Comparison of Efficacy of Low-Level Light Therapy and Intense Pulsed Light Therapy in Patients with Dry Eyes

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ABSTRACT

Objective: To compare the efficacy of low-level light therapy (LLLT) and intense pulsed light (IPL) therapy in the treatment of patients with dry eyes.

Study Design: Quasi-experimental study.

Place and Duration of the Study: Department of Ophthalmology, The Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan, from July to December 2022.

Methodology: There were 36 patients with dry eyes assigned to two groups receiving either the LLLT (Equinox >Eye machine) or IPL (E-Eye machine) therapy. They were given three sessions at 0th, 4th, and 6th weeks over a period of 6 weeks and the effects were noted. The parameters evaluated before the first session and two weeks after the last session included the OSDI questionnaire, non-invasive tear film break-up time, and the Meiboscore. Chi-square test (for qualitative variables) and paired sample t-test (for quantitative data variables) were applied, and a p-value of ≤0.05 was considered statistically significant. An independent sample t-test was conducted to evaluate the difference in the mean age of patients between the IPL and LLLT groups.

Results: Thirty-five eyes from each group that were treated with IPL or LLLT were included in the analysis. OSDI and Meibomian gland disease (MGD) degree significantly decreased in both groups after treatment ($p < 0.001$). Tear film break-up time increased in both groups after treatment ($p < 0.001$).

Conclusion: IPL and LLLT can be the latest treatment modality in treating Meibomian gland-related dry eye. IPL proved to have a significantly better efficacy compared to LLLT considering the improvement in OSDI, NIBUT, and Meiboscore.

Key Words: *Dry eyes, Intense pulse light therapy, Low-level light therapy, Meibomian gland disease, Ocular surface disease, Tear film break-up time.*

How to cite this article: Hassan A, Parveen S, Sameen M, Arain MA, Shahid M, Janjua TA. Comparison of Efficacy of Low-Level Light Therapy and Intense Pulsed Light Therapy in Patients with Dry Eyes. *J Coll Physicians Surg Pak* 2025; **35(03)**:313-317.

INTRODUCTION

A multifactorial disease with a prevalence of 5-50% globally[1] and 20.6% in the rural while 17.6% in the urban areas of Pakistan,[2] Dry eye disease (DED) is an ocular surface disease that causes discomfort and blurring of vision leading to the hampering of everyday activities.[3,4] It can either be due to aqueous tear deficiency or due to the evaporative dry eyes occurring secondary to the Meibomian gland dysfunction (MGD) that is characterised by a change in the gland secretions or the obstruction of the terminal ducts.[5] DED giving significant symptoms compels the patients to report to the doctors, thereby causing a burden to the economy.

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Received: November 23, 2024; Revised: February 09, 2025; Accepted: February 24, 2025
DOI: https://doi.org/10.29271/jcpsp.2025.03.313

MGD being the major causative factor for DED was treated with warm compresses, lubricant, antibiotic or antibiotic/steroid eye drops, and systemic antibiotics prior to the advent of the new technology. The need for this technology arose as conventional medical treatment started to seem ineffective.[6]

Lately, with the advancement, new in-house targeted therapies are now available.[7] Among these, Intense Pulsed Light (IPL) therapy is based on a polychromatic light source of wavelength spectrum of 1200-1500 nm, that is given to the periocular skin.[8] Liquefaction of the sebum and the involution of blood vessels occurs due to the effect of the heat on the tissue that gets irradiated. This increase in the lipid flow leads to decreased evaporation of the tears, decrease in microbes, and decreased turnover of the epithelium. Furthermore, IPL also improves collagen synthesis by activating the fibroblasts.[9] Studies have shown that IPL which was previously used by dermatologists only can be an effective and safe treatment for DED.[10,11]

Low-level light therapy (LLLT) of red light is the latest therapeutic option that uses light-emitting diodes to emit near-infrared light in the specific wavelength (λ = 600–1100 nm) to cause mitochondrial light absorption. This causes the cells to proliferate and migrate, especially the fibroblasts. Moreover, the endogenous heat of both eyelids is triggered in LLLT in contrast to IPL, which helps in improving the lipid layer. More importantly, unlike IPL, LLLT causes the therapeutic effect without causing any destruction in the thermal manner.[9,10]

There are multiple theories suggesting the mechanism of action of IPL. Some suggest a mechanism of action of IPL is such that its energy directed towards the eyelid is absorbed by the haemoglobin and is transformed into heat, causing the destruction of atypical blood vessels in a localised area hence preventing the eyelids and Meibomian glands from becoming inflamed.[11] How the LLLT works is not known but its potential mechanism is heat tissue penetration in combination with a constant exposure to light of wavelength 633 nm *via* mask for 15 minutes.[12]

A comparison between these two advancements to find the better of the two has not yet been conducted. As per the literature, no research has been done in Pakistan comparing the role of LLLT and IPL to date.

Therefore, the aim of this single-centre trial was to compare the efficacy of LLLT and IPL therapy in the treatment of patients with DED.

METHODOLOGY

This quasi-experimental study was conducted at the Department of Ophthalmology, The Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan, from July to December 2022. The study sought Ethics Committee approval prior to the data collection. Screening of the consecutive patients coming to the institute was done where a total of 36 patients were selected and 70 results were obtained where two patients were one-eyed. The sample size was calculated using the WHO calculator.[3]

Inclusion criteria were patients more than 18 years of age, having MGD signs, having any one of these symptoms of dryness, grittiness, irritation, and burning, and to be able to be compliant to the management. The signs of MGD included Meibomian gland capping with clear or opaque material expulsed on digital expression.

Exclusion criteria were patients with diabetes mellitus, use of anti-glaucoma medicines, contact lens wearer, any skin pigmentation in the area to be treated, pregnant and nursing mothers, and any other ocular or systemic disease that was not under control.

Informed consent was taken from all enrolled participants. Parameters that were assessed included the ocular surface disease index (OSDI) questionnaire, non-invasive tear film break-up time, and meiboscore. Ophthalmic evaluation including tear film break-up time and ocular surface work-up done at baseline (0 days before the first session of treatment) and two weeks after the last session. Similarly, the OSDI questionnaire was used to evaluate ocular discomfort symptoms. The noninvasive break-up time (NIBUT) was noted as the time taken in seconds for the first dry spot to appear after corneal staining using a fluorescein strip. An average score of less than 10 seconds indicated the presence of dry eyes. The images of Meibomian glands were digitally evaluated on the ME-CHECK meibography machine using the meiboscore. A scoring out of four was done on the basis of the level of meibomian-gland loss and the post-procedure improvement. Degree 0 on meiboscale depicted 0% meibomian-gland loss, increasing up to degree 4 which meant 75% meibomian-gland loss. The OSDI questionnaire evaluated the symptoms of the patients in certain conditions and a score between 0 to 100 was given where a higher score meant greater disability.

The same physician treated the patients of both groups using the E-Eye machine and the Equinox >Eye machine for IPL and LLLT, respectively. In both groups, everyone was given 3 treatment sessions (weeks 0, 2, and 6) over six weeks. In IPL therapy, patients were made to wear protective goggles after which four flashes of light were applied (three along the inferior orbital rim and one at the lateral canthus). For the LLLT group, patients were made to wear a special mask for 25 minutes through which the treatment was given. This did not involve the use of eye shields, and patients had to close their eyes throughout, ensuring that both the upper and lower eyelid were treated. Throughout the study, no patient was advised of any lubricating eye drops to see for the effects of the two therapies solely.

Data were analysed by using SPSS version 22.00. To evaluate the difference in the mean age of patients between the IPL and LLLT groups, an independent sample t-test was conducted. The sample consisted of 70 eyes of thirty-six patients, equally divided into two groups: IPL (n = 35) and LLLT (n = 35). The independent variable was the treatment group (IPL *vs*. LLLT), and the dependent variable was the age of the patients (measured in years).

Levine's test was used to check the equality of variances between the two groups. A significance value of 0.108 indicated that variances were not significantly different, justifying the use of the standard t-test. A significance level (alpha) of 0.05 was set to determine statistical significance. Mean ± standard deviation was used for the quantitative data, and qualitative data were represented by using percentage and frequency. Chi-square test (for qualitative variables) and paired sample t-test (for quantitative data variables) were applied, and a p-value of ≤0.05 was considered statistically significant. Normality was checked by the Shapiro Wilk's test as the p-value was found to be less than <0.05. This indicated that the data were normally distributed.

Table I: Demographic characteristics of patients (n = 70).

Demographic parameters		IPL (n = 35)	LLLT (n = 35)	Total	p-value
Mean age in years		52.03 ± 14.73	46.97 ± 17.65	49.50 ± 16.32	0.198
Gender	Male	21 (60.0%)	20 (57.1%)	41 (58.6%)	0.808
	Female	14 (40.0%)	15 (42.9%)	29 (41.4%)	

Independent t-test for age and Chi-square for gender.

Table II: Ocular surface parameters in the LLLT group and IPL group before and two weeks after the last session of treatment (n = 70).

Parameters	Groups	Before treatment	After treatment	p-value[1]
OSDI	IPL	69.70 ± 9.06	49.18 ± 10.93	<0.001
	LLLT	69.55 ± 12.49	56.55 ± 15.26	<0.001
Noninvasive tear film breakup time (seconds)	IPL	4.64 ± 1.93	8.91 ± 2.85	<0.001
	LLLT	5.33 ± 1.73	8.06 ± 2.32	<0.001
MGD degree	IPL	2.60 ± 0.68	1.74 ± 0.70	<0.001
	LLLT	2.60 ± 0.65	1.94 ± 0.80	<0.001

[1] *Paired t-test*.

RESULTS

A total of 36 patients, 18 in each group, were divided. Two of the total patients had one eye only. All patients completed their three treatment sessions except two (four results) who were lost to follow-up. The mean age for the IPL and LLLT groups were 52.03 years (SD = 14.734), and 46.97 years (SD = 17.656), respectively. The t-test result showed no statistically significant difference in mean age between the two groups (t, (68) = 1.301, p = 0.198). The demographic characteristics of both groups are shown in Table I.

The ocular surface parameters in the LLLT group and IPL group before and after the treatment are summarised in Table II. OSDI and MGD degree significantly decreased in both groups after treatment as p <0.001. Noninvasive tear film break-up time increased in both groups after treatment as p <0.001.

Both groups tolerated the treatment well, with one known case of eczema developing contact dermatitis after IPL.

DISCUSSION

Multiple studies have been conducted previously to evaluate the role of combination treatment with IPL and LLLT in MGD-related DED which proved that the two modalities together were very effective and safe.[13-16] Limited international data are available comparing the two machines, however, this research is the first one to be conducted in this region comparing the effects of IPL and LLLT in patients with dry eye due to MGD, which showed significant improvement of the signs and symptoms.

A study by Totuk *et al*. revealed that the OSDI score post-IPL treatment improved from 29.73 ± 4.58 to 12.36 ± 1.40 in their patients with a significant value of p <0.0001.[17] These results were consistent with the present study results where the OSDI score significantly improved from 69.70 ± 9.06 to 49.18 ± 10.93 after treatment with IPL. Antwi *et al*. in their study had a decrease of OSDI from 15.15 to 5.26 after LLLT, similar to current results of IPL of OSDI significantly decreasing from 69.55 ± 12.49 to 56.55 ± 15.26.[18] The improvement in OSDI was comparatively more in the IPL group in the patients of this study.

Totuk *et al*. also revealed a prolonged NIBUT from 4.52 ± 0.90 seconds to 6.66 ± 1.50 seconds after IPL treatment but it was not statistically significant.[17] In contrast to the current study, patients had a statistically significant improvement from 4.64 ± 1.93 seconds to 8.91 ± 2.85 seconds. This improvement was slightly better from the current LLLT group where the post-treatment NIBUT's significant result was 8.06 ± 2.32 from 5.33 ± 1.73.

The meiboscore decreased for IPL slightly more (by 0.2 score difference) than LLLT in which it was refractory for some patients while others showed mild improvement. This was consistent with the results of Solomos *et al*., where their patients after IPL had a decrease of 0.5 score more in IPL than the LLLT group.[19]

Previous studies have reported almost 13% of the patients treated with either modality complained of discomfort, redness and/or swelling.[20,21] However, in this study, only a known eczematous patient developed contact dermatitis after IPL treatment.

This study suffers from a few limitations that include the lack of comparison with the control group and the smaller duration of the therapeutic window. Further studies are encouraged on larger data to determine the significance of current findings.

CONCLUSION

IPL and LLLT proved to be an effective way of treating Meibomian gland-related dry eyes by improving the ocular discomfort symptoms. Both are considered safe, but IPL had a better efficacy (p <0.001) than LLLT as it was associated with a greater improvement in the OSDI, NIBUT, and meiboscore.

ETHICAL APPROVAL:
This study was carried out after obtaining approval from the Institutional Review Board and Ethical Committee of the Hospital.

PATIENTS' CONSENT:
Informed consent were taken from all patients who participated in the study.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
AH: Conception and design of the work.
SP: Data interpretation.
MS: Drafting and data acquisition.
MAA: Final approval of the manuscript.
MS: Drafting of the work.
TAJ: Data analysis.
All authors approved the final version of the manuscript to be published.

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