Journal of Advanced Scientific Research

Available online through https://sciensage.info

ISSN

0976-9595

Research Article

Impact of Lid Margin Diseases on Tear Film Stability and Ocular Surface Parameters: A Prospective Controlled Study with Healthy Subjects

Kundan Kumar Singh, Chandan Kumar*, Anurag Verma, Jawed Iqbal

Department of Ophthalmology, ANMMCH, Gaya, Bihar, India

Corresponding author: chandan.mbbs09@gmail.com

Received: 18-04-2026; Accepted: 27-05-2026; Published: 30-05-2026

https://doi.org/10.55218/JASR.2026170515

ABSTRACT

Background: Lid margin diseases, including anterior and posterior blepharitis and meibomian gland dysfunction, are major contributors to tear film instability and evaporative dry eye disease. Alterations in the lipid layer of the tear film disrupt ocular surface homeostasis, leading to discomfort, visual disturbance, and epithelial damage.

Aim: To prospectively evaluate the impact of lid margin diseases on tear film stability and ocular surface parameters and to compare findings with healthy controls attending at Anmmch Gaya, Bihar.

Methodology: This prospective controlled study included 200 participants over a 10-month period, comprising 100 patients with clinically diagnosed lid margin disease and 100 age- and sex-matched healthy controls. All participants underwent a comprehensive ophthalmic examination, tear film break-up time (TBUT), Schirmer's test, ocular surface staining assessment, and ocular surface disease index (OSDI) scoring. Meibomian gland morphology and expressibility were also evaluated.

Results: Patients with lid margin disease demonstrated significantly reduced TBUT and Schirmer values compared to controls ($p < 0.001$). Ocular surface staining and meibomian gland dropout were markedly higher among cases. A strong correlation was observed between disease severity and worsening tear film parameters, along with increased symptom scores.

Conclusion: Lid margin diseases significantly compromise tear film stability and ocular surface health. Early diagnosis and targeted management are essential to reduce disease burden and improve patient outcomes in tertiary care settings.

Keywords: Blepharitis, Meibomian gland dysfunction, Tear film, Dry eye syndromes, Ocular surface

INTRODUCTION

The tear film plays a vital role in maintaining ocular surface integrity, visual clarity, and protection against environmental stressors. It is a trilaminar structure consisting of lipid, aqueous, and mucin layers, each contributing to lubrication, tear stability, and defense against microbial invasion. Among these, the outermost lipid layer secreted primarily by the meibomian glands located in the lid margin, prevents evaporation and stabilizes the tear film. Any abnormality in lid margin anatomy or meibomian gland function can therefore lead to tear film instability and subsequent ocular surface disease [1].

Lid margin diseases encompass a broad spectrum of disorders, including anterior and posterior blepharitis, meibomian gland dysfunction (MGD), lid margin keratinization, and cicatricial changes. These conditions result in qualitative and quantitative alterations in meibum secretion, obstruction of gland orifices, and inflammatory changes, all of which disrupt tear film homeostasis. Studies have consistently shown that MGD is one of the leading causes of evaporative dry eye disease and is highly prevalent in Asian populations, including India [2]. In a hospital-based Indian study, MGD prevalence was reported as high as 48.4%, highlighting the significant burden of lid margin pathology in clinical practice [3].

The relationship between lid margin diseases and tear film instability is well established. Reduced lipid secretion leads to increased evaporation of the aqueous layer, decreased tear break-up time (TBUT), and increased ocular surface staining. Structural changes in meibomian glands, such as gland dropout, shortening, and tortuosity, have been shown to correlate with worsening tear film parameters and patient symptoms [4]. Furthermore, even in early or preclinical dry eye states, measurable changes in tear film stability and gland morphology have been demonstrated, emphasizing the importance of early detection and intervention [5].

Several ocular and systemic conditions further exacerbate lid margin pathology and tear film instability. For instance, pterygium, diabetes mellitus, and cicatricial conjunctival disorders have been shown to significantly affect meibomian gland morphology and tear film parameters, thereby contributing to ocular surface disease [6-8]. These findings indicate that lid margin disease is not only a localized ocular condition but also part of a broader systemic and environmental interaction affecting ocular surface health.

The pathophysiology of lid margin disease is multifactorial, involving age-related glandular atrophy, altered lipid composition, microbial colonization, and inflammatory changes. Aging leads to reduced meibocyte differentiation and lipid production, while microbial enzymes from lid margin flora alter meibum composition, increasing tear film instability [9]. Environmental factors such as pollution, ultraviolet exposure, and poor eyelid hygiene further contribute to disease progression. These factors are particularly relevant in developing regions with high environmental stressors and limited access to preventive eye care.

In the Indian context, dry eye disease and lid margin disorders are increasingly recognized as significant causes of ocular morbidity. Hospital-based studies from tertiary care centers have demonstrated that MGD is the most common underlying cause of dry eye symptoms among patients attending ophthalmology outpatient departments [4]. The burden is further compounded by systemic diseases such as diabetes, which is highly prevalent in India and is associated with higher rates of meibomian gland dysfunction and tear film abnormalities [7]. These findings underscore the importance of evaluating lid margin health as part of a comprehensive ocular surface assessment.

Despite the growing recognition of lid margin diseases, there is a paucity of region-specific prospective data evaluating their impact on tear film stability and ocular surface parameters, particularly in eastern India and Bihar. Bihar represents a densely populated state with significant socioeconomic challenges, limited access to specialized eye care, and a high prevalence of environmental and occupational risk factors such as dust exposure, agricultural work, and poor sanitation. These factors predispose the population to chronic eyelid inflammation and ocular surface disorders.

Tertiary care centers in Bihar function as major referral hubs for surrounding districts and neighboring states, receiving a large volume of patients with chronic ocular complaints, including dryness, irritation, foreign body sensation, and visual disturbance. However, many of these patients remain underdiagnosed or misdiagnosed due to a lack of standardized evaluation of lid margin disease and tear film parameters. Early identification of lid margin abnormalities and their effect on tear film stability can significantly improve patient outcomes by enabling targeted therapy such as lid hygiene, warm compresses, and meibomian gland expression.

Therefore, this prospective controlled study is designed to evaluate the impact of lid margin diseases on tear film stability and ocular surface parameters in patients attending a tertiary care center in Bihar, with comparison to healthy controls. The findings are expected to contribute to improved clinical protocols for early diagnosis and management of lid margin disorders and dry eye disease in resource-limited settings.

MATERIALS AND METHODS

The present prospective controlled study was conducted in the Department of Ophthalmology at ANMMCH, Gaya, Bihar, India. The institute functions as a major referral center catering to both urban and rural populations from surrounding districts and neighboring states. The ophthalmology outpatient department (OPD) receives a large number of patients presenting with symptoms of ocular irritation, dryness, redness, watering, foreign body sensation, and visual disturbance, many of which are attributable to lid margin diseases and ocular surface disorders. The study was carried out over a period of ten months following approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

This was a hospital-based, prospective, controlled observational study designed to evaluate the impact of lid margin diseases on tear film stability and ocular surface parameters. Participants were divided into two groups:

Group A (Cases): Patients diagnosed with lid margin diseases.

Group B (Controls): Age- and sex-matched healthy individuals without any lid margin abnormality or ocular surface disease.

All enrolled participants underwent standardized clinical evaluation and tear film assessment at baseline.

Inclusion Criteria

Participants fulfilling the following criteria were included in the study: Age ≥18 years. Patients presenting with symptoms suggestive of lid margin disease, such as itching, burning, crusting, lid margin redness, or foreign body sensation. Clinical diagnosis of lid margin disease, including anterior blepharitis, posterior blepharitis, or meibomian gland dysfunction based on slit-lamp examination. Willingness to provide informed consent and comply with study procedures. For the control group: healthy individuals without symptoms of dry eye or lid margin disease and with normal ocular examination.

Exclusion Criteria

Participants were excluded if they met any of the following criteria: History of ocular surgery or trauma within the past 6 months. Active ocular infection (bacterial, viral, or fungal conjunctivitis/keratitis). Presence of pterygium encroaching on the cornea or other ocular surface pathology affecting the tear film independently. Systemic diseases known to affect tear production, such as Sjögren's syndrome, rheumatoid arthritis, or thyroid eye disease. Use of topical medications affecting the tear film (e.g., lubricants, anti-glaucoma drugs) within the previous 2 weeks. Contact lens wearers. Pregnant or lactating women. Patients on systemic medications known to affect tear secretion (e.g., antihistamines, antidepressants).

The sample size consisted of randomly selected patients reporting to the ophthalmology OPD during a 6-month period. Based on OPD attendance patterns and feasibility, a total of 200 participants were included in the study, comprising 100 patients with lid margin disease (cases) and 100 healthy controls.

Random sampling was achieved by enrolling every third eligible patient presenting with lid margin disease during the OPD hours until the required sample size was reached. Controls were recruited from attendants and hospital staff after screening for eligibility and matching for age and gender distribution.

METHODOLOGY

Clinical Evaluation

All participants underwent a comprehensive ophthalmic examination, including: Detailed history taking regarding ocular symptoms, duration, and associated systemic conditions. Visual acuity assessment

Table 1: Demographic distribution of study population

Variable	*Group A (Cases) n=100*	*Group B (Controls) n=100*	*p-value*
Mean age (years)	42.6 ± 12.3	41.8 ± 11.9	0.68
Gender (Male:Female)	54:46	52:48	0.77
Urban (%)	38%	40%	0.75
Rural (%)	62%	60%	0.75

Table 2: Comparison of tear film parameters between cases and controls

Parameter	*Group A (Cases) Mean ± SD*	*Group B (Controls) Mean ± SD*	*p-value*
TBUT (seconds)	7.4 ± 2.1	12.6 ± 2.8	<0.001
Schirmer test (mm/5 min)	9.2 ± 3.5	16.4 ± 4.1	<0.001
OSDI score	38.5 ± 12.2	14.6 ± 6.3	<0.001

Table 3: Ocular surface staining and meibomian gland changes

Parameter	*Group A (Cases)*	*Group B (Controls)*	*p-value*
Corneal staining present (%)	68%	12%	<0.001
Conjunctival staining (%)	72%	15%	<0.001
Meibomian gland dropout (%)	64%	10%	<0.001
Poor gland expressibility (%)	70%	8%	<0.001

Table 4: Correlation between severity of lid margin disease and tear film parameters

Variable	TBUT (r value)	Schirmer (r value)	OSDI (r value)	*p-value*
Severity grade of lid margin disease	-0.62	-0.58	+0.66	<0.001

using Snellen's chart. Slit-lamp biomicroscopy to evaluate lid margin abnormalities such as telangiectasia, meibomian gland orifice plugging, lid margin irregularity, and the presence of scales or crusts. Meibomian gland expressibility and quality of secretion assessment using standardized digital pressure.

Tear Film Assessment

The following tear film and ocular surface parameters were evaluated in all participants in a standardized sequence:

Tear film break-up time (TBUT)

Fluorescein dye was instilled into the conjunctival sac, and the interval between a complete blink and the appearance of the first dry spot on the cornea was measured using a slit lamp with a cobalt blue filter. Three readings were taken and averaged. TBUT <10 seconds was considered abnormal.

Schirmer's test (without anesthesia)

Standard Whatman filter paper strips were placed in the lower fornix at the junction of the middle and lateral third of the eyelid. Wetting was measured after 5 minutes. Values <10 mm were considered indicative of decreased tear production.

Ocular surface staining

Corneal and conjunctival staining with fluorescein was graded using standardized scoring systems.

Meibography (where available)

Infrared meibography was used in selected patients to assess meibomian gland morphology, including gland dropout, shortening, and distortion.

Ocular surface disease index (OSDI) Questionnaire

Subjective symptoms were quantified using a validated questionnaire to correlate clinical findings with patient-reported symptoms.

All measurements were performed in a controlled clinical environment between 10 AM and 1 PM to minimize diurnal variation. The same examiner performed all tests to reduce inter-observer variability.

Outcome Measures

Primary outcome measures included: Tear Film Break-Up Time (TBUT), Schirmer test values, ocular surface staining score. Secondary outcome measures included: Meibomian gland morphology changes, OSDI symptom scores.

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Continuous variables such as TBUT and Schirmer values were expressed as mean ± standard deviation. Categorical variables such as the presence of staining and gland dropout were expressed as percentages. An independent sample t-test was used to compare mean values between cases and controls. Chi-square test was applied for

comparison of categorical variables. Pearson correlation coefficient was used to assess the relationship between the severity of lid margin disease and tear film parameters. A *p-value* <0.05 was considered statistically significant.

RESULTS

A total of 200 participants were included in the study, comprising 100 patients with lid margin disease (Group A) and 100 healthy controls (Group B). The results of tear film stability and ocular surface parameters were analyzed and compared between the two groups.

The demographic characteristics of both groups were comparable. There was no statistically significant difference in mean age, gender distribution, or rural–urban distribution between the two groups (p >0.05). This ensured appropriate matching and reduced confounding bias in outcome comparisons [Table 1].

Patients with lid margin disease demonstrated significantly reduced TBUT and Schirmer values compared to controls, indicating compromised tear film stability and aqueous production. The OSDI score was significantly higher in cases, reflecting increased subjective symptoms of dry eye. All differences were statistically highly significant (p <0.001) [Table 2].

A significantly higher proportion of patients with lid margin disease exhibited ocular surface staining, suggesting epithelial damage and tear film instability. Meibomian gland dysfunction parameters such as gland dropout and poor expressibility were markedly higher in cases than in controls (p<0.001), confirming structural and functional gland alterations in diseased patients [Table 3].

A strong negative correlation was observed between the severity of lid margin disease and TBUT as well as Schirmer values, indicating that increasing disease severity leads to worsening tear film stability and tear secretion. Conversely, a strong positive correlation with the OSDI score indicated increased symptom severity with worsening lid margin pathology. These correlations were statistically highly significant (p <0.001) [Table 4].

The present study demonstrated that lid margin diseases significantly affect tear film stability and ocular surface integrity. Patients with lid margin disease had: Reduced tear film break-up time, decreased Schirmer test values, higher ocular surface staining, marked meibomian gland structural abnormalities, and significantly higher symptom burden. The findings clearly indicate that lid margin disease is strongly associated with evaporative dry eye and ocular surface damage.

DISCUSSION

The present prospective controlled study evaluated the impact of lid margin diseases on tear film stability and ocular surface parameters in patients attending at Anmmch Gaya Ji Bihar. The findings demonstrate a significant association between lid margin pathology and compromised tear film function, with marked reduction in TBUT, Schirmer test values, and increased ocular surface staining among cases compared to healthy controls. These findings are consistent with the established concept that lid margin diseases, particularly meibomian gland dysfunction (MGD), represent the leading cause of evaporative dry eye disease worldwide [1].

In the current study, the mean TBUT in patients with lid margin disease was significantly lower than in controls. This reduction reflects instability of the lipid layer of the tear film due to altered meibomian gland secretion. Similar observations have been reported by Chatterjee *et al.*, who documented significantly decreased TBUT in Indian patients with MGD attending tertiary care centers [2]. The reduced TBUT observed in this study highlights the role of meibomian gland lipid deficiency in accelerating tear evaporation and destabilizing the tear film.

Schirmer test values were also significantly reduced among cases, indicating that lid margin disease may not only affect the lipid layer but may also secondarily influence aqueous tear production. Mehta *et al.* demonstrated that chronic inflammation associated with lid margin disease can involve the lacrimal functional unit, thereby reducing tear secretion [3]. This dual impact on both lipid and aqueous components explains the severity of dry eye symptoms observed in patients with advanced lid margin disease.

Ocular surface staining was significantly higher among cases, suggesting epithelial compromise and chronic ocular surface inflammation. This finding is consistent with the study by Mathur *et al.*, who reported increased corneal and conjunctival staining in patients with MGD associated with pterygium and ocular surface inflammation [4]. Chronic tear film instability leads to desiccation stress and inflammatory mediator release, resulting in epithelial cell damage and staining patterns observed clinically.

Meibomian gland morphological changes, including gland dropout and poor expressibility, were significantly more common in the study group. These structural changes have been shown to correlate strongly with functional tear film impairment. Fatima *et al.* demonstrated that gland dropout is directly associated with worsening tear film stability and symptom severity even in early dry eye disease [5]. The strong correlation observed in the present study between disease severity and tear film parameters further supports this relationship.

The positive correlation between lid margin disease severity and OSDI scores observed in this study indicates that structural and functional gland abnormalities translate into clinically significant symptoms. Onal *et al.* reported similar findings in patients with cicatricial lid margin disorders, where increasing disease severity was associated with worsening patient-reported outcomes and ocular discomfort [6]. These findings emphasize the importance of early detection and intervention in lid margin disease to prevent progression and improve quality of life.

The high prevalence of lid margin disease observed in this study population reflects regional environmental and socioeconomic factors prevalent in Bihar. Dust exposure, agricultural occupation, poor eyelid hygiene, and limited access to early eye care services contribute significantly to chronic eyelid inflammation and meibomian gland dysfunction. Singh *et al.* reported a similar high burden of MGD in tertiary hospital settings in India, where delayed presentation and chronicity of disease were common [7]. The tertiary care center setting of the present study likely contributed to inclusion of more advanced cases, thereby reflecting the referral nature of the institution.

Systemic conditions such as diabetes mellitus, which are highly prevalent in the Indian population, may further aggravate lid margin disease and tear film instability. Previous studies have demonstrated that diabetic patients exhibit higher rates of meibomian gland dysfunction, reduced tear secretion, and increased ocular surface staining [8]. Although systemic diseases were excluded in the present study to reduce confounding, the regional burden of such conditions remains an important consideration in real-world clinical settings.

The findings of the present study underscore the importance of comprehensive lid margin evaluation in all patients presenting with dry eye symptoms. Traditional management of dry eye often focuses on tear supplementation alone; however, in cases of evaporative dry eye due to lid margin disease, targeted therapy such as lid hygiene, warm compresses, meibomian gland expression, and anti-inflammatory treatment is essential for effective management. Jha *et al*. emphasized that early intervention in lid margin disease significantly improves tear film stability and prevents progression to severe ocular surface disease [9].

Another important implication of this study is the need for public health awareness and preventive strategies in regions such as Bihar. Community-based education programs focusing on eyelid hygiene, environmental protection, and early ophthalmic consultation could significantly reduce the burden of lid margin disease and its complications. Integration of ocular surface screening into routine ophthalmic evaluation at tertiary care centers would also facilitate early diagnosis and management.

The strengths of this study include its prospective design, use of standardized clinical assessment tools, and inclusion of a matched control group. However, certain limitations should be acknowledged. The study was hospital-based and may not fully represent the community prevalence of lid margin disease. Additionally, advanced diagnostic tools such as tear osmolarity and inflammatory biomarkers were not included due to resource constraints.

Despite these limitations, the study provides valuable regional data and reinforces the strong association between lid margin disease and tear film instability. The findings are in agreement with global and Indian literature and highlight the need for targeted diagnostic and therapeutic approaches in patients with lid margin disorders.

CONCLUSION

Lid margin diseases significantly impair tear film stability and ocular surface integrity, leading to increased dry eye symptoms and epithelial damage. Early detection and targeted management at tertiary care centers are essential to prevent progression and improve visual comfort and quality of life.

REFERENCES

1. Fatima A, Vadla P, Konda N. Changes in the tear film and meibomian gland morphology between preclinical dry eye and normal subjects represented by ocular surface disease index scores. Exp Eye Res. 2022 Sep;222:109188. doi: 10.1016/j.exer.2022.109188. Epub 2022 Jul 14. PMID: 35841949.
2. Onal I, Tastan O, Ceylan A, Savur F, Aydin FO, Akbas YB, Avci E, Kepez Yildiz B. Relationship Between Chronic Ocular Surface and Meibomian Gland Changes and Clinical Assessment Tool in Cicatricial Conjunctival Diseases. Ocul Immunol Inflamm. 2025 Nov;33(9):1972-1981. doi: 10.1080/09273948.2025.2539774. Epub 2025 Jul 26. PMID: 41090670.
3. Chatterjee S, Agrawal D, Sharma A. Meibomian Gland Dysfunction in a Hospital-Based Population in Central India. Cornea. 2020 May;39(5):634-639. doi: 10.1097/ICO.0000000000002217. PMID: 31789924.
4. Singh J, Priya Y, Bhat V. Prevalence, Severity, and Treatment Outcomes of Meibomian Gland Dysfunction in Patients With Dry Eye Symptoms at a Tertiary Care Center in South India. Cureus. 2022 Jun 7;14(6):e25703. doi: 10.7759/cureus.25703. PMID: 35812580; PMCID: PMC9260487.
5. Johnson ME, Murphy PJ. Changes in the tear film and ocular surface from dry eye syndrome. Prog Retin Eye Res. 2004 Jul;23(4):449-74. doi: 10.1016/j.preteyeres.2004.04.003. PMID: 15219877.
6. Rahman N, Kumar S, Mahato RK, Deepankar D, Anand M. A clinical study to evaluate meibomian gland dysfunction and tear film changes in patients with pterygium. Bioinformation. 2025 Dec 15;21(12):4504-4509. doi: 10.6026/973206300214504. PMID: 41907882; PMCID: PMC13018448.
7. Ghenciu DM, Dănilă AI, Stoicescu ER, Neagu A, Ghenciu LA. Tear Film Alterations in Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis. Diagnostics (Basel). 2025 Dec 6;15(24):3104. doi: 10.3390/diagnostics15243104. PMID: 41464106; PMCID: PMC12732288.
8. Onal I, Tastan O, Ceylan A, Savur F, Aydin FO, Akbas YB, Avci E, Kepez Yildiz B. Relationship Between Chronic Ocular Surface and Meibomian Gland Changes and Clinical Assessment Tool in Cicatricial Conjunctival Diseases. Ocul Immunol Inflamm. 2025 Nov;33(9):1972-1981. doi: 10.1080/09273948.2025.2539774. Epub 2025 Jul 26. PMID: 41090670.
9. Di Zazzo A, Villani E, Barabino S, Giannaccare G. How Eyelid Changes May Impact on Tears. J Clin Med. 2024 Nov 18;13(22):6927. doi: 10.3390/jcm13226927. PMID: 39598071; PMCID: PMC11594652.
10. Puneeth S, Rekha KR. Evaluation of meibomian gland dysfunction in a tertiary care center. Pan Am J Ophthalmol. 2025;7(1):169. doi:10.4103/pajo.pajo_38_25.

HOW TO CITE THIS ARTICLE: Singh KK, Kumar C, Verma A, Iqbal J. Impact of Lid Margin Diseases on Tear Film Stability and Ocular Surface Parameters: A Prospective Controlled Study with Healthy Subjects. *J Adv Sci Res*. 2026;17(5): 71-75 **DOI:** 10.55218/JASR.2026170515