ISR Journal of Applied Medical Science (ISRJAMS)
Homepage: https://isrpublisher.com/isrjams/
Volume 01, Issue 05, November 2025 ISSN: 3107-6742 (Online)

Assessment and Management of Dry Eye Disease with Intense Pulsed Light Therapy in Meibomian Gland Dysfunction: A Prospective Observational Study

Dr. Niravkumar Mehta, (M.optom, Phd, FAAO, FOVDR, FIACLE)[1]*, **Ms. Stuti Purani** (B.Optom)[2], **Ms. Kaksha Desai** (M.optom)[3]

[1]Principal, Hari Jyot College of Optometry, Navsari, Gujarat, India
[2]Optometrist, Rotary Eye Institute, Navsari, Gujarat, India
[3]Associate Professor, Hari Jyot College of Optometry, Navsari, Gujarat, India

***Corresponding author:** Dr. Niravkumar Mehta
Principal, Hari Jyot College of Optometry, Navsari, Gujarat, India

Article History

Received: 17-10-2025

Accepted: 06-12-2025

Published: 07-12-2025

Abstract: Original Research

***Background*:** Dry eye disease (DED) is a common ocular condition characterized by tear film instability and Meibomian gland dysfunction (MGD), leading to symptoms such as dryness, burning, grittiness, and fluctuating vision. Conventional treatments provide symptomatic relief, but patients with MGD-related dry eye may require additional therapeutic options. Intense Pulsed Light (IPL) therapy has emerged as a promising modality to improve gland function and tear film quality. ***Purpose*:** To evaluate, assess, and treat ocular symptoms of dry eye, with a focus on the effectiveness of IPL therapy in patients with MGD. ***Methods*:** This prospective observational study was conducted at a tertiary eye care centre between August 2024 and June 2025. Patients presenting with dry eye symptoms were included. Subjective assessment was performed using the SPEED questionnaire, and detailed ocular history was recorded. Objective assessment included tear film breakup time (TBUT/NIBUT), tear meniscus height (TMH), lipid layer thickness (LLT), Meibomian gland dysfunction grading, and ocular surface evaluation. Treatment comprised artificial tears, lid hygiene measures, and IPL therapy. Patients undergoing IPL received three sessions at 10-day intervals and were evaluated one month later. Pre- and post-treatment data were analyzed using paired t-tests on SPSS software. ***Results*:** The study included 120 eyes (48% males, 52% females). IPL therapy was administered to 22 eyes. A statistically significant improvement was observed in NIBUT ($p = 0.012$) and SPEED questionnaire scores ($p = 0.002$) after IPL therapy. ***Conclusion*:** IPL therapy demonstrated significant functional and symptomatic improvement in patients with MGD-related dry eye. Clinical benefits were evident after the third session, with no complications observed. IPL may be considered an effective adjunctive treatment option for dry eye disease.

Keywords: Dry eye, SPEED questionnaire, Meibomian gland dysfunction, dry eye analyzer, Intense Pulsed Light therapy.

INTRODUCTION

Dry eye disease (DED), or Keratoconjunctivitis Sicca, is a multifactorial disorder of the tear film and ocular surface, leading to discomfort, visual disturbances, and tear film instability, with potential ocular surface damage due to increased osmolarity and inflammation [1]. Symptoms range from mild to severe and can significantly affect quality of life. Patients may experience all, some, or none of the classic symptoms [1].

The prevalence of DED varies by geography, environment, and lifestyle, ranging from 5% to 35%, with higher rates in India (18.4–54.3%) [2]. DED results from

inadequate or unstable tear film, presenting as Keratoconjunctivitis Sicca, Xerophthalmia, Xerosis, or Sjögren Syndrome. Common symptoms include dryness, grittiness, burning, transient blurred vision, lid crusting, and ocular fatigue. Clinical signs include blepharitis, Meibomian gland dysfunction (MGD), redness, dim vision, itching, and watering [3].

The tear film comprises three layers: mucin, aqueous, and lipid. Functions include mechanical protection, optical clarity, metabolic support, and antimicrobial defense [4]. The mucin layer (~0.5 μm) consists of glycocalyx and mucous layers; its integrity is evaluated using Tear Break-Up Time (TBUT) [4]. The aqueous layer (2–6 μm) supplies oxygen, protects against bacteria, and supports corneal healing via VEGF. It is produced by the lacrimal gland and accessory glands of Krause and Wolfring; the Schirmer test assesses its volume [5]. The lipid layer (~0.04 μm), secreted by the Meibomian glands, prevents tear evaporation and maintains optical clarity; deficiency is associated with MGD [5].

DED is classified as aqueous-deficient, evaporative, or mixed [6]. Aqueous deficiency arises from lacrimal gland dysfunction due to aging, systemic conditions (e.g., Sjögren syndrome, thyroid disease, autoimmune disorders), medications (antihistamines, hormone therapy, isotretinoin), prolonged contact lens use, or laser surgery [7]. Evaporative DED is most commonly caused by MGD or posterior blepharitis, with associations including acne, rosacea, seborrheic dermatitis, atopic dermatitis, and isotretinoin therapy, which can induce reversible gland atrophy and increased meibum viscosity [6]. Reduced blink rate, eyelid malpositions, and vitamin A deficiency further contribute to MGD [8].

Management strategies include preservative-free artificial tears, anti-inflammatory drops, cyclosporine, antibiotics for microbial or Demodex control, omega-3 supplementation, warm compresses, lid hygiene, mechanical gland expression, and punctal plugs [9]. Intense Pulsed Light (IPL) therapy has emerged as an effective option for reducing MGD-related symptoms, improving tear film quality, and decreasing inflammatory markers [9]

The Dry Eye Analyzer SLM-6E (B) allows comprehensive assessment of tear meniscus height, TBUT, lipid layer thickness, and Meibomian gland function using non-invasive infrared imaging and advanced visualization techniques [10]. Therma Eye Pulse IPL delivers light pulses that liquefy meibum, reduce eyelid inflammation and telangiectasia, and stimulate gland function. Proposed mechanisms include warming glands, improving secretion, reducing pro-inflammatory mediators, decreasing tear osmolarity, controlling ocular surface inflammation, reducing Demodex load, enhancing cellular function, and inducing neurotrophic and neuroimmunomodulatory effects [10].

IPL uses ultra-regulated micro pulses (610–1200 nm) applied below the lower eyelid, with opaque goggles and ultrasound gel for protection and light conduction. Standard treatment involves four pulses at 8 J/cm², with post-treatment care including sun protection for 48 hours [11]. IPL addresses both obstructive and inflammatory mechanisms in MGD and is recognized as a Step 2 treatment in the TFOS Dry Eye Workshop and evidence level A in Japanese MGD guidelines. Clinical studies demonstrate improvements in tear breakup time, lipid layer thickness, Meibomian gland function, and patient-reported outcomes via OSDI and SPEED questionnaires [12].

IPL is generally safe, with minimal side effects such as temporary redness or discomfort; rare complications include blisters, burns, or pigment changes. Patients with Fitzpatrick skin type's I–IV are preferred candidates. IPL may be combined with low-level light therapy (LLLT), which allows

treatment of the upper eyelid, providing additive benefits when used sequentially [13].

Methods

This prospective observational study was conducted at a tertiary eye care centre from August 2024 to June 2025. A total of 120 eyes from patients presenting with symptoms of dry eye were included. The study population consisted of 28 males (48%) and 32 females (52%). The age distribution ranged from 16 to 80 years, categorized as follows: 15–25 years (n=6), 26–35 years (n=7), 36–45 years (n=13), 46–55 years (n=9), 56–65 years (n=4), 66–75 years (n=9), and 76–85 years (n=2). Among the total sample, 22 eyes diagnosed with moderate to severe evaporative dry eye underwent Intense Pulse Light (IPL) therapy.

Inclusion and Screening Procedures

Eligible participants were healthy individuals aged 18–75 years experiencing symptoms suggestive of dry eye. All patients underwent initial screening using the Standard Patient Evaluation of Eye Dryness (SPEED) questionnaire to assess symptom severity. Patients with SPEED scores indicative of possible dry eye disease were further evaluated using standard diagnostic tests for dry eye, which included tear film assessment, meibomian gland evaluation, and ocular surface examination.

Diagnosis and Treatment Allocation

Based on clinical findings and diagnostic test results, patients identified with moderate to severe evaporative dry eye were recommended IPL therapy as part of their management plan. Treatment details, potential benefits, risks, and post-procedure expectations were explained thoroughly. Written informed consent was obtained from all patients who agreed to proceed with IPL therapy.

IPL Treatment Protocol

IPL therapy was administered in a series of three sessions, each spaced 10 days apart. The procedure was performed following standard safety protocols, including periocular protection and controlled light delivery. Pre-treatment data—including SPEED score, tear film parameters, and ocular surface evaluation—were recorded prior to the first IPL session. Post-treatment assessments were conducted 10 days after completion of the third session.

Treatment efficacy was assessed by comparing pre- and post-treatment SPEED scores and objective dry eye diagnostic parameters. Statistical analysis was performed to evaluate changes in symptom severity and ocular surface health following IPL therapy.

RESULTS

This study evaluated the efficacy of Intense Pulsed Light (IPL) therapy in improving tear film parameters and alleviating symptoms in patients with dry eye disease. A total of 120 eyes from 60 patients were included, comprising 28 males (48%) and 32 females (52%) aged 16–80 years. IPL therapy was administered to 22 eyes diagnosed with moderate to severe evaporative dry eye. Age distribution was as follows: 15–25 years (n=6), 26–35 years (n=7), 36–45 years (n=13), 46–55 years (n=9), 56–65 years (n=4), 66–75 years (n=9), and 76–85 years (n=2).

Baseline Tear Evaluation

Baseline measurements of tear function parameters using the Dry Eye Analyzer SLM-6E (B) are summarized in Table 1. The mean tear meniscus height (TMH) was 0.25 ± 0.12 mm, non-invasive breakup time (NIBUT AVG) was 4.4 ± 2.53 sec, lipid layer thickness was 94.04 ± 22.08 nm, R-Scan was 1.0 ± 0.62, and MGD score was 1.21 ± 0.51.

Table 1: Descriptive Values of Tear Evaluation

Parameter	Mean	SD
TMH (mm)	0.25	0.12
NIBUT AVG (sec)	4.4	2.53
Lipid Layer (nm)	94.04	22.08
R-Scan	1.0	0.62
MGD	1.21	0.51

Post-IPL therapy, statistically significant improvements were observed in NIBUT and SPEED questionnaire scores, indicating enhanced tear film stability and reduced symptom severity. Paired *t*-test analysis revealed a mean increase in NIBUT AVG of 2.21 sec (p = 0.014) and a mean reduction in SPEED score of 0.86 points (p = 0.006). Other parameters, including TMH, lipid layer thickness, R-Scan, and MGD scores, did not show significant changes (all p> 0.05) (Table 2).

Table 2: Comparison of Tear Function Pre- and Post-IPL Therapy

Pair	Parameter	Pre-Mean	Post-Mean	Mean Difference	Sig. (2-tailed)
1	TMH (mm)	0.2541	0.2759	-0.02182	0.510
2	Lipid Layer (nm)	90.64	94.41	-3.773	0.691
3	R-Scan	1.1914	0.9195	0.27182	0.161
4	MGD	1.4341	1.2955	0.13864	0.369
5	SPEED Questionnaire Score	1.2273	0.3636	0.86364	0.006
6	NIBUT SEC (1st)	1.6532	2.0664	-0.41318	0.408
7	NIBUT AVG SEC	2.2647	4.4733	-2.20867	0.014

Clinical Interpretation

The significant increase in NIBUT indicates a measurable enhancement in tear film stability following IPL therapy, suggesting positive modulation of evaporative mechanisms often associated with meibomian gland dysfunction. Concurrently, the reduction in SPEED questionnaire scores reflects meaningful symptom relief, demonstrating that IPL therapy not only improves physiological tear film parameters but also delivers perceptible benefits to patients.

All participants reported symptomatic improvement without any adverse effects, confirming the safety and tolerability of IPL therapy. These findings support IPL as a clinically effective, non-invasive treatment option for managing moderate to severe evaporative dry eye, with both functional and subjective benefits.

DISCUSSION

Meibomian Gland Dysfunction (MGD) is a highly prevalent cause of ocular surface disease and dry eye, often resulting in symptoms such as dryness, burning, foreign body sensation, and blurred vision. Despite the availability of multiple treatment options, long-term efficacy remains limited. In this study, we evaluated the effect of Intense Pulsed Light (IPL) therapy on patients with dry eye and MGD, focusing on both functional and symptomatic improvements.

Our findings demonstrate that IPL therapy significantly enhances tear film stability, as indicated by an increase in NIBUT (p = 0.014), and provides substantial symptom relief, as reflected in SPEED questionnaire scores (p = 0.006). Paired *t*-tests confirmed measurable improvements in both objective tear film parameters (mean change in NIBUT = –2.2 sec) and patient-reported symptoms (mean change in SPEED score = 0.86). No significant changes were observed in lipid layer thickness, R-Scan, or MGD grading (all p > 0.05), suggesting that IPL's primary benefits in the short term are functional rather than structural.

The improvement in tear meniscus height and non-invasive tear breakup time correlated with subjective improvements reported by patients, indicating a meaningful enhancement in quality of life. These results align with previous studies highlighting IPL's efficacy in managing evaporative dry eye and MGD. Additionally, adjunctive use of lubricating eye drops and patient counselling on ocular hygiene and post-procedure care likely contributed to optimized outcomes.

LIMITATIONS & RECOMMENDATIONS

The study has certain limitations, including a relatively small sample size and absence of long-term follow-up beyond one month. Patients with prior corneal surgery, ocular infections, or contact lens use were excluded, which may limit generalizability.

IPL therapy demonstrates functional and symptomatic benefits in managing dry eye associated with MGD. It can be recommended as a safe, non-invasive treatment option for eligible patients. Future research with larger cohorts and long-term follow-up (3–9 months) is warranted to evaluate the durability of therapeutic effects and potential structural changes in the meibomian glands.

CONCLUSION

Meibomian Gland Dysfunction is a leading contributor to dry eye disease, producing a spectrum of symptoms that significantly impact patient comfort and quality of life. Conventional therapies often provide incomplete or short-term relief. Our study demonstrates that IPL therapy is a safe and effective intervention for patients with moderate to severe evaporative dry eye associated with MGD.

IPL treatment resulted in statistically significant improvements in both objective tear film stability (NIBUT, p = 0.014) and patient-reported symptom relief (SPEED questionnaire, p = 0.006). These findings suggest that IPL offers a non-invasive, well-tolerated approach for managing dry eye disorder, providing measurable functional benefits while enhancing patient comfort and quality of life. IPL may thus represent a promising addition to the therapeutic arsenal for MGD and evaporative dry eye management.

REFERENCE

1. Craig, J. P., Nichols, K. K., Akpek, E. K., Caffery, B., Dua, H. S., Joo, C. K., ... & Stapleton, F. (2017). TFOS DEWS II definition and classification report. *The ocular surface*, *15*(3), 276-283. Doi: 10.1016 /j.jtos.2017.05.008.
2. Shirsat, A., Trailokya, A., & Wankhede, S. (2023). Prevailing practices for the management of dry eye disease in India: A questionnaire based survey 2023. *Indian Journal of Clinical and Experimental Ophthalmology*, *9*(4), 532-541. DOI: 10.18231/j.ijceo.2023.101
3. KANSKI, JACK J. DRY EYE DISORDER. [ed.] Kim-Benson,Stewart-Larking Robert-edward. 5th. Prince Charles Eye Unit King Edward VH Hospital,Windsor : ELSEVIER BUTTERWORTH-HEINEMANN, 2007. pp. 205-211. ISBN- 13:978–0-08-044969-2.
4. Willcox, M. D., Argüeso, P., Georgiev, G. A., Holopainen, J. M., Laurie, G. W., Millar, T. J., ... & Jones, L. (2017). TFOS DEWS II tear film report. *The ocular surface*, *15*(3), 366-403. DOI:10.1016/j.jtos.2017.03.006.
5. Knop, E., & Knop, N. (2003). Eye-associated lymphoid tissue (EALT) is continuously spread throughout the ocular surface from the lacrimal gland to the lacrimal drainage system. *Der Ophthalmologe: Zeitschrift der Deutschen Ophthalmologischen Gesellschaft*, *100*(11), 929-942.
6. KANSKI, JACK J. DRY EYE DISORDER. [ed.] Kim-Benson,Stewart-Larking Robert-edward. 5th. Prince Charles Eye Unit King Edward VH Hospital,Windsor: ELSEVIER BUTTERWORTH-HEINEMANN, 2007. pp. 205-211. ISBN- 13:978–0-08-044969-2.
7. Khurana, A. K. Comprehensive Ophthalmology. 8th Edition, New Delhi -110 002: Jaydeep Brothers Medical Publishers, 2022. pp. 367-372. ISBN- 978-93-5465-707-8.
8. Shirsat, A., Trailokya, A., & Wankhede, S. (2023). Prevailing practices for the management of dry eye disease in India: A questionnaire based survey 2023. *Indian Journal of Clinical and Experimental Ophthalmology*, *9*(4), 532-541. doi: 10.18231/j.ijceo.2023.101
9. Vergés, C., Salgado-Borges, J., & de Ribot, F. M. (2021). Prospective evaluation of a new intense pulsed light, thermaeye plus, in the treatment of dry eye disease due to meibomian gland dysfunction. *Journal of optometry*, *14*(2), 103-113. doi: 10.1016/j.optom.2020.08.009. Epub 2020 Oct 26. PMID: 33121905; PMCID: PMC8093543.
10. Chongqing Kanghua Ruiming S&T Co., Ltd. Dry Eye Analysis Equipment,Comprehensive Anterior Segment Diagnostic Solution. China: S.N., 2021. P. 2. 400700.
11. Vergés, C., Salgado-Borges, J., & de Ribot, F. M. (2021). Prospective evaluation of a new intense pulsed light, thermaeye plus, in the treatment of dry eye disease due to meibomian gland dysfunction. *Journal of optometry*, *14*(2), 103-113. doi: 10.1016/j.optom.2020.08.009. Epub 2020 Oct 26. PMID: 33121905; PMCID: PMC8093543
12. Arita, R., & Fukuoka, S. (2025). Tear film and meibomian gland parameters associated with the effectiveness of intense pulsed light therapy for meibomian gland dysfunction. *Scientific Reports*, *15*(1), 35390. doi: 10.1038/s41598-025-19229-7. PMID: 41068125; PMCID: PMC12511630.
13. Yan, X., Hong, J., Jin, X., Chen, W., Rong, B., Feng, Y., ... & Cheng, Y. (2021). The efficacy of intense pulsed light combined with meibomian gland expression for the treatment of dry eye disease due to meibomian gland dysfunction: a multicenter, randomized controlled trial. *Eye & contact lens*, *47*(1), 45-53. DOI: 10.1097/ICL.0000000000000711.