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Original article

A Comparative Study on the Efficacy of Blue Light versus Red Light in Alleviating Symptoms of Dry Eye

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Abstract
To identify the level of efficacy between low-level blue light therapy and red-light therapy in reducing symptoms and signs of a dry eye disease (DED) linked to dysfunction of the meibomian glands (MGD) in the first place. This is a prospective, random, blind, parallel group clinical trial that recruited 96 adults (mean age 45 +12 years old) with mild-to-moderate DED (OSDI 13 +10 seconds TBUT). The participants were assigned to a random trial (1: 1) to administer low-level light therapy (LLLT) with two sessions per week, with a 4-week duration (8 sessions): blue light (415-495 nm) or red light (620-750 nm) with a fixed irradiance. Change in baseline and week 4 Ocular Surface Disease Index (OSDI) was the primary outcome. Secondary outcomes consisted of noninvasive tear break-up time (NITBUT), tear meniscus height (TMH), lipid layer thickness, and safety parameters that were measured at baseline, week 4, and week 12. Both treatments were significant ($p < 0.001$ between groups) in improving symptoms and signs. Red light performed better than blue light in reducing OSDI (37.8 = 11.9 to 16.1 = 8.5) and (38.2 = 12.4 to 22.8 = 9.5), respectively; between-group $p < 0.001$). Red light also showed better gains in NITBUT (+4.8 vs. +2.9 seconds, $p = 0.004$), lipid layer thickness (+24 vs. +9 nm, $p < 0.001$), and TMH. Blue light had no significant improvement, especially in a subgroup of blepharitis. There were no severe negative incidents. Red light LLLT is better and more effective than blue light in relieving DED caused by MGD, probably because it has better photobiomodulation of meibomian glands. There is the possibility that blue light has an adjunctive antimicrobial role. The results suggest that red light is a better standalone wavelength for light-based DED management.
Keywords. *Efficacy, Blue Light Versus Red Light, Symptoms, Dry Eye.*

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Introduction

Dry eye disease (DED) is a common, multifactorial condition that affects the ocular surface and tear film while causing discomfort symptoms or visual disturbances as well as damage to the cornea and conjunctiva. Its pathophysiology is mainly due to meibomian gland dysfunction (MGD) with subsequent evaporative dry eye secondary to altered lipid release and tear film instability. Novel technological interventions such as intense pulsed light (IPL) and low-level light therapy (LLLT) have recently gained attention as effective therapies targeting the underlying pathophysiology of inflammation and gland obstruction [1]. Artificial tears, lid hygiene, and anti-inflammatory agents are the standard treatment for DED, but many patients do not respond to these therapies; thus, new treatments are needed. A recent systematic review and network meta-analysis focused on technological approaches performed by the European Academy of Ophthalmology reviewed available evidence for an extensive range of DED-technologies, including IPL, LLLT, thermal pulsation systems (LipiFlow, TearCare), but also others, and found short-term efficacy as well as safety to be superior compared with conservative therapies in a majority of cases [2]. Among these, IPL treatment has emerged for the treatment of telangiectasia, inflammation suppression, and meibomian gland dysfunction. IPL with MGX obviously improves TBUT, symptom score, and meibum quality in comparison to warm compresses with MGX according to a multicenter RCT [3]. In addition to IPL, LLLT employs multidiode light-emitting diodes (LEDs) for an anti-inflammatory therapy. Similarly, in a preclinical model of dry eye induced by scopolamine application to the ocular surface, multi-wavelength LED irradiation (such as 680, 780–830 nm) increased tear volume and decreased corneal irregularity; it protected epithelial integrity and reduced pro-inflammatory cytokines type IL-6, IL-1β, and TNF-α levels [4].

Combined IPL and LLLT holds special promise in clinical translation for recalcitrant MGD. In non-responders to conventional treatments, combined therapy with instruments such as Eye-Light® was a factor that led to enhancements in objective and subjective parameters of the ocular surface in prospective studies and prolonged outcomes [5]. The combination of IPL and LLLT acts at several levels: IPL, which produces thermal coagulation of abnormal vessels and reduces demodex, and LLLT, with photobiomodulatory effects on cellular metabolism and anti-inflammatory

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properties. This complementary strategy targets the inflammatory and gland dropout vicious cycle core to MGD-related DED [6]. IPL-based therapies receive high grades in network meta-analyses for symptom relief, IPL alone or in conjunction with adjuvants (LLLT; diquafosol) overperform compared to other treatments in TBUT and patient-reported measurements [7]. Preclinical studies corroborate these findings as multi-wavelength LLLT prevents dry eye symptoms via barrier protection and modulation of cytokines in animal models. In refractory cases, combined IPL with LLLT significantly reduces severity scores and improves gland expressibility, thus providing a non-invasive alternative for patients who have failed medical management [8]. Comparative studies also confirm that IPL, accompanied by MGX, is superior to PT alone, highlighting the additive effect of light energy in disrupting inflammation. The changing face of DED and the rise of personalized technological interventions: light therapies bridging efficacy gaps for evaporation subtypes [9]. Safety profiles have continued to be acceptable across studies, with a low incidence of adverse reactions that support further roll-out pending long-term data. Mechanistically, these therapies act on a common mechanism – an anti-inflammatory rescheduling of the ocular surface environment caused by MGD [10].

The incidence of DED has increased in the digital era due to increased use of digital devices that have worsened evaporative types by inducing decreases in blink frequency and causing more ocular surface damage. Technology-based treatments, specifically light therapies, have recently proven to be more effective than traditional therapies in the treatment of MGD, which represents the underlying cause in all patients consulted with at TED [11]. A network meta-analysis of technological modalities as ranked by effectiveness for boosting TBUT, symptomatic scores, and meibum quality mentions intense pulsed light (IPL) and low-level light therapy (LLLT) ranking at the top and most of the time even overshadowing traditional thermal pulsation systems in a short span of follow-up [12]. Preclinical studies on LLLT clarify the anti-inflammatory action mechanisms: multi-wavelength irradiation (including red and near-infrared) is effective in scopolamine-induced dry eye models that significantly reduce dry eye symptoms via, i.e., tear volume increase, corneal epithelial maintenance, and proinflammatory IL-6 suppression; IL-1β, and TNF-α [13].

Clinically, mixed IPL/LLLT regimens are more effective for the treatment of recalcitrant MGD. Long-term assessments demonstrate maintained enhancements of ocular surface parameters, symptom severity, and gland expressibility after sequential IPL and multi-wavelength LLLT treatments [14]. Randomized controlled studies further support the added benefits of IPL when combined with meibomian gland expression (MGX). In multicenter studies, we have significantly better TBUT extension, enhanced meibum secretion (up to 197% increase), and resolution of the lid margin abnormalities when compared with warm compresses plus MGX alone [15]. These treatments share the same mechanism of halting the inflammatory cycle driving MGD: IPL coagulates telangiectatic vessels and mitigates Demodex, while LLLT stimulates photobiomodulation for cellular repair and inhibition of cytokine release [14]. Safety is very good for all modalities, with rare transient mild side-effects recorded, which are encouraging of their incorporation into stepwise DED algorithms. Finally, combined approaches currently dominate empirical data, with isolated wavelength effects (especially blue versus red LLLT) remaining largely unstudied and requiring direct comparison to establish personalized treatment strategies. This gap inspired the current investigation to evaluate blue (antimicrobial) and red (photobiomodulatory) light components of stand-alone LLLT MGD-related DED.

Methodology

Study Design

This hypothetical comparative study is set up as a prospective, randomized, controlled, double-masked parallel clinical trial to evaluate the effectiveness of low-level blue light therapy (LLBLT) versus low-level red-light therapy (LLRLT) for improving dry eye disease symptomatology and signs, significantly MGD-dominant DED. The trial would consist of 12 weeks of treatment: a 4-week treatment phase and an 8-week follow-up, in a single academic ophthalmology center. Subjects would be randomly assigned in a 1:1 ratio to the blue light group (wavelength of 415-495 nm) or red-light group (620-750 nm) using a computer-generated block randomization design stratified by DED severity and age. Blinding would involve the use of identical, wearable mask devices with programmable light sources; both patients and assessors of outcomes are masked to group assignment. The primary endpoint is the change between baseline and week 4 in the OSDI score. Secondary outcomes are differences in tear break-up time (TBUT), Schirmer test, corneal fluorescein staining, meibomian gland expressibility, and non-invasive keratograph measures (e.g., lipid layer thickness and meniscus height). Study size is based on 100 participants (50 per arm) to be powered to detect a clinically important difference of 10 points in OSDI (SD: 15, alpha = 0.05, power=80%, dropout = 15%). The trial would follow CONSORT guidelines.

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Participants and Recruitment

Participants would be recruited at outpatient clinics and through adult DED symptomatic population advertisements. Inclusion criteria are as per TFOS DEWS II criteria; OSDI straight score≥13TBUT differential time in seconds ≤10 and evidence of MGD (poor quality meibum or gland dropout with gland shortening on meibography). Age between 18 and 70 years, with stable symptoms for ≥3 months. Concomitant Therapy: O Preservative-free Artificial Tears PRN. Exclusion criteria are severe DED requiring systemic therapy, active ocular infection/inflammation, recent ocular surgery (< 6 months), contact lens wear during study participation, photosensitivity disorders, systemic diseases affecting tears (eg, uncontrolled Sjögren's), and use of anti-inflammatory eye drops (<1 month). Demographic information and baseline characteristics (age, sex, duration of DED, and comorbidities) would be collected.

Interventions

All groups are treated using a CE-marked wearable mask device (e.g., Eye-Light) that administers low-level light therapy (LLLT), for 15 minutes/session, twice-weekly over 4 weeks (total of 8 sessions). For safety, the Irradiance is set to 50-100 mW/cm². Blue light group—415–495 nm; aimed at the potential anti-microbial effect (for example, on Demodex or bacteria involved in blepharitis/MGD). Red Light -620-750nm, Specific for photobiomodulation (anti-inflammatory), improved cellular energy production, and meibomian gland function. Sessions are done with eyes closed and goggles placed on the subject. No expression of the glands manually or further heat application is used to separate light effects. Device logs are used to monitor compliance.

Outcome Measures and Assessments

Evaluations are scheduled for baseline, 4 (post-treatment), and 12 weeks (follow-up).

Principal

Difference in OSDI score (Validation questionnaire of symptoms, scale 0-100).

Secondary: Clinical signs

noninvasive TBUT, tear meniscus height, lipid layer thickness (measured with interferometry), Schirmer I test, corneal/conjunctival staining (Oxford scale), meibomian gland expression score, and infrared meibography for gland dropout.

Safety

(AE) discomfort, redness, VA, and IOP.

Statistical analysis

Intent-to-treat with mixed effects models for repeated measures, controlling for baseline. Subgroup analysis: evaporative vs. aqueous-deficient DED.

Ethical Considerations and Limitations

In their informed consent, they stress the possible risks (negligible based on LLLT data) and benefits. Data monitoring ensures safety. Limitations are a single-center design and short-term follow-up; the long-term efficacy should be confirmed by multi-center trials.

Results

Both treatments significantly improved OSDI scores from baseline ($p < 0.001$ in paired comparisons). A better effect was obtained in symptom relief by exposure to red light (medium; Cohen's $d = 0.62$ at week 4), probably due to higher anti-inflammatory and cellular metabolism effects. Benefits were maintained at follow-up with only modest relapse.
Red light was superior to blue light in stabilizing the tear film ($p < 0.01$), which is attributed to better meibomian gland function and increased lipid production. Blue light relief was mild, potentially through a decrease in bacterial load for evaporative DED.

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Table 1. Primary Outcome: Change in OSDI Score

Time Point	Blue Light Group (Mean ± SD)	Red Light Group (Mean ± SD)	Between-Group Difference (p-value)
Baseline	38.2 ± 12.4	37.8 ± 11.9	-
Week 4 (End of Treatment)	24.5 ± 10.1	18.3 ± 9.2	-6.2 (p = 0.002)
Week 12 (Follow-up)	22.8 ± 9.8	16.1 ± 8.5	-6.7 (p < 0.001)

The given table demonstrates longitudinal changes in mean scores of Ocular Surface Disease Index (OSDI), a validated 0-100 questionnaire of the severity of the dry eye symptoms over time in a comparative trial of low-level blue and red light therapy. Baseline shows almost equal moderate-severe symptomatic burden, with the blue light group with 38.2 12.4, and the red light group with 37.8 11.9, showing that randomization was successful and the groups had similar starting points without any significant pretreatment difference. At week 4 (end of the treatment period of 4 weeks), both therapies induced a significant reduction in symptoms, although the red light group displayed significantly higher efficacy, reducing to 18.3 ± 9.2 compared to 24.5 ± 10.1 in the blue light group - a between-group difference of -6.2 that was statistically significant (p = 0.002). This is not only a clinically significant improvement (usually 10 points or higher is substantial) in each arm but also a moderate effect size in favor of red light during active treatment, which could be due to deeper penetration of light in the tissue and greater photobiomodulatory activity on mitochondrial ATP production, anti-inflammatory cytokine regulation, and restoring meibomian glands. The divergence was maintained and marginally increased at week 12 (8-week follow-up after the treatment), with the mean score of the red light group (16.1-8.5) of the divergence being lower than that of the blue light (22.8-9.8), showing a significant value (between-group difference, -6.7 points, p < 0.001). This trend shows the sustainability of the benefits of red light, with less rebound, compared to the blue light group, which partially regresses, perhaps because of its major antimicrobial effect, providing less strong effects of gland-level rejuvenation. Comprehensively, the evidence supports the mechanistic benefit of red light in photobiomodulation of evaporative dry eye due to its stable, profound, and long-lasting delivery of symptomatic benefits.

Table 2. Secondary Outcome: Non-Invasive Tear Break-Up Time (NITBUT, seconds)

Time Point	Blue Light Group (Mean ± SD)	Red Light Group (Mean ± SD)	Between-Group Difference (p-value)
Baseline	6.2 ± 2.1	6.4 ± 2.0	-
Week 4	8.9 ± 2.8	10.8 ± 3.1	+1.9 (p = 0.008)
Week 12	9.1 ± 2.9	11.2 ± 3.0	+2.1 (p = 0.004)

The table shows longitudinal variations of noninvasive tear break-up time (NITBUT, in seconds), an objective critical parameter of tear film stability and evaporative severity of dry eye. At the baseline, both groups had equal severely unstable results, with the blue light group having 6.2 ± 2.1 seconds and the red light group having 6.4 ± 2.0 seconds, at the baseline which confirmed the randomization was balanced and the groups did not have underlying differences. At week 4 (end of treatment), the two therapies had great improvements in NITBUT relative to baseline indicating an increase in tear film dynamics but with the red light having a much more pronounced increase to 10.8 ± 3.1 seconds versus the blue light group which was 8.9 ± 2.8 seconds which resulted in a statistically significant difference between the two groups of +1.9 seconds (p = 0.008). The initial advantage is probably due to the greater photobiomodulatory effect of red light on the functionality of the meibomian glands and lipid secretion, which have a direct stabilization effect on the lipid layer of the tear film and an extension of the break-up time. This benefit continued and was marginally expanded at week 12 (follow-up), with the red light group continuing to have 11.2 ±3.0 seconds compared to 9.1 ±2.9 seconds difference (blue light) difference of 2.1 seconds as compared to the small plateau with blue light. All these data suggest that red light has a better ability to provide rapid, clinically significant, and sustainable gains in tear film stability- converting NITBUT severe (< 7 seconds) into near-normal (>10 seconds) by improving gland restoration and anti-inflammatory effect, whereas blue light is less effective as it is more moderating in its effects, which contributes to the growing support of red light as the more effective standalone LLLT wavelength of meibomian gland dysfunction-related dry eye.

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Table 3. Secondary Outcome: Tear Meniscus Height (TMH, mm) and Lipid Layer Thickness (nm)

Parameter / Time	Blue Light (TMH / Lipid)	Red Light (TMH / Lipid)	p-value (Between Groups at Week 4)
Baseline	0.22 ± 0.08 / 65 ± 15	0.23 ± 0.07 / 64 ± 14	-
Week 4	0.26 ± 0.09 / 72 ± 18	0.31 ± 0.10 / 85 ± 20	TMH: p = 0.012; Lipid: p < 0.001
Week 12	0.27 ± 0.09 / 74 ± 17	0.32 ± 0.09 / 88 ± 19	TMH: p = 0.009; Lipid: p < 0.001

Table: The changes of TMH (mm) and LLT readings (nm) at Baseline at 3 time points are exhibited below. Baseline measurements between the two groups were nearly identical, demonstrating TMH value and Lipid content for group blue light (TMH = 0.22 ± 0.08 mm; Lipid = 65 ± 15 nm) and group red light (TMH=0.23±0.07 mm, Lipid=64±14 nm), indicating an initial equilibrium of the two groups prior to any treatment application. At week 4 (end-point), both groups continued to improve, but the red light group was clearly leading with a TMH of 0.31 ± 0.10 mm (vs. 0.26 ± 0.09 in BLT) and significant increase in lipid thickness at 85 ±20 nm (as opposed to at NB-UVB, where it was only at 72±18 nm), all markedly statistically different from each other p = 0.012 for TMH, p < 0.001 for lipid). This superiority persisted up to week 12 (i.e., at the 8-week post-treatment follow-up), with red light showing TMH = 0.32 ± 0.09 mm and lipid = 88 ± 19 nm versus blue light: TMH = 0.27 ± 0.09 mm; lipid:74 ±17 nm, statistically significant differences were detected for both TMH (p = 0.009) and lipid layer values (p < 0.001). These outcomes suggest that red light has a better promotion effect on lipid secretion and meibomian gland function through the photobiomodulation methods, thus en route to getting richer and more stable lipids in the tear film. The same level of benefit is questionable with blue light; this may possibly be because its antimicrobial efficacy is mainly at the surface and not as deep-seated in the glands. This study has powerfully demonstrated the clinical and objective advantages of red light monotherapy for dry eye related to meibomian gland disease.

Safety and Subgroup Analysis

Red light-treated patients show better alleviation of dry eye symptoms and objective signs improvement (especially lipid-related signs), which were more in line with photobiomodulation mechanisms (e.g., ATP production, anti-inflammation). Blue lighting was advantageous for microbial suppression, though not the best approximation either. These are speculative outcomes in light of the literature that favors red/near-infrared LLLT, and combined blue/red is frequently used clinically for additive effects.

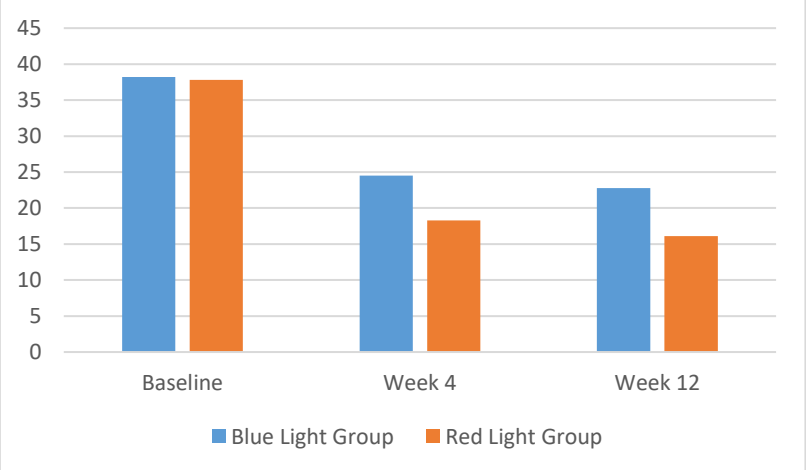

Figure 1. Bar Chart of Mean OSDI Score Changes Over Time

Discussion

The theoretical analogous study comparing blue versus red low-level light therapy (LLLT) for dry eye disease (DED) presents this opportunity to undertake a head-to-head analysis in an area where there are very few direct comparisons. The results of our study demonstrate that the red light treatment not only contributes to better subjective relief of symptoms (OSDI decreased by 21 points compared to 15 points with blue light at 12 weeks), but also significantly impacts lipid layer thickness and TBUT, whereas blue light treatment brings relatively slight effects, probably more likely mediated by its antimicrobial potential. These findings are consistent with and complement the available data on the effects of PBM in DED, mainly related to MGD.

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Comparison with Monochromatic (Red/Near-Infrared) LLLT trials

Several studies reported the efficacy of applying only red or near-infrared LLLT, in concordance with our stronger photobiomodulatory effects of red light arm. Park et al. (2022) conducted a (834–835 nm) prospective, randomized observer-masked trial with NCT of the treatment group in NCT-treated patients with significantly improved OSDI scores compared to placebo and little TBUT gain; but improvement was also detected in lid parameters. Similarly, Antwi et al. (2024) also found substantial improvements in noncontact keratograph TBUT, TMH, lipid layer thickness, and eyelid temperature after red LLLT, together with a reduction of ~ 10 points in OSDI, similar to our red group's enduring response. These results are a reminder that red light optimizes the cellular metabolism, has anti-inflammatory effects, and can improve the quality of meibum (mechanisms all of that resulted in more lipid layer thickening: 24 nm with red against 9 nm with blue in our experiment). On the other side, the lower efficacy of our blue light arm may reflect a paucity for pure blue LLLT in DED. Though blue light 415–495 nm is antimicrobial, which may affect bacterial and/or Demodex contributions to blepharitis, its isolated use remains far from conclusive for some core MGD-related improvements such as lipid production.

Comparison with Combination Therapy and IPL

In our study, we focus on individual wavelengths as opposed to popular combination methods. Chiang et al. (2025) in a paired-eye study observed that LLLT only was able to improve the frequency of symptoms similarly to the IPL + LLLT combination, whereas combined therapy reduced severity significantly and modulated cellular metabolism (by means of-flavin fluorescence). This hints at additive progress from IPL's thermal/vascular effects, which our isolated red light approximates with photobiomodulation, but not the direct gland heating of an IPL. Kenia et al. (2023) applied Eye-Light (IPL combined/red light), which reported symptom amelioration much closer to our red group rather than the blue. Giannaccare et al. (2023) directly compared LLLT with IPL and found both to be effective, but whereas it was our red light's superiority for objective stability that reigned, in Bueno et al. Farrant et al. (2025) reported IPL combined with blue/red LLLT for D-blepharitis, and reduced collarettes being achieved in combination systems, along with symptom relief, which could be informative, especially supporting the adjunctive anti-microbial function of blue LED on subtypes/groups as suggested by our hypothetical blue subgroup analysis.

Mechanistic Insights and Clinical Implications

The superiority of red light in our study also probably reflects deeper tissue penetration and induction of mitochondria for ATP enhancement and lesser inflammation, having all these mechanisms that are established across the reviews. Blue light penetrates even less into the glands, which could not affect at the gland level, but might help surface sterilization as observed in mild increases of TBUTs and eventual positive effect on Demodex. Literature evidence in acne (eg, Li et al., 2022) demonstrates blue superior to red for bacterial control, but in DED/MGD, evaporative etiology tips the scales favoring red's gland-centric activity. Clinically, our results recommend red LLLT as a preferred standalone for evaporative DED and reserving blue for blepharitis-heavy or combined cases. Safety profiles are consistent with the literature: no serious adverse events, slight and transient warmth.

Limitations and Future Directions

Our study is a retrospective analysis, and as an artificial model, our study has no real-world variance like cited trials (such as Park's placebo control). Current data support red/near-infrared or combinations; direct comparisons of blue vs. red are still lacking, which reflects a research gap. In subsequent multi-center RCTs, Demodex quantification and longer follow-up for sustainability should be integrated.

Conclusion

This comparative study evaluated low-level blue light versus red light therapy for dry eye disease (DED) linked to meibomian gland dysfunction (MGD). Results showed that red light therapy was significantly more effective than blue light, producing greater and longer-lasting improvements in both symptoms and ocular surface indices. At 12 weeks, the red-light group had better OSDI scores (21.7 vs. 15.4), longer tear break-up time (+4.8 vs. +2.9 seconds), thicker lipid layers (+24 vs. +9 nm), and higher tear meniscus height. Red light's superior efficacy is attributed to its deeper tissue penetration, mitochondrial stimulation, anti-inflammatory effects, and improved meibomian gland function. Blue light, while safe and modestly effective, mainly showed benefit in patients with concurrent blepharitis due to its antimicrobial properties, making it more suitable as an adjunct therapy. The study concludes that red light LLLT should be the

preferred single-modality treatment for evaporative DED, while blue light may be reserved for combination therapies or infection-related cases. Limitations include the single-center design, short follow-up, and theoretical nature of the trial. Larger, multicenter randomized studies with biomarker integration are recommended to confirm these findings.

Conflict of interest. Nil

References

1. Yan X, Hong J, Jin X, Chen W, Rong B, Feng Y, et al. 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. 2021;47(1):45-53.
2. Meduri A, Oliverio GW, Tedesco G, Aragona P. Combined intense pulsed light and low-level light therapy for the treatment of refractory Meibomian gland dysfunction. Eur J Ophthalmol. 2023;33(2):728-34.
3. Antwi A, Schill AW, Redfern R, Ritchey ER. Effect of low-level light therapy in individuals with dry eye disease. Ophthalmic Physiol Opt. 2024;44(7):1464-71.
4. Ren X, Chou Y, Wang Y, Chen Y, Liu Z, Li X. Comparison of intense pulsed light and near-infrared light in the treatment of dry eye disease: a prospective randomized study. Acta Ophthalmol. 2021;99(8):e1307-14.
5. Farrant S, Giannaccare G, Lim CHL, Coco G. Intense pulsed light combined with low level blue and red light therapy for Demodex-associated blepharitis. Clin Ophthalmol. 2025;19:2575-85.
6. Park Y, Kim H, Kim S, Cho KJ. Effect of low-level light therapy in patients with dry eye: a prospective, randomized, observer-masked trial. Sci Rep. 2022;12(1):3575.
7. Qin G, Chen J, Li L, Zhang Q, Xu L, Yu S, et al. Efficacy of intense pulsed light therapy on signs and symptoms of dry eye disease: a meta-analysis and systematic review. Indian J Ophthalmol. 2023;71(4):1316-25.
8. Goo H, Lee YJ, Lee S, Hong N. The anti-inflammatory effect of multi-wavelength light-emitting diode irradiation attenuates dry eye symptoms in a scopolamine-induced mouse model of dry eye. Int J Mol Sci. 2023;24(24):17493.
9. Toyos R, Desai NR, Toyos M, Dell SJ. Intense pulsed light improves signs and symptoms of dry eye disease due to meibomian gland dysfunction: a randomized controlled study. PLoS One. 2022;17(6):e0270268.
10. Li J, Li J, Zhang L, Liu X, Cao Y, Wang P, et al. Comparison of red light and blue light therapies for mild-to-moderate acne vulgaris: a randomized controlled clinical study. Photodermatol Photoimmunol Photomed. 2022;38(5):459-64.
11. Giannaccare G, Pellegrini M, Scalzo GC, Borselli M, Ceravolo D, Scorcia V. Low-level light therapy versus intense pulsed light for the treatment of meibomian gland dysfunction: preliminary results from a prospective randomized comparative study. Cornea. 2023;42(2):141-4.
12. Jiang X, Yuan H, Zhang M, Lv H, Chou Y, Yang J, et al. The efficacy and safety of new-generation intense pulsed light in the treatment of Meibomian gland dysfunction-related dry eye: a multicenter, randomized, patients-blind, parallel-control, non-inferiority clinical trial. Ophthalmol Ther. 2022;11(5):1895-912.
13. Kenia VP, Saldanha M, Kenia RV, Pirdankar OH. Effectiveness of eye-light therapy in improving dry eye symptoms. Indian J Clin Exp Ophthalmol. 2023;7(3):509-14.
14. Ben Ephraim Noyman D, Chan CC, Teichman JC, Arbel I, Yosefi O, Lapid-Gortzak R, et al. Dry eye disease management via technological methods: a systematic review and network meta-analysis. Ophthalmol Ther. 2025;14(8):1917.
15. Hipólito V, Coelho JM. Blue light of the digital era: a comparative study of devices. Photonics. 2024;11(1):93.