optimisation was planned, and surgery was performed at the earliest safe opportunity. Intraoperative steps to maintain ocular surface stability included the use of viscoelastic agents and adequate lubrication. Postoperative treatment included topical antibiotics, corticosteroids, and lubricants. Follow-up evaluations were conducted at 1, 4, and 6 weeks postoperatively. Each visit included assessments of best-corrected visual acuity (BCVA), TBUT, Schirmer's test, and slit-lamp examination. Any intraoperative and postoperative complications were systematically recorded and appropriately managed.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using SPSS version 24 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are shown as frequencies and percentages. To evaluate changes in ocular surface parameters and visual outcomes over time and across dry eye subtypes, a comparative analysis was conducted. For continuous variables, paired t-tests or repeated-measures ANOVA and the Friedman test were used as appropriate. Categorical variables were analysed using the chi-squared test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

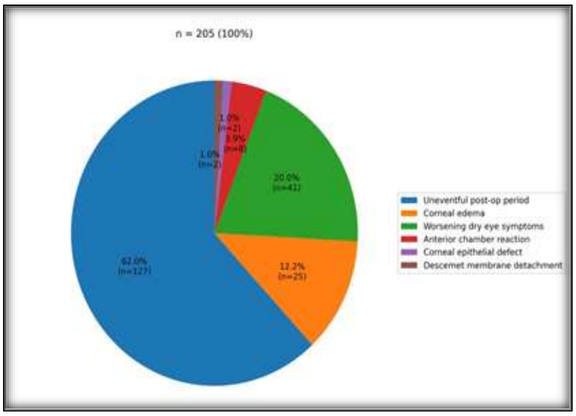

Figure 1: Showing intraoperative and postoperative complications in 205 study participants

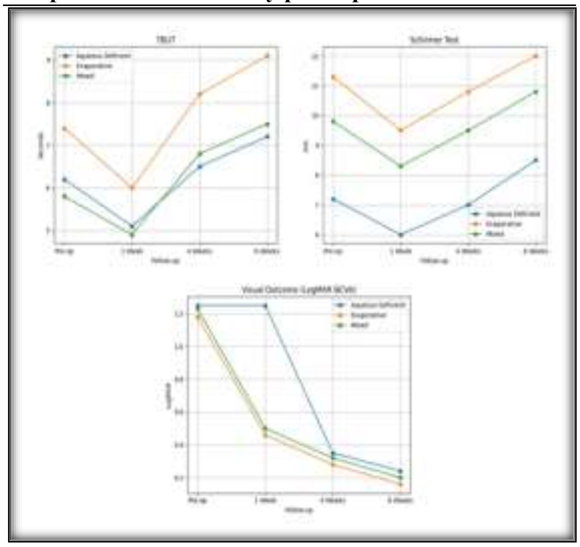

Figure 2: TBUT, Schirmer, and LogMAR BCVA trends showing an early decline at 1 week, followed by improvement over 6 weeks, with the best outcomes in the evaporative group across all sub types.

During the study period, 1200 patients with cataract were screened at outreach camps. Of these, 205 patients (17. 1%) were diagnosed with coexisting dry eye disease (DED). Among the DED cases, 61 patients (29. 7%) had mature cataracts. The majority of patients were aged 61–70 years (40. 3%), with the next largest group aged 51–60 years (29. 9%). There was a slight female predominance, with 109 females (53. 2%) and 96 males (46. 8%). In patients with both cataract and DED, the most common subtype was mixed dry eye (n = 143), followed by evaporative dry eye (n = 52) and aqueous- deficient dry eye (n = 10) [Table 1]. After 2–4 weeks of preoperative ocular surface optimisation, all patients underwent Manual Small Incision Cataract Surgery (MSICS). The surgery was uneventful in 201 (98%) of cases, with minor intraoperative complications in 4 (2%) patients, including corneal epithelial defects in 2 (1%) and Descemet membrane detachment in 2 (1%). These cases were managed appropriately. Postoperative observations revealed that 8 patients (3.9%) experienced grade 1-2 anterior chamber reactions, while 25 patients (12%) developed mild corneal oedema, which was managed conservatively. During the early postoperative phase, 41 patients (20%) exhibited transient worsening of dry eye parameters [Figure 1]. Table 2 summarises changes in all ocular surface parameters among 205 study participants over the 6-week postoperative period. TBUT dropped sharply at 1 week (4. 61 ± 1. 49 sec) compared with the preoperative value (6. 60 ± 1. 45 sec), then gradually improved at 4 weeks (5. 92 ± 1. 50 sec) and 6 weeks (6. 42 ± 1. 51 sec). The Friedman test confirmed overall significance (χ^2 = 554.288. 288, p < 0. 001). Post hoc analysis revealed that all pairwise differences were significant. Schirmer's test also decreased at 1 week (5. 45 ± 2. 19 mm) from the preoperative level (6. 94 ± 2. 17 mm), then steadily recovered at 4 weeks (6. 50 ± 2. 18 mm) and nearly returned to baseline at 6 weeks (6. 89 ± 2. 20 mm). This change was statistically significant (χ^2 = 522.783. 783, p < 0. 001). Nevertheless, the difference between preoperative and 6-week Schirmer's values was not statistically significant (p = 0.263), suggesting that tear secretion had recovered by 6 weeks. Table 3 and Figure 2 reveal significant changes in tear film parameters (TBUT and Schirmer's test) across subtypes of dry eye disease (DED) during the 6- week postoperative follow-up. All three subtypes, aqueous-deficient, evaporative, and mixed showed statistically significant variation, as confirmed by the Friedman test (p < 0. 001), reflecting a clear temporal pattern after surgery. In the aqueous-deficient group (n = 10), TBUT dropped from 6.66 ± 1.52 seconds preoperatively to 4.62 ± 1.68 seconds at 1 week, then improved to 5. 94 ± 1. 66 seconds at 4 weeks and 6. 42 ± 1. 66 seconds at 6 weeks. Schirmer's values also declined at 1 week (5.15 ± 1.75 mm) from a baseline of 6.70 ± 1.98 mm, but gradually returned to near-baseline levels by 6 weeks (6.60 ± 1.81 mm). Post hoc analysis indicated that most differences were statistically significant, except for the comparison between preoperative and 6-week values for both TBUT (p = 0.785) and Schirmer's (p = 1.000), suggesting near-complete recovery. In the evaporative group (n = 52), TBUT decreased from 6. 53 ± 1. 43 seconds before surgery to 4. 54 ± 1. 53 seconds at 1 week, then gradually improved at 4 weeks (5. 83 ± 1. 54 seconds) and 6 weeks (6. 31 ± 1. 56 seconds). Schirmer's test values also dropped at 1 week (5.53 ± 2.30 mm) but recovered by 6 weeks (6.97 ± 2.33 mm), approaching the baseline (7.02 ± 2.29 mm). All pairwise comparisons showed significant differences except between preoperative and 6-week Schirmer's values (p = 1.000), indicating that tear secretion was nearly normalised by 6 weeks, although TBUT still showed a slight residual difference. In the mixed subtype group (n = 143), a similar trend was observed. TBUT significantly decreased at 1 week (4. 64 ± 1. 48 sec) from baseline (6. 62 ± 1. 46 sec), then improved at 4 weeks (5. 95 ± 1. 48 sec) and nearly returned to normal at 6 weeks (6. 46 ± 1. 48 sec). Schirmer's test also initially declined at 1 week (5.44 ± 2.18 mm) but recovered by 6 weeks (6.88 ± 2.18 mm), close to baseline (6.93 ± 2.15 mm). Post hoc analysis confirmed all comparisons were significant except between preoperative and 6-week Schirmer's values (p = 0.506), again indicating tear secretion recovery over time. [Table 4 and Figure 2] demonstrate significant subtype-specific changes in visual outcomes (LogMAR BCVA) during the 6-week postoperative follow-up in patients with dry eye disease (DED). All three subtypes, aqueous-deficient, evaporative, and mixed, showed highly significant changes (p < 0.001), reflecting consistent improvements in visual acuity. In the aqueous-deficient group (n = 10), LogMAR BCVA improved markedly from 1.17 ± 0.22 preoperatively to 0.45 ± 0.03 at 1 week, and continued to improve at 4 weeks (0.36 ± 0.03) and 6 weeks (0.31 ± 0.02). All pairwise differences were statistically significant, indicating ongoing visual enhancement. The evaporative group (n = 52) experienced similar improvements, with LogMAR BCVA decreasing from 1.26 ± 0.22 preoperatively to 0.45 ± 0.03 at 1 week, then further to 0.35 ± 0.03 at 4 weeks and 0.31 ± 0.02 at 6 weeks; all differences were statistically significant (p < 0.001). Likewise, the mixed subtype (n = 143) followed the same pattern, with LogMAR BCVA improving from 1.22 ± 0.21 preoperatively to 0.45 ± 0.03 at 1 week, then to 0.35 ± 0.03 at 4 weeks and 0.31 ± 0.02 at 6 weeks, with all comparisons highly significant.

Table 1: Baseline Demographic and Clinical Characteristics of 205 study participants

Variable	**Value**
Patients with Cataract & coexisting DED	205 (17.1%)
Age (years)	47.33 ± 14.20 (range: 19–67)*
Age Distribution	
51–60 years	61 (29.9%)
61–70 years	83 (40.3%)
Others	61 (29.8%)
Gender	
Male	96 (46.8%)
Female	109 (53.2%)
Cataract Type	
Mature cataract	61 (29.7%)
Immature cataract	144 (70.3%)
Dry Eye Subtype	
Aqueous Deficient (ADDE)	10 (4.9%)
Evaporative (EDE)	52 (25.4%)
Mixed	143 (69.7%)
Surgical Technique	
SICS	205 (100%)

Table 2: Overall Ocular Surface Parameters changes over 6 Weeks postoperative Follow-Up Period in 205 study participants

Parameter	**Preoperative**	**1 Week**	**4 Weeks**	**6 Weeks**	**Friedman χ^2**	**p-value**	**Pairwise Comparisons**
TBUT (sec)	6.60 ± 1.45	4.61 ± 1.49	5.92 ± 1.50	6.42 ± 1.51	554.288	<0.001	Pre vs 1W (<0.001); Pre vs 4W (<0.001); Pre vs 6W (<0.001); 1W vs 4W (<0.001); 1W vs 6W (<0.001); 4W vs 6W (<0.001)
Schirmer’s (mm)	6.94 ± 2.17	5.45 ± 2.19	6.50 ± 2.18	6.89 ± 2.20	522.783	<0.001	Pre vs 1W (<0.001); Pre vs 4W (<0.001); Pre vs 6W (0.263, NS); 1W vs 4W (<0.001); 1W vs 6W (<0.001); 4W vs 6W (<0.001)

Table 3: Subtype-wise Changes in Tear Film Parameters over 6 Weeks postoperative Follow-Up Period in 205 study participants

Dry Eye Type	**Parameter**	**Pre-op**	**1 Week**	**4 Weeks**	**6 Weeks**	**Friedman χ^2**	**p-value**	**Post-hoc Analysis**
Aqueous Deficient (n=10)	TBUT (sec)	6.66 ± 1.52	4.62 ± 1.68	5.94 ± 1.66	6.42 ± 1.66	27.480	<0.001	Pre vs 1W (0.0117*); Pre vs 4W (0.0117*); Pre vs 6W (0.785, NS); 1W vs 4W (0.0117*); 1W vs 6W (0.0117*); 4W vs 6W (0.0117*)
	Schirmer’s (mm)	6.70 ± 1.98	5.15 ± 1.75	6.20 ± 1.79	6.60 ± 1.81	25.320	<0.001	Pre vs 1W (0.0117*); Pre vs 4W (0.0352*); Pre vs 6W (1.000, NS); 1W vs 4W (0.0117*); 1W vs 6W (0.0117*); 4W vs 6W (0.0117*)
Evaporative (n=52)	TBUT (sec)	6.53 ±	4.54 ±	5.83 ± 1.54	6.31 ± 1.56	140.931	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (0.002**); 1W vs

		1.43	1.53					4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)
	Schirmer's (mm)	7.02 ± 2.29	5.53 ± 2.30	6.60 ± 2.31	6.97 ± 2.33	131.838	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (1.000, NS); 1W vs 4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)
Mixed (n=143)	TBUT (sec)	6.62 ± 1.46	4.64 ± 1.48	5.95 ± 1.48	6.46 ± 1.48	386.064	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (<0.001***); 1W vs 4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)
	Schirmer's (mm)	6.93 ± 2.15	5.44 ± 2.18	6.48 ± 2.17	6.88 ± 2.18	365.662	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (0.506, NS); 1W vs 4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)

Legend: Statistical significance was considered at *p < 0.05, **p < 0.01, and ***p < 0.001; NS = not significant.

Table 4: Subtype-wise Visual Outcome (Log MAR) Over 6 Weeks postoperative Follow-Up Period in 205 DED patients

Dry Eye Type	Parameter	Pre-op	1 Week	4 Weeks	6 Weeks	Friedman χ^2	p-value	Post-hoc Analysis
Aqueous Deficient (n=10)	Log MAR BCVA	1.17 ± 0.22	0.45 ± 0.03	0.36 ± 0.03	0.31 ± 0.02	28.920	<0.001	Pre vs 1W (0.0117*); Pre vs 4W (0.0117*); Pre vs 6W (0.0117*); 1W vs 4W (0.0117*); 1W vs 6W (0.0117*); 4W vs 6W (0.0469*)
Evaporative (n=52)	Log MAR BCVA	1.26 ± 0.22	0.45 ± 0.03	0.35 ± 0.03	0.31 ± 0.02	149.884	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (<0.001***); 1W vs 4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)
Mixed (n=143)	Log MAR BCVA	1.22 ± 0.21	0.45 ± 0.03	0.35 ± 0.03	0.31 ± 0.02	411.136	<0.001	Pre vs 1W (<0.001***); Pre vs 4W (<0.001***); Pre vs 6W (<0.001***); 1W vs 4W (<0.001***); 1W vs 6W (<0.001***); 4W vs 6W (<0.001***)

DISCUSSION

NPCBVI's outreach camps have been crucial in addressing the cataract burden in our country. Numerous studies have emphasized the significance of these initiatives. For instance, Sobti et al. highlighted that the current demand for cataract surgeries remains unmet. This underscores the need to understand and address the reasons behind the limited availability of surgical services in order to improve the utilization of existing facilities.[12] It is also widely recognized that dry eye disease is common among cataract patients, caused by various factors and serving as a significant risk for post-cataract surgical outcomes.[13,14] However, in these outreach camps, patients typically arrive with the expectation of being operated on. A major challenge is to communicate that conditions like dry eye disease and the need for several weeks of preoperative optimisation are often difficult due to low awareness and socioeconomic barriers that restrict healthcare access. Despite these challenges, we effectively educated the patients and earned their trust, reaffirming our dedication to their well-being.[15] The high prevalence of mature cataracts posed another challenge, as urgent cases often leave little time for preoperative optimisation of the ocular surface in patients with coexisting dry eye disease. To address this, individualised optimisation and a tailored, pragmatic perioperative strategy were implemented in our study, resulting in favourable outcomes. Literature rarely discusses these issues in outreach cataract screening camps. Bhat A et al examined the benefits of outreach eye screening in the context of the 2030 agenda for promoting health and well-being in rural India, discovering that many patients were unfit for cataract surgery. Conversely, our study concentrated on coexisting DED and the potential benefits of these outreach camps for underprivileged patients.[16] The predominance of mixed dry eye in our study aligns with the current understanding of the condition as a complex, multifactorial disease with overlapping causes, particularly in older individuals.[17] In our study, MSICS was performed in all cases. Other research also indicates that Manual Small Incision Cataract Surgery (MSICS) is preferred for camp patients because of its cost-effectiveness, shorter surgery duration, and excellent visual outcomes, even in busy, high-volume settings.[18,19] In this study, changes in the ocular surface and visual outcomes after cataract surgery were examined in camp cataract patients . Early postoperative deterioration of ocular surface parameters may be due to corneal nerve damage, reduced corneal sensitivity, intraoperative irrigation, microscope light exposure, and preservative-containing medications. These factors can destabilise the tear film, causing a temporary escalation of symptoms. Improvement at four and six weeks suggests gradual recovery of ocular surface health, likely facilitated by corneal nerve regeneration and restoration of lacrimal gland function. Similar postoperative tear film patterns have been observed in longitudinal studies.[20,21] Analysis by subtype showed that patients with aqueous-deficient and mixed dry eye experienced more significant and prolonged deterioration compared to those with evaporative dry eye. This may be due to lower baseline tear production and reduced regenerative capacity in aqueous-deficient conditions.[22,23] Meanwhile, evaporative dry eye, often caused by meibomian gland dysfunction, typically responded better to perioperative treatments like lubricants, lid hygiene and oral doxycycline.[24,25] Despite these differences in ocular surface changes, all groups achieved good visual outcomes, highlighting the success of manual small-incision cataract surgery (MSICS) in a high-volume cataract surgery settings.[18] However, the slower visual recovery in aqueous-deficient and mixed subtypes emphasises the importance of tear film stability for effective postoperative visual rehabilitation.[21] Transient dry eye symptoms and mild corneal oedema during early recovery are probably due to surgical trauma and inflammation.[19] This study highlights the importance of a balanced approach, combining prompt preoperative preparation, careful surgical technique, and proper postoperative care, to achieve the best results in camp patients with cataract and coexisting DED. Importantly, it adds valuable new information to the limited literature on dry eye disease in camp cataract surgeries and provides subtype-specific insights to support the development of tailored perioperative management strategies.

Limitations

This study has some limitations. Firstly, its camp-based approach may restrict how broadly the results can be applied. Secondly, the length of preoperative optimization varied for each patient, causing differences in baseline ocular surface conditions. Thirdly, the lack of a control group without dry eye disease limits the ability to make direct comparisons. Fourthly, the follow-up period was relatively brief, preventing evaluation of long-term outcomes. Furthermore, differences in patient compliance and unmeasured environmental factors could have affected the findings. Despite these limitations, the study provides valuable real-world insights into the management of dry eye disease in high-volume cataract surgery settings.

CONCLUSION

The study emphasizes the importance of screening for Dry Eye Disease during outreach cataract screening programmes. Incorporating simple dry eye assessment protocols into routine cataract camp screening can enhance the quality of care for camp patients by enabling appropriate management of DED prior to cataract surgery, improving surgical satisfaction, visual rehabilitation outcomes and overall ocular surface health. This approach may also help increase awareness of this commonly underdiagnosed condition among rural and outreach populations.

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