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Original Article

Association of Cyanoacrylate-Based Eye Cosmetics With Allergic Blepharitis, A Cross-Sectional Study

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ABSTRACT

Background: Cyanoacrylate-based eye cosmetic adhesives, including eyelash extension adhesives and artificial lash glues, are increasingly used for cosmetic enhancement but may expose the eyelid margin and ocular surface to irritant or allergenic compounds. Objective: This study aimed to determine the association between cyanoacrylate-based eye cosmetic adhesive use and clinically diagnosed allergic blepharitis among young adult females and to assess whether frequency and duration of use were associated with eyelid inflammation and tear film instability. Methods: An analytical cross-sectional study was conducted among 73 females aged 18–35 years, including 37 users and 36 non-users of cyanoacrylate-based eye cosmetics. Data were collected using a structured proforma, symptom severity assessment, slit-lamp examination, Tear Break-Up Time test, Schirmer I test, and ocular surface pH assessment. Data were analyzed using SPSS version 26. Results: Allergic blepharitis was diagnosed in 29 participants (39.7%) and was more frequent among users than non-users (62.2% vs. 16.7%; OR = 8.21, 95% CI: 2.73–24.67). Frequency of use was significantly associated with allergic blepharitis, $\chi^2(3, N = 73) = 22.684$, $p = 0.002$, while duration of use was significantly associated with eyelid inflammation, $\chi^2(3, N = 73) = 11.632$, $p = 0.009$. Users had significantly lower mean TBUT than non-users (8.38 ± 2.06 vs. 10.44 ± 2.10 seconds; $p < 0.001$). Conclusion: Cyanoacrylate-based eye cosmetic adhesive use was significantly associated with allergic blepharitis and reduced tear film stability among young adult females, particularly with frequent and prolonged use. Keywords: Cyanoacrylate; eye cosmetics; allergic blepharitis; eyelash adhesive; tear film stability; TBUT; ocular surface.

INTRODUCTION

The periocular region is one of the most sensitive cutaneous and mucosal interfaces of the face because the eyelid skin is thin, highly permeable, and anatomically close to the ocular surface. Cosmetic products applied around the eyelids may therefore act not only as aesthetic agents but also as potential sources of irritant and allergic exposure. Eye cosmetics such as mascara, eyeliner, kajal, artificial strip lashes, and eyelash extensions are widely used among young females, and adhesive-based products have become increasingly popular because they provide a longer-lasting cosmetic effect. However, repeated application close to the eyelid margin may expose the eyelid skin, meibomian gland openings, conjunctiva, and tear film to chemical substances capable of inducing ocular irritation, allergic contact reactions, or inflammatory eyelid disease (1,2).

Cyanoacrylate-based adhesives are commonly used in eyelash extensions and artificial lash glues because they polymerize rapidly and produce strong bonding. Although these properties are useful for cosmetic application, cyanoacrylates and related acrylate compounds are recognized as potential sensitizers in cosmetic, occupational, and medical adhesive exposure. Repeated exposure may increase

the likelihood of immune sensitization, particularly in anatomically sensitive areas such as the eyelids, where even low-level allergen exposure can produce clinically relevant inflammation (3,4). Cyanoacrylate adhesives may also release irritant degradation products, including formaldehyde, which has been associated with allergic contact dermatitis and periocular irritation, thereby providing a biologically plausible pathway through which eyelash adhesives may contribute to eyelid inflammation (5,6). In susceptible individuals, repeated cosmetic adhesive exposure near the lash line may therefore promote inflammatory responses through both allergic sensitization and irritant mechanisms (7).

Allergic blepharitis is characterized by inflammation of the eyelid margins and may present with itching, redness, burning sensation, eyelid swelling, scaling, tearing, and foreign body sensation. These symptoms overlap with several ocular surface conditions, including dry eye disease, infectious blepharitis, and meibomian gland dysfunction, which makes clinical recognition difficult unless cosmetic exposure history is specifically assessed. The eyelid margin plays an important role in tear film stability through the function of meibomian glands, sebaceous glands, and hair follicles. Inflammatory disruption of this region can compromise the tear film lipid layer and contribute to reduced tear break-up time, ocular discomfort, reflex tearing, and dryness-like symptoms even when aqueous tear production remains relatively preserved (8,9). Previous studies have also reported ocular discomfort, redness, dryness, and tear film instability among users of eyelash extensions, supporting the clinical relevance of evaluating both eyelid inflammation and tear film parameters in cosmetic adhesive users (10,11).

Existing literature on eyelid dermatitis and cosmetic allergy indicates that periocular cosmetic ingredients, preservatives, fragrances, and adhesive-related compounds are important triggers of eyelid inflammation. Reviews and clinical studies have shown that patients with eyelid dermatitis frequently demonstrate sensitization to cosmetic allergens and preservative compounds, and that eyelid allergic contact dermatitis may be mistaken for other inflammatory eyelid disorders if exposure history is not carefully documented (12,13). Multicentre and adult eyelid dermatitis studies have further highlighted the role of cosmetic allergens, acrylate components, and preservative exposure in itching, redness, swelling, and eyelid irritation (14,15). Evidence from occupational and cosmetic exposure studies also suggests that acrylate and cyanoacrylate compounds are emerging allergens of concern, particularly among individuals repeatedly exposed to adhesive products used on the face and eyelashes (16,17). Experimental and clinical reports have shown that eyelash adhesive exposure may influence inflammatory mediators in tears and may be associated with adverse periocular reactions, including redness, dryness, eyelid swelling, and irritant blepharitis (18–20).

Despite increasing use of eyelash adhesives and cyanoacrylate-containing cosmetic products, structured clinical evidence examining their association with allergic blepharitis remains limited, particularly in local clinical settings. Much of the available literature focuses on allergic contact dermatitis of the skin or occupational exposure, while fewer studies directly evaluate clinically diagnosed allergic blepharitis, frequency and duration of cyanoacrylate-based eye cosmetic use, and objective tear film findings in young adult female cosmetic users. This creates an important knowledge gap for optometrists and eye care professionals because patients may present with recurrent itching, redness, burning, or tear film instability without recognizing eyelash adhesive exposure as a possible contributor. Therefore, the present study was conducted to determine whether the use of cyanoacrylate-based eye cosmetic adhesives is associated with clinically diagnosed allergic blepharitis among young adult females and to assess whether frequency and duration of use are related to eyelid inflammation and tear film instability.

MATERIALS AND METHODS

This analytical cross-sectional study was conducted at Mayo Hospital Lahore to evaluate the association between cyanoacrylate-based eye cosmetic adhesive use and clinically diagnosed allergic blepharitis among young adult females. A cross-sectional design was selected because the study aimed to measure

exposure status, ocular symptoms, clinical eyelid findings, and tear film parameters at a single point in time and compare findings between exposed and non-exposed participants. The target population comprised females aged 18–35 years who were eligible for structured ocular examination and willing to provide informed consent. A total of 73 participants were enrolled through non-probability convenience sampling based on availability, eligibility, and willingness to participate. Participants were classified into two comparison groups according to exposure history: 37 users of cyanoacrylate-based eye cosmetic adhesives and 36 non-users who had no history of using cyanoacrylate-containing eyelash adhesive products.

Participants were included if they were females aged 18–35 years, provided informed consent, and were able to undergo slit-lamp biomicroscopy and tear film assessment. Participants in the exposed group were required to have used eyelash extension adhesives, artificial strip lash glues, decorative eye adhesives, or other cyanoacrylate-containing eye cosmetic adhesive products within the previous six months. Participants in the comparison group had no reported history of cyanoacrylate-based eyelash or eye cosmetic adhesive use. Individuals were excluded if they had chronic blepharitis unrelated to cosmetic exposure, severe dry eye disease, diagnosed meibomian gland dysfunction, autoimmune disease affecting the eyelids, dermatological disease involving the eyelid region, ocular surgery or ocular trauma within the previous six months, or current/recent use of topical ophthalmic antibiotics, corticosteroids, or antihistamines. These criteria were applied to reduce alternative explanations for eyelid inflammation and improve the clinical interpretability of the association between cosmetic adhesive exposure and allergic blepharitis.

Data were collected using a structured proforma that recorded demographic characteristics, cosmetic exposure history, ocular symptoms, slit-lamp findings, tear film parameters, ocular surface pH, and final clinical diagnosis. Demographic variables included age, sex, and occupational status. Exposure variables included cosmetic use status, type of cyanoacrylate-based cosmetic adhesive product used, frequency of use, duration of use, and previous history of cosmetic allergy. Frequency of use was categorized as non-use, 1–2 times per month, 3–4 times per month, and ≥5 times per month. Duration of use was categorized as non-use, <3 months, 3–6 months, 6–12 months, and >1 year. Ocular symptoms were assessed using a 0–3 symptom severity scale for itching, redness, eyelid swelling, burning sensation, tearing, scaling, and foreign body sensation, where higher scores represented greater symptom severity. The total symptom severity score was calculated by summing individual symptom scores.

Clinical examination was performed after completion of the questionnaire. Visual acuity was first assessed using a Snellen chart. Slit-lamp biomicroscopy was then performed to examine the eyelid margin and ocular surface. The main clinical signs recorded were eyelid margin erythema, eyelid edema, scaling or crusting, and conjunctival hyperemia. Allergic blepharitis was clinically defined as the presence of compatible ocular symptoms, particularly itching, redness, burning, swelling, scaling, tearing, or foreign body sensation, together with slit-lamp evidence of eyelid margin inflammation in the context of relevant cosmetic adhesive exposure and after exclusion of alternative inflammatory, infectious, autoimmune, dermatological, surgical, or medication-related causes. Non-allergic blepharitis was recorded when eyelid inflammation was present without a compatible allergic exposure pattern, and participants without relevant symptoms or clinical signs were classified as having no blepharitis.

Tear film stability was assessed using the Tear Break-Up Time test. Fluorescein was instilled into the eye, the participant was asked to blink to distribute the dye evenly over the ocular surface, and the time from the last blink to the first appearance of a dry spot on the cornea was recorded in seconds. A TBUT value of <10 seconds was considered abnormal, while a value of ≥10 seconds was considered normal. Tear production was assessed using the Schirmer I test without topical anesthesia by measuring the wetting length of the strip after five minutes. A value of <10 mm/5 minutes was interpreted as reduced tear production, and a value of ≥10 mm/5 minutes was interpreted as normal tear production. Ocular surface

pH was measured using sterile pH indicator strips and classified in relation to the normal ocular surface pH range of 7.0–7.4.

Several procedural steps were used to reduce bias and improve data quality. Eligibility criteria were applied before clinical classification to minimize confounding from pre-existing ocular surface disease, medication use, autoimmune disease, dermatological eyelid involvement, and recent ocular trauma or surgery. Exposure history was recorded before final clinical classification using a structured questionnaire to improve consistency across participants. Clinical findings were documented on a predefined proforma to standardize data capture. Objective measures, including slit-lamp findings, TBUT, Schirmer I test, and ocular surface pH, were included alongside subjective symptoms to reduce reliance on self-reported complaints alone. Data entries were reviewed for completeness and consistency before statistical analysis.

Data were entered and analyzed using SPSS version 26. Categorical variables, including age group, occupational status, cosmetic use status, frequency of use, duration of use, symptom categories, TBUT classification, Schirmer classification, ocular surface pH category, and blepharitis status, were summarized as frequencies and percentages. Continuous or score-based variables, including clinical sign scores, TBUT values, Schirmer I test values, ocular surface pH, and total symptom severity score, were summarized using mean, standard deviation, median, mode, and variance where appropriate. The chi-square test of association was used to evaluate the relationship between frequency of cyanoacrylate-based eye cosmetic use and clinically diagnosed allergic blepharitis, and between duration of cyanoacrylate-based eye cosmetic use and eyelid inflammation. Where sparse categories were present, interpretation was based on the appropriateness of expected cell counts and clinical relevance of category distribution. Mean TBUT values between users and non-users were compared using an independent samples t-test because the exposure groups were independent. Statistical significance was set at $p < 0.05$. Ethical approval and departmental permission were obtained before data collection, and informed consent was obtained from all participants before questionnaire completion and ocular examination.

RESULTS

A total of 73 young adult females were included in the study. The largest age group was 18–22 years, comprising 28 participants (38.4%), followed by 23–27 years with 24 participants (32.9%), 28–32 years with 14 participants (19.2%), and 33–35 years with 7 participants (9.6%). All participants were female. Most participants were students (n = 42, 57.5%), while 21 (28.8%) were working females and 10 (13.7%) belonged to other occupational categories. Based on exposure history, 37 participants (50.7%) were classified as users of cyanoacrylate-based eye cosmetic adhesives and 36 (49.3%) were classified as non-users. The demographic and exposure distribution is presented in Table 1.

Table 1. Demographic Characteristics and Cosmetic Exposure Status of Participants (N = 73)

Variable	Category	Frequency (n)	Percentage (%)
Age group	18–22 years	28	38.4
	23–27 years	24	32.9
	28–32 years	14	19.2
	33–35 years	7	9.6
Gender	Female	73	100.0
	Male	0	0.0
Occupational status	Students	42	57.5
	Working females	21	28.8
	Others	10	13.7
Cosmetic exposure status	Users of cyanoacrylate-based eye cosmetics	37	50.7
	Non-users	36	49.3

Among the 37 users of cyanoacrylate-based eye cosmetic adhesives, 13 participants (17.8% of the total sample) reported use 1–2 times per month, 14 (19.2%) reported use 3–4 times per month, and 10 (13.7%)

reported use ≥5 times per month. Regarding duration of use, 12 participants (16.4%) had used these products for <3 months, 13 (17.8%) for 3–6 months, 11 (15.1%) for 6–12 months, and 1 participant (1.4%) for >1 year. For inferential analysis, the 6–12 months and >1 year categories were combined as ≥6 months because the >1 year category contained only one participant. The exposure pattern is summarized in Table 2.

Table 2. Pattern of Cyanoacrylate-Based Eye Cosmetic Use Among Participants (N = 73)

Exposure Variable	Category	Frequency (n)	Percentage
Cosmetic use status	Non-users	36	49.3
	Users	37	50.7
Frequency of use	Non-users	36	49.3
	1–2 times/month	13	17.8
	3–4 times/month	14	19.2
	≥5 times/month	10	13.7
Duration of use	Non-users	36	49.3
	<3 months	12	16.4
	3–6 months	13	17.8
	6–12 months	11	15.1
	>1 year	1	1.4
Duration category used for inferential analysis	Non-users	36	49.3
	<3 months	12	16.4
	3–6 months	13	17.8
	≥6 months	12	16.4

Clinically diagnosed allergic blepharitis was identified in 29 participants (39.7%), while 44 participants (60.3%) did not have allergic blepharitis. Allergic blepharitis was substantially more frequent among users of cyanoacrylate-based eye cosmetics, affecting 23 of 37 users (62.2%), compared with 6 of 36 non-users (16.7%). The crude odds of allergic blepharitis were approximately 8.21 times higher among users than non-users (OR = 8.21, 95% CI: 2.73–24.67), indicating a strong association between cyanoacrylate-based eye cosmetic use and allergic blepharitis. This comparison is presented in Table 3.

Table 3. Association Between Cosmetic Exposure Status and Allergic Blepharitis

Cosmetic Exposure Status	Allergic Blepharitis Present n (%)	Allergic Blepharitis Absent n (%)	Total	Crude OR (95% CI)
Non-users	6 (16.7)	30 (83.3)	36	Reference
Users of cyanoacrylate-based eye cosmetics	23 (62.2)	14 (37.8)	37	8.21 (2.73–24.67)
Total	29 (39.7)	44 (60.3)	73	—

The frequency of cyanoacrylate-based eye cosmetic use showed a significant association with clinically diagnosed allergic blepharitis. Among non-users, allergic blepharitis was present in 6 of 36 participants (16.7%). The proportion increased to 5 of 13 participants (38.5%) among those using these cosmetics 1–2 times per month, 9 of 14 participants (64.3%) among those using them 3–4 times per month, and 9 of 10 participants (90.0%) among those using them ≥5 times per month. Chi-square analysis demonstrated a statistically significant association between frequency of use and allergic blepharitis, $\chi^2(3, N = 73) = 22.684$, $p = 0.002$, with a large association magnitude based on Cramer's $V = 0.56$. These findings suggest a clear exposure-response pattern, with higher frequency of use corresponding to a higher proportion of allergic blepharitis. The analysis is shown in Table 4.

Table 4. Association Between Frequency of Cyanoacrylate-Based Eye Cosmetic Use and Allergic Blepharitis

Frequency of Use	Allergic Blepharitis Present n (%)	Allergic Blepharitis Absent n (%)	Total	χ^2	df	p-value	Cramer's V
Non-users	6 (16.7)	30 (83.3)	36				
1–2 times/month	5 (38.5)	8 (61.5)	13				
3–4 times/month	9 (64.3)	5 (35.7)	14				
≥5 times/month	9 (90.0)	1 (10.0)	10	22.684	3	0.002	0.56
Total	29 (39.7)	44 (60.3)	73				

Duration of cyanoacrylate-based eye cosmetic use was also significantly associated with eyelid inflammation. Because only one participant reported use for >1 year, the 6–12 months and >1 year categories were combined into a ≥6 months category for inferential analysis. Eyelid inflammation was present in 9 of 36 non-users (25.0%), 5 of 12 participants (41.7%) with <3 months of use, 8 of 13 participants (61.5%) with 3–6 months of use, and 9 of 12 participants (75.0%) with ≥6 months of use. Chi-square analysis showed a statistically significant association between duration of use and eyelid inflammation, $\chi^2(3, N = 73) = 11.632$, $p = 0.009$, with a moderate-to-large association magnitude based on Cramer's V = 0.40. This indicates that longer exposure duration was associated with a higher proportion of eyelid inflammation. The analysis is presented in Table 5.

Table 5. Association Between Duration of Cyanoacrylate-Based Eye Cosmetic Use and Eyelid Inflammation

Use Duration	Eyelid Inflammation Present n (%)	Eyelid Inflammation Absent n (%)	Total	χ^2	df	p-value	Cramer's V
Non-users	9 (25.0)	27 (75.0)	36				
<3 months	5 (41.7)	7 (58.3)	12				
3–6 months	8 (61.5)	5 (38.5)	13				
≥6 months	9 (75.0)	3 (25.0)	12	11.632	3	0.009	0.40
Total	31 (42.5)	42 (57.5)	73				

The clinical examination findings showed that eyelid margin erythema was the most prominent slit-lamp sign, with a mean score of 1.58 ± 0.82, followed by conjunctival hyperemia with a mean score of 1.49 ± 0.76. Eyelid edema and scaling/crusting were less severe but still clinically relevant, with mean scores of 1.31 ± 0.46 and 1.27 ± 0.45, respectively. Tear film assessment showed that mean TBUT was slightly below the normal clinical threshold of 10 seconds in both eyes, with a right-eye mean of 9.42 ± 2.31 seconds and a left-eye mean of 9.36 ± 2.28 seconds. Overall, 42 participants (57.5%) had abnormal TBUT values below 10 seconds, while 31 participants (42.5%) had normal TBUT. In contrast, tear production was relatively preserved in most participants: mean Schirmer I values were 12.18 ± 3.46 mm/5 min in the right eye and 12.04 ± 3.39 mm/5 min in the left eye, and 51 participants (69.9%) had normal tear production. Ocular surface pH was also mostly within the normal range, with 66 participants (90.4%) showing normal pH values. These findings indicate that tear film instability was more prominent than reduced tear production or pH disturbance. Clinical and tear film findings are summarized in Table 6.

Table 6. Clinical Findings, Tear Film Assessment, and Ocular Surface Parameters

Variable	Finding / Category	Value
Eyelid margin erythema	Mean ± SD	1.58 ± 0.82
Eyelid edema		1.31 ± 0.46
Scaling/crusting		1.27 ± 0.45
Conjunctival hyperemia		1.49 ± 0.76
TBUT right eye		9.42 ± 2.31 sec
TBUT left eye		9.36 ± 2.28 sec
TBUT classification	Normal, ≥10 sec	31 (42.5%)
	Abnormal, <10 sec	42 (57.5%)
Schirmer I right eye	Mean ± SD	12.18 ± 3.46 mm/5 min
Schirmer I left eye		12.04 ± 3.39 mm/5 min
Tear production classification	Normal, ≥10 mm/5 min	51 (69.9%)
	Reduced, <10 mm/5 min	22 (30.1%)
Ocular surface pH	Normal, 7.0–7.4	66 (90.4%)
	Abnormal, outside normal range	7 (9.6%)

Comparison of TBUT between users and non-users demonstrated significantly reduced tear film stability among users of cyanoacrylate-based eye cosmetics. The mean TBUT among users was 8.38 ± 2.06 seconds, compared with 10.44 ± 2.10 seconds among non-users. The mean difference was −2.06 seconds, indicating lower TBUT among users. Independent samples t-test showed that this difference was statistically significant, $t(71) = -4.236$, $p < 0.001$. The 95% confidence interval for the mean difference ranged from −3.03 to −1.09 seconds, and the standardized mean difference was large in magnitude (Cohen's d = −0.99). These findings suggest that cyanoacrylate-based eye cosmetic users had clinically and statistically lower tear film stability than non-users. The comparison is presented in Table 7.

Overall, the results demonstrate a consistent association between cyanoacrylate-based eye cosmetic exposure and adverse eyelid and tear film findings. Allergic blepharitis was more common among users than non-users, and the odds of allergic blepharitis were markedly higher among exposed participants. A frequency-response pattern was observed, with allergic blepharitis increasing from 16.7% among non-users to 90.0% among those using cyanoacrylate-based eye cosmetics ≥5 times per month.

Table 7. Comparison of Tear Break-Up Time Between Users and Non-Users of Cyanoacrylate-Based Eye Cosmetics

Group	n	Mean TBUT ± SD (sec)	Mean Difference (sec)	95% CI	t	df	p-value	Cohen's d
Users of cyanoacrylate based eye cosmetics	37	8.38 ± 2.06	−2.06	−3.03 to −1.09	−4.236	71	<0.001	−0.99
Non-users	36	10.44 ± 2.10	Reference	Reference				

Duration of use showed a similar gradient, with eyelid inflammation increasing from 25.0% among non-users to 75.0% among participants using these products for ≥6 months. Tear film stability was also significantly reduced among users, while tear production and ocular surface pH were relatively preserved in most participants. These findings suggest that cyanoacrylate-based eye cosmetic exposure is associated primarily with eyelid inflammation and tear film instability rather than generalized tear deficiency or major ocular surface pH disturbance.

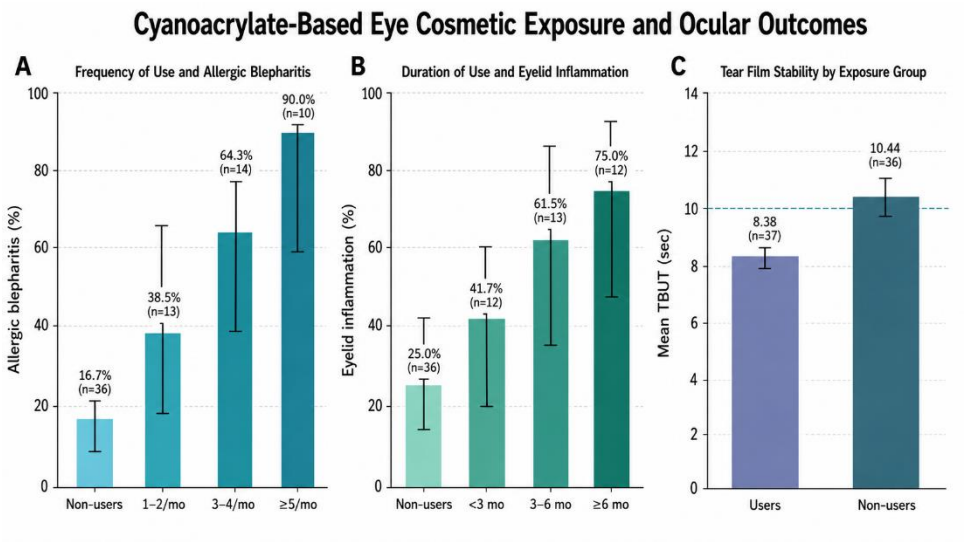

Figure 1. Cyanoacrylate-based eye cosmetic exposure and ocular outcomes among young adult females.

The figure shows a dose–response pattern between cyanoacrylate-based eye cosmetic exposure and ocular inflammatory outcomes: allergic blepharitis increased from 16.7% in non-users to 90.0% among participants using these products ≥5 times/month, while eyelid inflammation increased from 25.0% in non-users to 75.0% among those with ≥6 months of use. Mean TBUT was lower among users than non-users (8.38 vs. 10.44 seconds), with the user group falling below the 10-second clinical reference line, indicating reduced tear film stability alongside higher eyelid inflammation.

DISCUSSION

The present study evaluated the association between cyanoacrylate-based eye cosmetic adhesive use and clinically diagnosed allergic blepharitis among young adult females. The findings demonstrated a clear difference in allergic blepharitis between exposed and non-exposed participants, with allergic blepharitis identified in 23 of 37 users (62.2%) compared with 6 of 36 non-users (16.7%). The crude odds of allergic blepharitis were markedly higher among users of cyanoacrylate-based eye cosmetics than among non-users, indicating a strong association between cosmetic adhesive exposure and eyelid inflammatory disease. Importantly, the association also showed an exposure-response pattern: allergic blepharitis increased from 16.7% among non-users to 38.5% among participants using these products 1–2 times/month, 64.3% among those using them 3–4 times/month, and 90.0% among those using them ≥5

times/month. This frequency-based gradient was statistically significant, $\chi^2(3, N = 73) = 22.684$, $p = 0.002$, with a large association magnitude based on Cramer's V. These findings support the clinical relevance of obtaining a detailed cosmetic adhesive exposure history in young females presenting with recurrent itching, redness, burning, eyelid swelling, or foreign body sensation.

The observed association is biologically plausible because cyanoacrylate-based adhesives and related acrylate compounds have been recognized as potential sensitizers in cosmetic, occupational, and medical adhesive exposure. Repeated exposure to acrylate-containing adhesives may promote sensitization, particularly when products are applied repeatedly to thin and highly permeable periocular skin. The eyelid margin is anatomically vulnerable because it contains hair follicles, sebaceous glands, and meibomian gland openings that contribute to ocular surface protection and tear film stability. Recurrent exposure to adhesive compounds near the lash line may therefore produce symptoms through allergic sensitization, irritant inflammation, or a combined mechanism. Previous literature has described acrylate and cyanoacrylate allergy as an emerging concern, particularly with increasing cosmetic and adhesive use, and has identified cosmetic allergens, preservatives, fragrances, and adhesive-related compounds as important triggers of eyelid dermatitis and periocular inflammation (3,4,12–15). The current findings extend this concern into a local clinical sample by showing that clinically diagnosed allergic blepharitis was more common among users of cyanoacrylate-based eye cosmetic adhesives than among non-users.

Duration of use was also significantly associated with eyelid inflammation. Eyelid inflammation was present in 25.0% of non-users, 41.7% of participants using cyanoacrylate-based eye cosmetics for <3 months, 61.5% of those using them for 3–6 months, and 75.0% of those using them for ≥6 months. This significant duration-related pattern, $\chi^2(3, N = 73) = 11.632$, $p = 0.009$, suggests that prolonged exposure may be associated with greater eyelid inflammatory involvement. Although the cross-sectional design does not permit confirmation of temporality or causation, the increasing proportion of eyelid inflammation across longer duration categories is consistent with the concept that repeated or prolonged exposure to adhesive-based cosmetics may increase the likelihood of irritation or sensitization in susceptible individuals. Prior occupational and cosmetic studies have similarly reported allergic contact dermatitis related to eyelash extension glues and repeated acrylate exposure, supporting the interpretation that cumulative exposure may be clinically important (16,17).

The symptom profile observed in this study further supports the clinical relevance of cyanoacrylate-based eye cosmetic exposure. Itching was the most common symptom, reported by 52 participants (71.2%), followed by redness in 48 (65.8%), burning sensation in 43 (58.9%), foreign body sensation in 39 (53.4%), eyelid swelling in 36 (49.3%), tearing in 34 (46.6%), and scaling in 31 (42.5%). These symptoms are compatible with allergic or irritant eyelid inflammation and are particularly important because patients may not spontaneously associate periocular symptoms with cosmetic adhesive exposure. In clinical practice, allergic blepharitis can overlap with dry eye disease, infectious blepharitis, meibomian gland dysfunction, and allergic contact dermatitis of the eyelid. Therefore, careful evaluation of cosmetic use, frequency, duration, and previous cosmetic allergy history is essential to avoid misclassification and delayed management. Previous studies on eyelid dermatitis have similarly emphasized that cosmetic allergens and adhesive-related ingredients can produce itching, redness, swelling, and eyelid irritation, which may resemble other ocular surface disorders (12–15).

Objective clinical findings supported the symptom-based observations. Slit-lamp examination showed eyelid margin erythema as the most prominent sign, with a mean score of 1.58 ± 0.82, followed by conjunctival hyperemia with a mean score of 1.49 ± 0.76. Eyelid edema and scaling/crusting were present at lower mean severity levels, 1.31 ± 0.46 and 1.27 ± 0.45, respectively. These findings indicate that inflammation was not based solely on subjective symptoms but was also supported by observable clinical signs. The prominence of eyelid margin erythema and conjunctival hyperemia is clinically meaningful because cyanoacrylate-based adhesives are applied close to the lash line, where localized chemical

exposure may affect the eyelid margin and adjacent ocular surface. These results are consistent with reports of periocular cosmetic procedures and eyelash extensions being associated with irritation, redness, swelling, and ocular discomfort (10,19,20).

Tear film assessment provided an additional dimension to the clinical interpretation. Mean TBUT values were slightly below the normal threshold of 10 seconds, with right-eye TBUT of 9.42 ± 2.31 seconds and left-eye TBUT of 9.36 ± 2.28 seconds. Overall, 42 participants (57.5%) had abnormal TBUT values below 10 seconds, indicating that tear film instability was common in the study population. More importantly, users of cyanoacrylate-based eye cosmetics had significantly lower mean TBUT than non-users, with values of 8.38 ± 2.06 seconds and 10.44 ± 2.10 seconds, respectively. The mean difference of −2.06 seconds was statistically significant, $t(71) = -4.236$, $p < 0.001$, and clinically relevant because reduced TBUT is associated with burning, irritation, tearing, and foreign body sensation. This finding suggests that cyanoacrylate-based eye cosmetic use was associated not only with eyelid inflammation but also with reduced tear film stability. Previous studies have reported tear film instability, ocular discomfort, dryness, and meibomian gland-related changes following eyelash extension use, supporting the interpretation that periocular cosmetic adhesives may influence ocular surface homeostasis (8–11).

In contrast to TBUT, Schirmer I test findings indicated that aqueous tear production was relatively preserved in most participants. Mean Schirmer I values were 12.18 ± 3.46 mm/5 min in the right eye and 12.04 ± 3.39 mm/5 min in the left eye, and 51 participants (69.9%) had normal tear production. Ocular surface pH was also mostly normal, with 66 participants (90.4%) within the pH range of 7.0–7.4. This pattern suggests that the predominant ocular surface abnormality in the study was tear film instability rather than generalized tear deficiency or major pH disturbance. Clinically, this may reflect disruption of the tear film lipid layer, eyelid margin inflammation, or meibomian gland-related functional disturbance rather than primary aqueous tear insufficiency. Such a mechanism is consistent with the anatomical role of the eyelid margin and meibomian glands in maintaining tear film stability.

The findings should be interpreted in light of several limitations. First, the cross-sectional design limits causal inference because exposure and outcome were measured at the same point in time, and temporality cannot be established. Second, the study used non-probability convenience sampling from a single clinical setting, which may limit generalizability to the wider population of cosmetic users. Third, exposure status was based on participant-reported cosmetic adhesive use, and product-level chemical verification or patch testing was not performed. This may have introduced exposure misclassification, particularly if participants were unaware of the exact adhesive ingredients used in cosmetic products or salon procedures. Fourth, although exclusion criteria were applied to reduce alternative causes of eyelid inflammation, residual confounding may remain from unmeasured factors such as atopy, contact lens use, use of other eye cosmetics, skincare products, occupational exposures, environmental allergens, and prior allergic history. Fifth, the sample size was modest, and some exposure categories, particularly longer duration groups, contained small numbers. Therefore, sparse categories required careful interpretation, and larger multicenter studies are needed to confirm these findings with greater statistical precision.

Despite these limitations, the study provides clinically useful evidence that cyanoacrylate-based eye cosmetic adhesive use is associated with allergic blepharitis and reduced tear film stability among young adult females. The strength of the association, the observed frequency-response and duration-response patterns, and the consistency between symptoms, slit-lamp findings, and TBUT support the relevance of cosmetic adhesive exposure as an important clinical consideration. The findings highlight the need for improved user awareness, safer cosmetic practices, careful product selection, avoidance of repeated exposure in symptomatic individuals, and early optometric or ophthalmic evaluation when eyelid irritation develops after eyelash adhesive use. Future studies should use larger probability-based samples, product ingredient verification, patch testing, blinded clinical assessment, and multivariable analysis to

clarify the independent contribution of cyanoacrylate exposure to allergic blepharitis and ocular surface instability.

CONCLUSION

This analytical cross-sectional study found that cyanoacrylate-based eye cosmetic adhesive use was significantly associated with clinically diagnosed allergic blepharitis and reduced tear film stability among young adult females. Allergic blepharitis was more common among users than non-users, and both higher frequency and longer duration of use were associated with a greater proportion of eyelid inflammation. Users also had significantly lower mean TBUT than non-users, indicating impaired tear film stability, while Schirmer I values and ocular surface pH were relatively preserved in most participants. These findings suggest that repeated periocular exposure to cyanoacrylate-based cosmetic adhesives may be clinically relevant in young females presenting with itching, redness, burning, eyelid swelling, foreign body sensation, or tear film instability. Because the study design was cross-sectional, the findings should be interpreted as associations rather than proof of causation, and further longitudinal, patch-test-confirmed, and multicenter research is required to establish temporality and strengthen causal interpretation.

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