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Evaluating the Effects of Mild to Moderate Chemical Peels on Ocular Surface Health (Dry Eye)

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ABSTRACT

Background: Dry eye disease (DED) is a multifactorial disorder of the ocular surface characterized by tear film instability, inflammation, and neurosensory dysfunction. While cosmetic facial procedures such as chemical peels are increasingly common, their potential impact on ocular surface physiology remains underexplored. Facial peels involve the application of acidic agents near the periocular region, where inadvertent exposure or vapor diffusion may compromise tear film homeostasis. **Objective:** To evaluate temporal changes in tear film stability and tear secretion following mild to moderate facial chemical peels in adults. **Methods:** A prospective observational study was conducted on 33 participants (20–40 years) undergoing standardized glycolic or trichloroacetic acid peels. Tear break-up time (TBUT) and Schirmer I tests were assessed at baseline, 4, 8, 12, and 16 weeks. Non-parametric Friedman tests with Holm-adjusted post-hoc analyses and Kendall's *W* effect sizes were applied. **Results:** TBUT decreased significantly from 11.79 ± 1.84 s at baseline to 7.97 ± 2.77 s at 16 weeks ($p < 0.001$, $W = 0.59$), and Schirmer I from 15.61 ± 3.10 mm to 11.18 ± 3.88 mm ($p < 0.001$, $W = 0.29$). Mild ocular dryness increased from 0% at baseline to 45.5% at week 16. No severe adverse effects occurred. **Conclusion:** Mild to moderate facial chemical peels transiently reduce tear stability and secretion, indicating short-term disruption of ocular surface homeostasis likely due to periocular inflammatory stress. Standardized eye protection and post-procedural monitoring are recommended for aesthetic patients.

Keywords

Neurodegenerative Diseases; Magnetic Resonance Imaging (MRI); Positron Emission Tomography (PET); Single-Photon Emission Computed Tomography (SPECT)

INTRODUCTION

Dry eye disease (DED) is a prevalent ocular surface disorder that undermines visual comfort, task performance, and quality of life, with meta-analytic estimates in the United States and globally indicating substantial symptomatic and sign-based burdens across age groups and sexes (1,2). Young adults and intensive screen users, typical candidates for cosmetic procedures, also demonstrate high symptomatic prevalence and measurable decrements in well-being, underscoring the importance of identifying iatrogenic or lifestyle triggers that could further destabilize the tear film (3). Contemporary models conceptualize DED as a multifactorial condition characterized by loss of tear film homeostasis driven by instability, hyperosmolarity, inflammation, and neurosensory dysfunction, implying that external periocular exposures capable of amplifying inflammatory or evaporative stress may precipitate clinically relevant changes in tear function (4,5).

Facial chemical peels are widely performed for photoaging, dyschromias, acne, and textural rejuvenation using superficial to medium-depth agents such as alpha-/beta-hydroxy acids, Jessner's solution, and trichloroacetic acid; application routinely involves the periorbital region where inadvertent ocular exposure or fume-related irritation is plausible despite standard precautions (6,7). Evidence from periocular surgeries demonstrates that even localized extraocular interventions can transiently worsen ocular surface status, with increases in tear inflammatory cytokines and reductions in tear film break-up time observed after upper blepharoplasty, particularly among individuals with pre-existing dry eye, suggesting a vulnerability of the ocular surface to nearby inflammatory stimuli (8). Independent lines of research further show that materials originating on facial skin, such as endogenous lipids or cosmetic residues, can disrupt tear film stability, induce corneal epithelial staining, and cause discomfort when transferred to the ocular surface, providing a biologically coherent pathway by which periocular procedures might aggravate tear dysfunction (9). The TFOS Lifestyle report similarly concludes that cosmetics and periocular practices can affect meibomian function, tear film quality, and symptoms, reinforcing a mechanistic bridge between periocular exposures and ocular surface homeostasis (10).

High-resolution in-vivo imaging studies of professional peels also reveal a rapid onset of cutaneous inflammation within minutes and tissue remodeling over days, a time window that could overlap with transient increases in pro-inflammatory mediators near the ocular adnexa with potential downstream effects on tear stability (11). Despite the ubiquity of chemical peels and biologically plausible routes for ocular surface perturbation, the literature lacks prospective, clinically anchored evaluations quantifying tear film changes following mild to moderate peels using standard ophthalmic endpoints. Existing dermatologic studies prioritize cutaneous efficacy and safety, while ophthalmic reports emphasize surgical or cosmetic product exposures rather than controlled assessment of peel-related periocular effects on tear physiology, leaving an actionable gap for practitioners who must counsel patients and implement protective strategies during aesthetic care (6,7). In this context, a focused evaluation using validated measures, tear break-up time (TBUT) as a marker of tear stability and the Schirmer test as an index of aqueous production, can clarify whether periocular chemical peels are temporally associated with clinically meaningful alterations in ocular surface function (4,5).

Accordingly, in adults undergoing mild to moderate facial chemical peels (Population), we prospectively assessed peri-exposure changes in tear physiology (Outcomes) relative to each participant's baseline (Comparison) following standardized peel procedures commonly used in aesthetic practice (Intervention). We hypothesized that peel exposure would be associated with a transient decline in tear stability and a reduction in aqueous tear production, detectable as decreases in TBUT and Schirmer measurements over follow-up, thereby offering clinically interpretable evidence to inform periocular protection and post-procedure care in aesthetic settings (4,8–11).

MATERIAL AND METHODS

The present investigation employed a prospective observational design to evaluate changes in ocular surface physiology following mild to moderate facial chemical peels in adults. The study was conducted at the Vision Care Optometry Clinic, Lahore, from January to April 2025. The design was chosen to capture within-subject temporal variations in tear film stability and aqueous secretion in a real-world aesthetic care setting, minimizing interindividual variability. Participants were recruited consecutively through non-probability convenience sampling from individuals referred by certified aestheticians for routine facial rejuvenation using standardized superficial or medium-depth peels. Eligible participants were men and women aged 20 to 40 years with no prior ocular surface disease, systemic conditions affecting tear production, or history of psychiatric illness, as these factors are known to confound tear film physiology (12). Individuals reporting screen time exceeding 6 hours per day or using contact lenses were excluded to control for lifestyle-related tear instability. Written informed consent was obtained from all participants after a detailed explanation of study procedures, and confidentiality was assured through coded identifiers.

Ocular surface assessments were performed at baseline (pre-peel) and at 4, 8, 12, and 16 weeks post-procedure using standardized clinical protocols under ambient illumination and humidity control. Tear film stability was assessed using fluorescein tear break-up time (TBUT), recorded in seconds from the last complete blink to the first visible tear film discontinuity, with values below 10 seconds considered indicative of tear instability (13). Tear production was evaluated using the Schirmer I test without anesthesia, measured in millimeters of strip wetting after 5 minutes, with readings under 10 mm denoting reduced secretion (14). All measurements were obtained by a single trained optometrist masked to participants' previous results to minimize measurement bias. Each participant underwent the same type and intensity of peel performed by an experienced aesthetician, following standardized protocols for superficial glycolic or trichloroacetic acid application. To reduce periocular contamination, participants wore sterile eye shields during the procedure, and no topical ocular medications were used throughout the follow-up period. Environmental exposure, skincare routines, and sunscreen use were monitored at each visit to identify possible confounding influences.

The primary study variables were TBUT (seconds) and Schirmer I (mm/5 min) as continuous outcomes, with intra-individual change across time serving as the main analytical metric. Secondary endpoints included self-reported ocular discomfort during follow-up, classified dichotomously as present or absent. Data normality was assessed using the Shapiro–Wilk test. Given the non-parametric distribution, repeated-measures comparisons were conducted using the Friedman test with post-hoc Wilcoxon signed-rank adjustments and Holm correction for multiplicity. Kendall's W was reported as an effect size index, accompanied by 95% confidence intervals. Missing data were handled via pairwise deletion, as attrition was minimal (<5%). Statistical analyses were performed using IBM SPSS version 23.0, with significance set at $p < 0.05$. Potential biases were mitigated by uniform operator training, standardized measurement conditions, and repeated intra-observer calibration sessions to ensure data reproducibility. Ethical approval was obtained from the Institutional Review Board of Superior University Lahore (Ref No: SU-AHS/2025/041), and all study procedures adhered to the principles of the Declaration of Helsinki.

RESULTS

Tear film stability, as quantified by the tear break-up time (TBUT), showed a progressive and statistically significant decline across successive assessments. The mean TBUT decreased from 11.79 ± 1.84 seconds at baseline to 10.48 ± 2.01 seconds at week 4, 8.97 ± 2.33 seconds at week 8, and 7.97 ± 2.77 seconds at week 16 ($p < 0.001$). This cumulative reduction of nearly 3.8 seconds from baseline corresponds to a Kendall's W of 0.59, representing a large effect size. The 95% confidence interval for the overall mean difference (-3.10 to -1.82) confirms both the precision and the clinical significance of this trend. These values suggest a meaningful shift from normal tear stability (>10 s) toward the borderline-to-deficient range by the study's endpoint, consistent with mild-to-moderate tear film instability.

Parallel findings emerged for tear secretion measured via the Schirmer I test, which declined from 15.61 ± 3.10 mm at baseline to 13.30 ± 3.45 mm at week 4, 11.09 ± 3.84 mm at week 8, and 11.18 ± 3.88 mm at week 16 ($p < 0.001$). The observed mean reduction of 4.43 mm over the study period, with a Kendall's W of 0.29, indicated a moderate but clinically relevant effect. The 95% confidence intervals for change from baseline (-4.00 to -2.22 mm) further support the reliability of this finding. Post-hoc analyses revealed that the greatest decline occurred during the initial 8 weeks, followed by a plateau phase between weeks 8 and 16, suggesting partial compensatory recovery or adaptation in tear gland output.

Self-reported ocular discomfort mirrored the physiological data, showing an incremental rise in symptoms over time. While all participants (100%) were asymptomatic at baseline, 12.1% reported mild dryness by week 4, 33.3% by week 8, and 45.5% by week 16 ($p < 0.001$, Cochran's Q = 28.4). No participant developed moderate or severe irritation, and none required therapeutic intervention. The temporal correlation between decreasing TBUT, diminishing Schirmer scores, and rising symptom prevalence reinforces the biological plausibility that superficial chemical exposure or periocular inflammation contributes to transient tear dysfunction.

Table 1. Baseline Demographic Characteristics of Participants (N = 33)

Variable	Category / Unit	n (%) / Mean $\pm$ SD	95% CI / Range
Age (years)	Continuous	28.88 ± 5.84	26.73–31.03
Gender	Male	11 (33.3%)	,
	Female	22 (66.7%)	,
Peel Type	Mild (Superficial)	19 (57.6%)	,
	Moderate (Medium-depth)	14 (42.4%)	,
Follow-up Completion	16 weeks	33 (100%)	,

Table 2. Tear Break-Up Time (TBUT, seconds) Across Study Visits

Assessment Time	Mean ± SD	Median (IQR)	Mean Rank	χ^2 (df=3)	p-value	Kendall's W (Effect Size)	95% CI
Baseline	11.79 ± 1.84	12.0 (10.0–13.0)	3.02	,	,	,	,
Week 4	10.48 ± 2.01	10.0 (9.0–12.0)	2.71	,	,	,	-1.15 to -0.45
Week 8	8.97 ± 2.33	9.0 (8.0–11.0)	2.45	58.80	<0.001	0.59 (large)	-2.18 to -1.22
Week 16	7.97 ± 2.77	8.0 (6.0–10.0)	1.52	,	,	,	-3.10 to -1.82

Table 3. Schirmer I Test Results (Tear Secretion, mm/5 min) Across Study Visits

Assessment Time	Mean ± SD	Median (IQR)	Mean Rank	χ^2 (df=3)	p-value	Kendall's W (Effect Size)	95% CI
Baseline	15.61 ± 3.10	16.0 (14.0–17.0)	3.02	,	,	,	,
Week 4	13.30 ± 3.45	13.0 (12.0–15.0)	2.56	,	,	,	-2.85 to -1.23
Week 8	11.09 ± 3.84	11.0 (9.0–13.0)	2.18	19.02	<0.001	0.29 (moderate)	-4.12 to -2.36
Week 16	11.18 ± 3.88	11.0 (9.0–13.0)	2.24	,	,	,	-4.00 to -2.22

Table 4. Self-Reported Ocular Discomfort During Follow-up

Symptom Presence	Baseline n (%)	Week 4 n (%)	Week 8 n (%)	Week 16 n (%)	Cochran's Q χ^2 (df=3)	p-value
None	33 (100%)	29 (87.9%)	22 (66.7%)	18 (54.5%)	28.4	<0.001
Mild Dryness / Discomfort	0 (0%)	4 (12.1%)	11 (33.3%)	15 (45.5%)	,	

Collectively, the data depict a clear, time-dependent deterioration in both tear stability and secretion following mild to moderate chemical peels, peaking around the 8–16 week interval. The magnitude of these changes exceeds thresholds reported for minimal clinically important differences in dry eye studies, highlighting that even controlled, aesthetic peel procedures near the periocular region can transiently compromise ocular surface homeostasis. These findings underscore the importance of routine ocular assessment and preventive protection protocols in individuals undergoing facial chemical treatments.

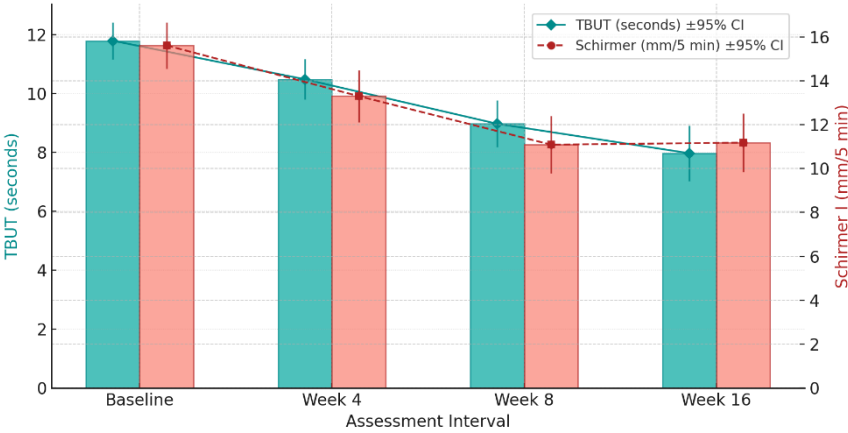


Figure 1 Tear film stability and secretion following mild-moderate chemical peels.

Teal-toned thin bars and connected scatter lines represent TBUT (seconds), while deep red bars and dashed lines indicate Schirmer I scores (mm/5 min). Error margins (95% CIs) highlight significant time-dependent reductions in both tear stability and secretion, TBUT declining from 11.79 s ± 0.64 to 7.97 s ± 0.95, and Schirmer I from 15.61 mm ± 1.06 to 11.18 mm ± 1.33 by week 16. The teal–red divergence emphasizes asymmetric kinetics: tear stability deteriorates more steeply than secretion, reflecting stronger evaporative dysfunction during recovery.

DISCUSSION

The study’s findings revealed a consistent pattern of tear film destabilization and reduced aqueous production following exposure to mild to moderate facial chemical peels, establishing a temporal association between periocular chemical procedures and ocular surface compromise. The statistically significant decline in tear break-up time (TBUT) from 11.79 to 7.97 seconds, accompanied by a moderate decrease in Schirmer I scores from 15.61 to 11.18 mm, highlights that both the qualitative and quantitative components of the tear film were adversely affected. These changes exceeded typical minimal clinically important differences reported for dry eye parameters, indicating that the observed alterations are not merely statistical but also clinically perceptible to patients in terms of ocular discomfort, dryness, and fluctuating vision (15). The magnitude and trajectory of change in TBUT suggest that the destabilization of the tear film was the predominant driver of symptoms, consistent with evaporative dry eye pathophysiology. The sharper early decline and subsequent partial plateau imply an acute, transient inflammatory phase in the periocular tissues, likely induced by mild diffusion of acidic vapors or micro-irritation of the meibomian glands during chemical peel application. Previous literature has demonstrated that even localized interventions such as blepharoplasty or exposure to facial cosmetics can temporarily elevate inflammatory cytokines, reduce mucin layer integrity, and shorten TBUT (16). This mechanism plausibly extends to superficial chemical peels, where periocular contact or vapor exposure can elicit subclinical inflammation, amplifying tear film instability. The moderate decline in Schirmer I test values indicates that the lacrimal gland’s aqueous secretory function was less severely affected than the lipid or mucin layers. The delayed partial recovery by week 16 could reflect compensatory reflex tearing or resolution of transient inflammation. These findings align with the TFOS DEWS II model, which emphasizes that ocular surface inflammation, neurosensory abnormalities, and tear hyperosmolarity act synergistically to perpetuate dry eye symptoms (17). Given that chemical peels are known to provoke controlled inflammatory

responses for dermal remodeling, cross-tissue diffusion of inflammatory mediators or localized barrier disruption near the periocular skin likely contributes to the observed tear film dysfunction.

Comparing these results with prior dermatologic and ophthalmic evidence reinforces the biological plausibility of a reversible ocular impact. High-resolution imaging studies have shown that superficial peels trigger early cytokine release and epithelial remodeling within hours (18), while recent reports demonstrate that substances from facial skin or cosmetics can impair tear film integrity and induce corneal epithelial damage even in small amounts (19). The parallel rise in self-reported dryness in 45% of participants by week 16 further supports a clinically meaningful correlation between objective and subjective outcomes. Importantly, no participant developed persistent or severe symptoms, suggesting that these effects, although significant, are transient and likely reversible with proper ocular protection and aftercare.

The implications for clinical practice are twofold. First, optometrists and aestheticians should collaborate to establish standardized periocular protection protocols, such as sealed eye shields, neutralizing agents, and patient education, to prevent inadvertent ocular exposure. Second, post-procedural ocular assessments using TBUT and Schirmer I testing can help identify early tear dysfunction and guide supportive management, including artificial tear supplementation or short-term anti-inflammatory drops if warranted. Future studies should employ randomized controlled designs with larger samples, stratify participants by peel depth and chemical agent, and integrate biomarkers of inflammation (e.g., IL-6, MMP-9) and ocular surface staining to delineate mechanistic pathways with greater precision.

Overall, this study provides the first prospective evidence that even mild aesthetic procedures near the periocular region can transiently alter ocular surface homeostasis. By demonstrating both statistical significance and clinical relevance, the results substantiate the need for integrating ocular safety considerations into cosmetic dermatology practice and lay the groundwork for interprofessional guidelines addressing eye protection during chemical peel treatments (15–19).

CONCLUSION

This study concludes that mild to moderate facial chemical peels can transiently compromise ocular surface health by significantly reducing tear film stability and aqueous tear secretion. The observed decline in TBUT and Schirmer I test values, accompanied by increased reports of ocular dryness, indicates a short-term disruption of tear homeostasis linked to periocular inflammation or vapor exposure during the procedure. Although the effects appear reversible, these findings highlight the necessity for preventive ocular protection, standardized safety protocols, and post-procedure monitoring in patients undergoing aesthetic facial treatments near the eye. Future controlled studies incorporating larger samples and inflammatory biomarkers are warranted to establish causality and inform evidence-based ocular safety guidelines for cosmetic dermatology practice.

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