بسم الله الرحمن الرحيم

Diode laser photobiomodulation adjunctive treatment for resistant corneal infections, haze and delayed healing after PRK. Three case reports.

Osama Mohiey El Deen Al Nahrawy, Professor of Ophthalmology,
Faculty of Medicine, Suez Canal University.
Email: alnahrawyosama@gmail.com. +201223154002.
www.osamanahrawy.com

ABSTRACT

- **Title:** Diode laser Photobiomodulation for management of resistant corneal infections, haze, and delayed healing after PRK. Case reports.
- **Introduction:** There are several corneal pathological conditions that are resistant or poorly responding to the conventional lines of management. Examples of such cases are, corneal infections, abnormal healing responses (haze and delayed healing) after photo refractive keratectomy (PRK), or after keratoplasty. New methods that may promote healing and may be anti-inflammatory and antimicrobial may be tried and used as an adjunctive treatment. Diode laser photobiomodulation is an emerging modality that could help in these cases.

- **Patients**: Three cases are presented. Resistant corneal fungal ulcer, haze after PRK (grade 2 in one eye and 3 in the other one), and bilateral delayed epithelial healing after PRK. Those cases were managed using the conventional lines of management, but did not improve over many months (4-6 months).
- **Methods:** Exposure to subthreshold diode laser, 810 um, over a number of sessions (8-12) was done. Spot size was 200-300 microns. Power was 200-300 mwats. Time was 150-200 msec. Duty cycle was 5-10%. Gradual improvement of every case occurred and was documented. The patients could have 1-2 sessions per week. Fluorescein corneal stating was used to document the healing process. The conventional lines of management of each case were used.
- **Results**: The case with fungal ulcer showed healing over 2 month and cornea partially cleared. Vision improved from HM to 3/60, there was a residual moderately dense corneal opacity. The case with haze grade 2 improved totally, eye with grade 3 improved to be grade 1 with significant improvement of vision. The case with delayed epithelial healing after PRK was healed over 3 month.
- **Conclusion**: Diode laser photobiomodulation proved helpful as an adjunctive therapy in improving the resistant corneal conditions, which may encourage its use.

My professor (Hamed.N.Taha)
who taught me and directed my attention to PBM

Introduction

- Fotobiomodulation (FBM) using diode lasers at sub-threshold levels is an emerging, non-invasive therapy for various ocular diseases. It involves low-level laser therapy (LLLT) that stimulates cellular activity without causing tissue damage. Here are some key points:
  1. **Mechanism**:
  - The therapy enhances mitochondrial function, leading to increased ATP production, Stimulate production of heat shock proteins who are the house-keeprs of the living cells.
  - It reduces inflammation, oxidative stress, and promotes cellular repair.
  2. **Applications in Ocular Diseases**:
  - Conditions like diabetic retinopathy, age-related macular degeneration (AMD), and dry eye syndrome have shown potential benefits.
  - It may improve visual function, reduce inflammation, and promote tissue regeneration.
  3. **Advantages**:
  - Non-invasive and painless.
  - Low risk of side effects due to sub-threshold (below pain threshold) dosing.
  - Can be used as an adjunct to conventional treatments.

Three Case Reports

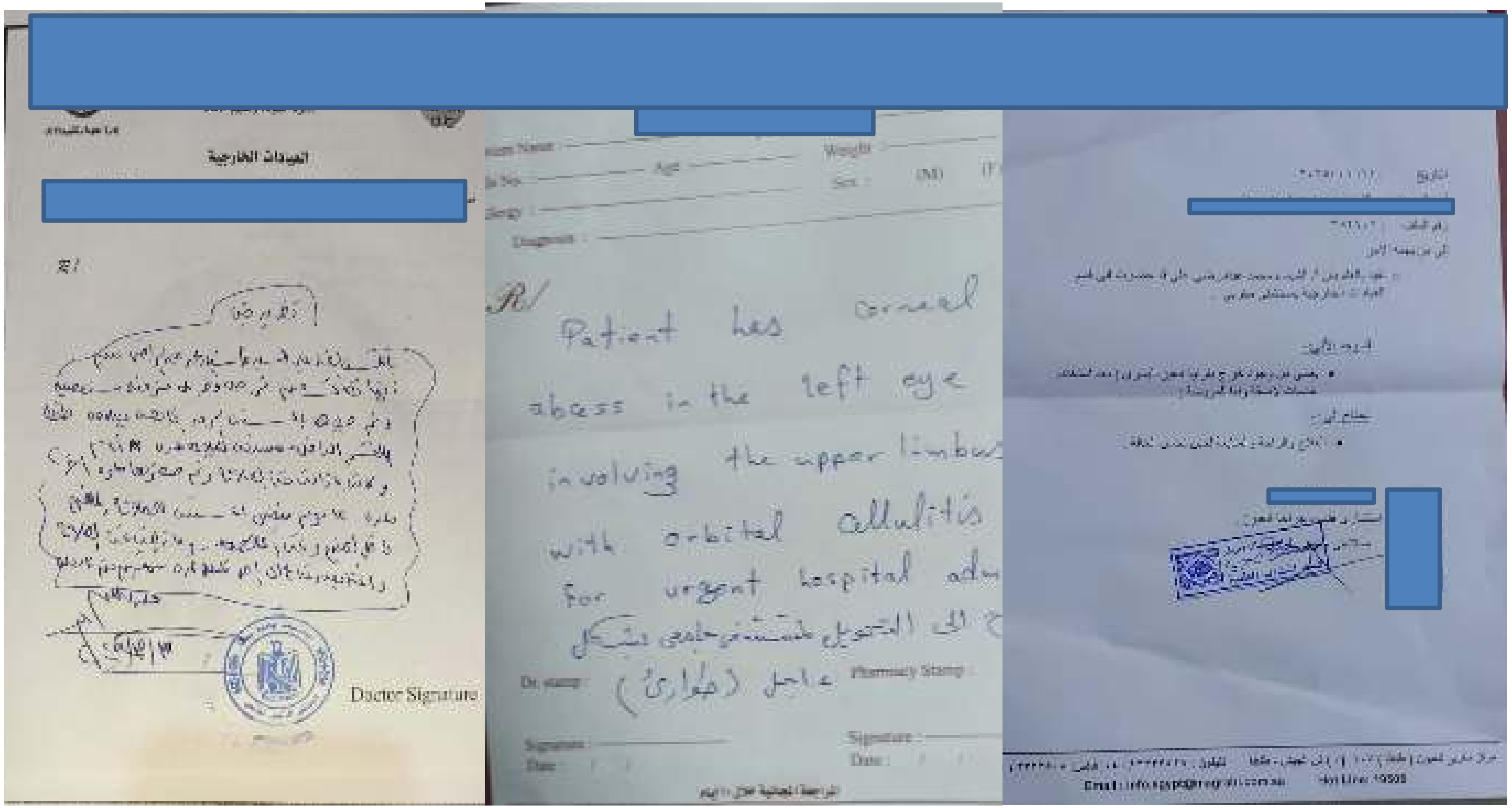
1. Resistant Fungal ulcer (6 months ttt)

A 45 years old lady,
Using cosmetic contact lenses for 10 years. Presented at June, 2025. complaining of a resistant fungal corneal infection. She received all possible antibacterial and antifungal medications and was admitted in a hospital for one week and got subconjunctival injections. There was sever keratitis, iritis, complicated cataract, elevated IOP.
Vision: HM.
<u>She got 12 sessions of Diode laser subthreshold photobiomodulation</u>.

Sever lid edema, conjunctival chemosis, conjunctival and ciliary injection, extensive corneal ulceration and abscess.

Normal posterior segment (B-scan).

The patient over 6 months visiting many clinics and admitted for subconj injections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العيادات الخارجية

[redacted]

R/

Doctor Signature

[redacted]

Name

Age

Weight

Sex (M) (F)

Allergy

Diagnosis

R/ Patient has corneal abscess in the left eye involving the upper limbus with orbital cellulitis for urgent hospital adm

Dr. stamp

Pharmacy Stamp

Signature

Date

Signature

Date

[redacted]

[redacted]

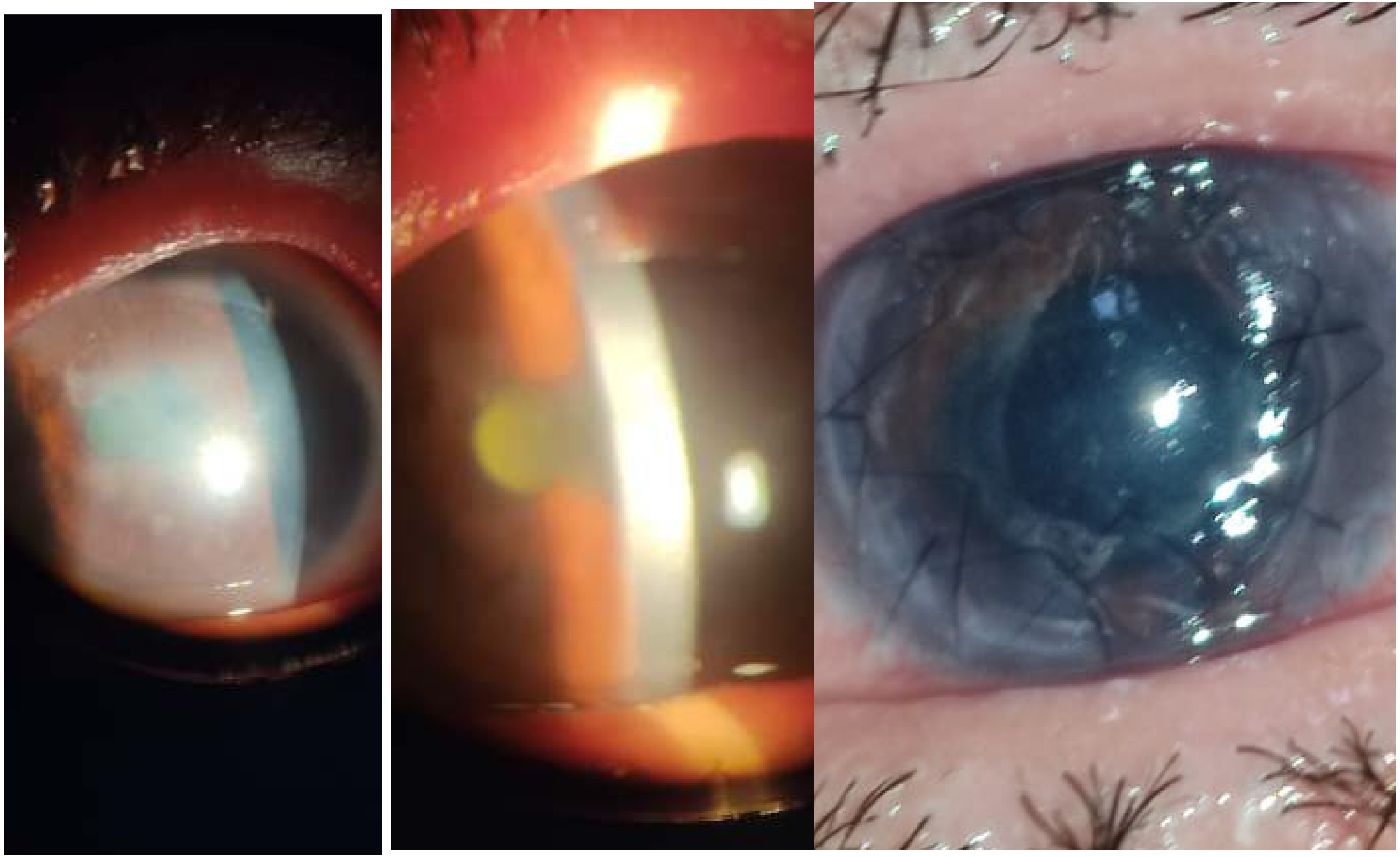
The Diode laser, Lightlas810 (Lightmed).

(no financial interest)

Technique of Diode laser sessions

- Diode 810 nm (Lightlas810 LightMed)
- Subliminal mode
- Power 200-300 mw
- Spot size: 200 microns.
- Duty cycle 5%
- Pulses in a session: 300
- 12 sessions, two sessions in one week or once weekly.

After 12 sessions of Diode laser (810 nm), subthreshold photobiomodulation over 3 month, then combined PKP+PHAKO



2. Case report: PBM for Haze after PRK

- 27 years old, lady,
- Presented to have laser vision correction

Right eye				Left eye		
Sph	Cyl	axis	IPD	Sph	Cyl	axis
-4.50	-0.75	125	58	-6.00	-0.50	90

- Had surface ablation at February 2024.
- Mitomycin C (0.02%) had been used for 20 seconds immediately after ablation.
- Standard post operative medications: moxifloxacin 0.5%, Dexamethasone 1% drops, Lubricant eye drops containing methycellulose and hyaluronate sodium

PATHOPHYSIOLOGY OF POST PRK HAZE

Post PRK haze develops as an inflammatory response to intraoperative epithelial insult.

Immediately after disruption of the epithelium and basement membrane, a complex process of cytokine-mediated wound healing begins.

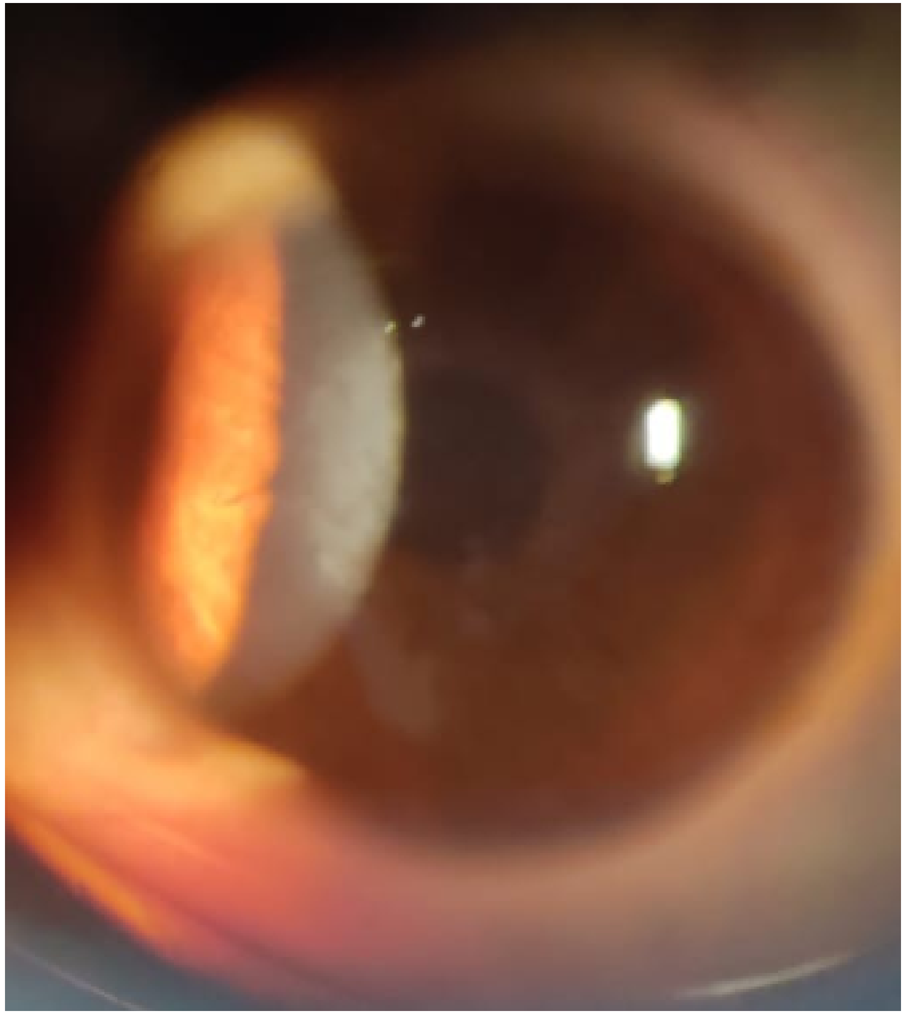
Interleukin-1 (IL-1), IL-6, bone morpho-genic protein (BMP) 2 and 4, epidermal growth factor (EGF), platelet-derived growth factor (PDGF), FAS ligand, tumor necrosis factor alpha (TNFa), platelet-activating factor (PAF), transforming growth factor beta (TGFb), and insulin-like growth factor (IGF) 1 and 2 are released [7–9].

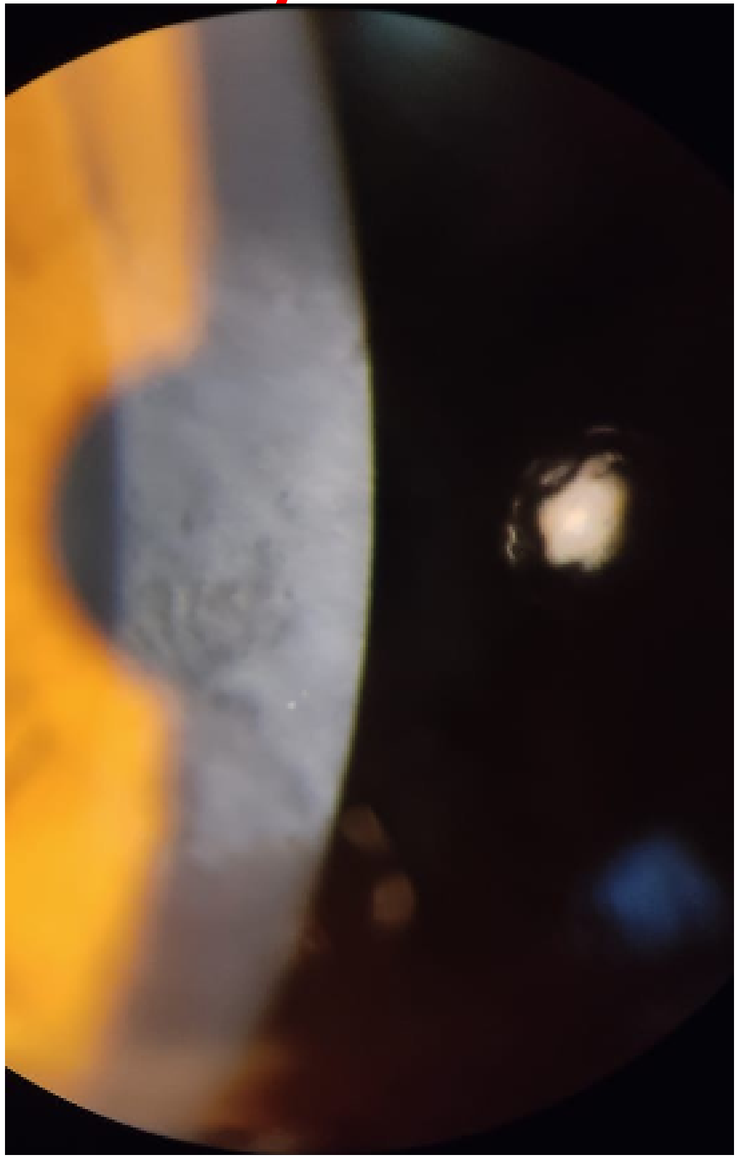
IL-1 and PDGF activate keratocytes, which then produce hepatocyte growth factor (HGF) and keratinocyte growth factor (KGF), which in turn drive epithelial proliferation.

Ophthalmol Ther (2023) 12:2841–2862 2843

External view (haze G2, G3)

Haze right and left eyes

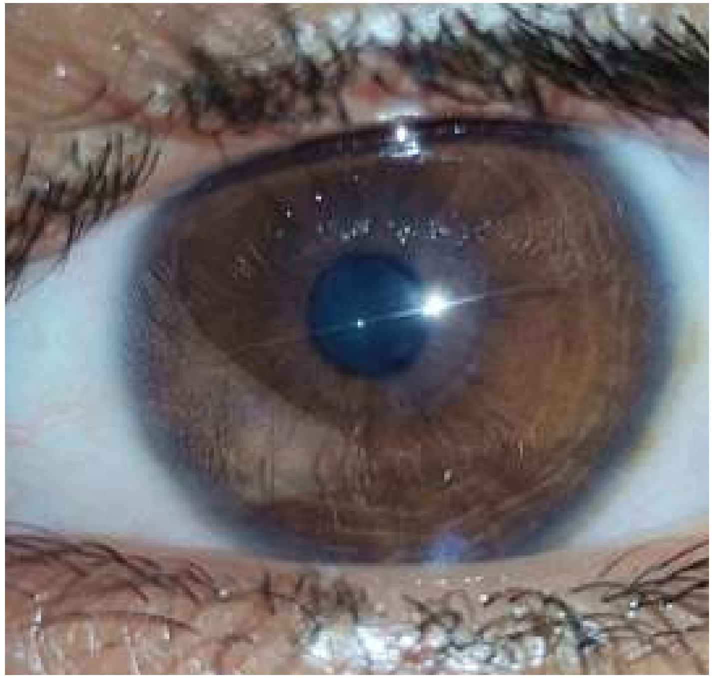




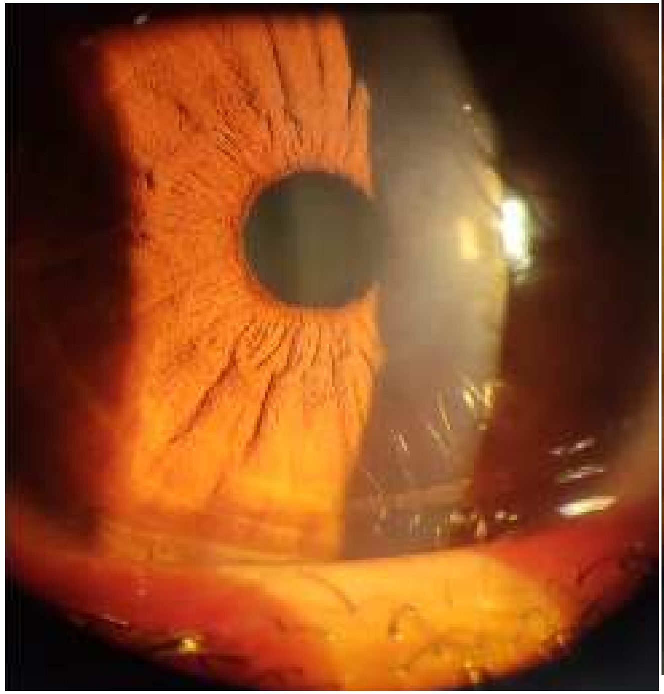
TECHNIQUE

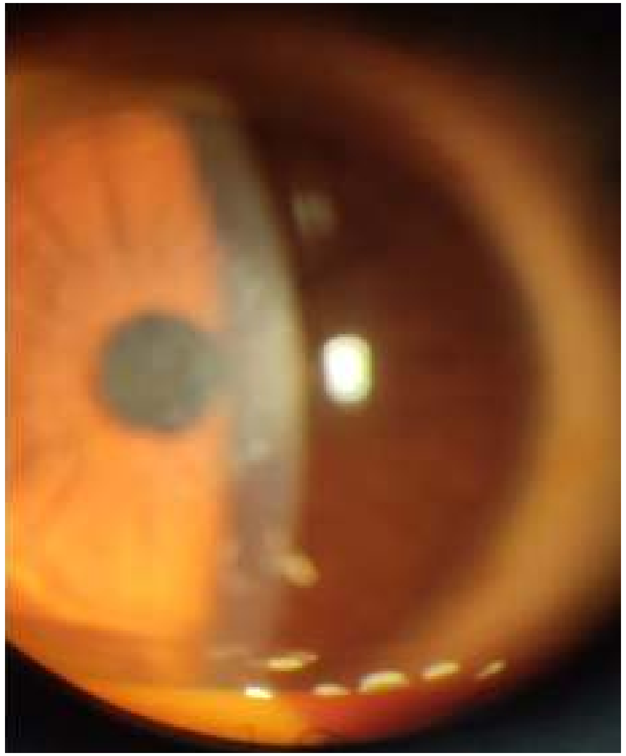
- Diode 810 nm (Lightlas810 LightMed)
- Subliminal mode
- Power 200-300 mw
- Spot size: 200 microns.
- Duty cycle 5%
- Pulses in a session: 300
- 8 sessions, two sessions in one week or once weekly.

After PBM: External view: improved haze

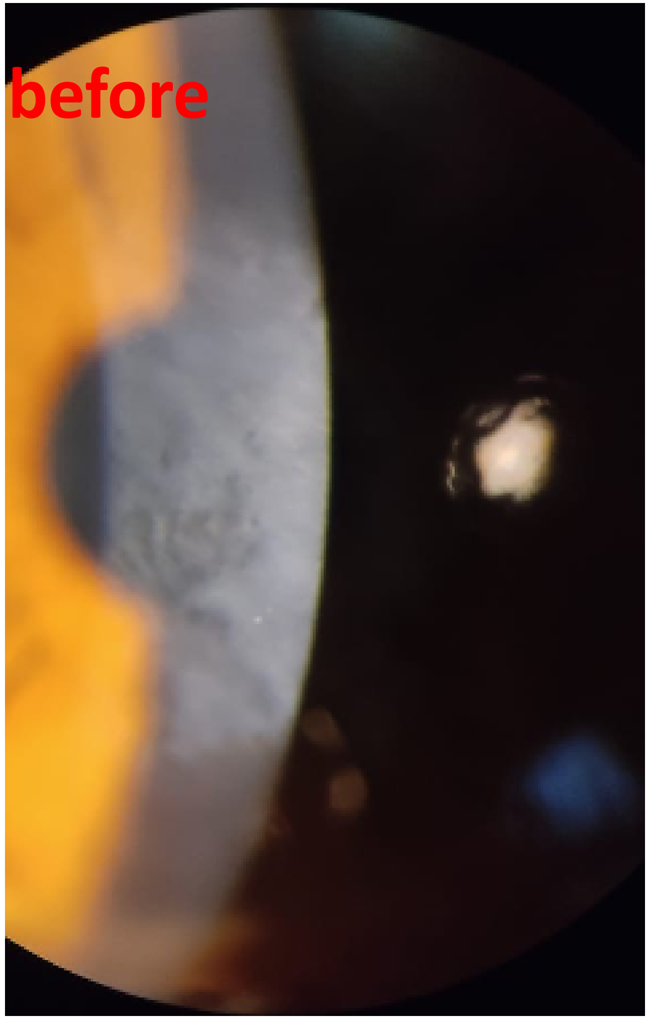


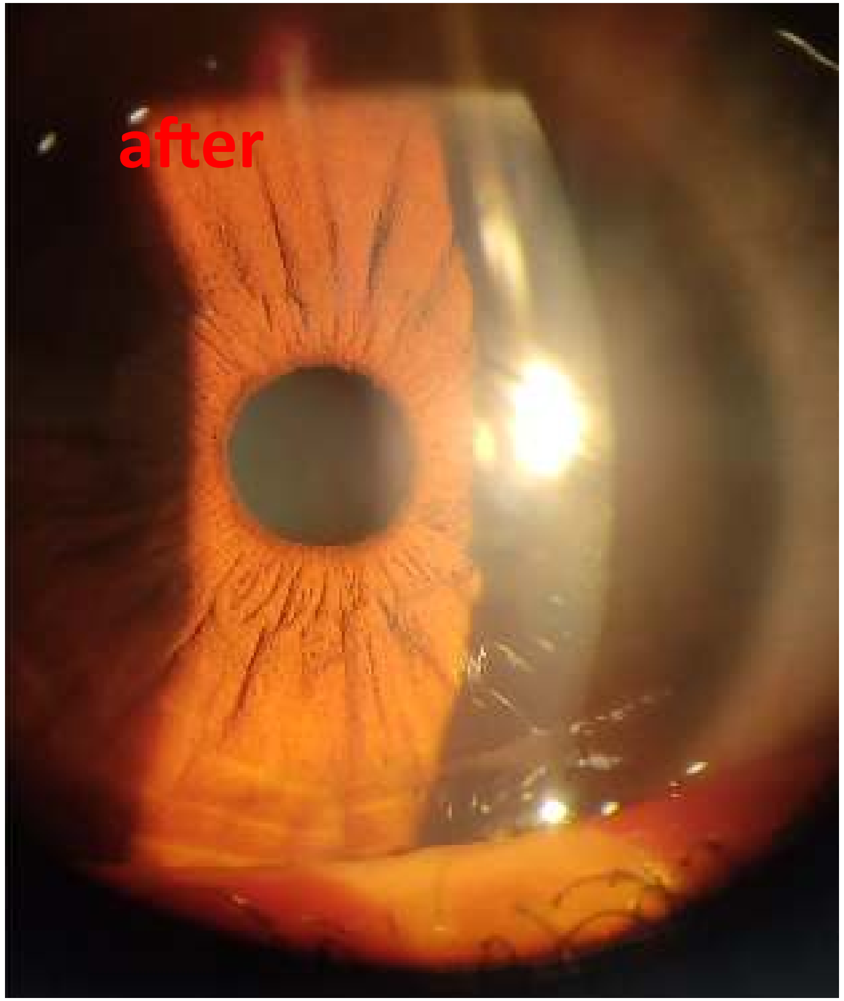
Corneal haze improvement after PBM





Comparison between before and after PBM





3. Case report: delayed healing after PRK improved by adding PBM

- A 35 years old, lady, presented at 21 December 2024, to have laser vision correction, and had the surgery next day.
- Her refraction was moderate myopia in both eyes, (around -6.0 DS), and the thinnest corneal location was 500 u in right eye and 498 in left eye.
- The epithelium was removed by the excimer laser (Visx Star S4 IR) (8.00 mm area).. Then the stromal ablation was done.
- Mitomycin C (0.02%) was placed over the corneal for 20 seconds.
- A bandage contact lens was placed.
- Moxifloxacin hydrochloride 0.5% eye drops, dexamethasone 0.1% eye drops and Lubricant drops were used.
- Additional therapies: Autologous serum, Insulin drops, Bee honey, Zamzam water, had been used all the way.
- There was no healing, as proved by the fluoroscein staining. Healing started when we used the photobiomodulation sessions

	RIGHT EYE			LEFT EYE		
	Sph	Cyl	axis	Sph	Cyl	axis
	-6.50	-0.50	150	-5.50	-0.50	20
Tinnest location	500 u			497 u		

Important dates

- Date of PRK 22-12-24
- Duration of using the conventional methods alone (as mentioned before) :
- Date of starting the diode micropusle laser : March, 3, 2025 (first session, with Iridex 577 nm).
- second session , 2 weeks later (same machine).
- Then 12 sessions once every week (with Lightlas 810, Lightmed).
- Complete epithelial healing (no fluoroscein staining): April, 30, 2025.

TECHNIQUE

- Diode 810 nm (Lightlas810 LightMed)
- Subliminal mode
- Power 200-300 mw
- Spot size: 200 microns.
- Duty cycle 5%
- Pulses in a session: 300
- 8 sessions, two sessions in one week or once weekly.

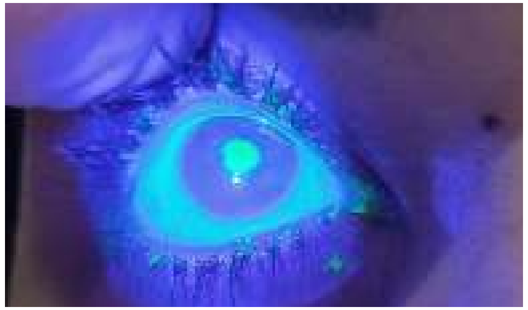
25-1-25
(after more than 1 month of PRK)

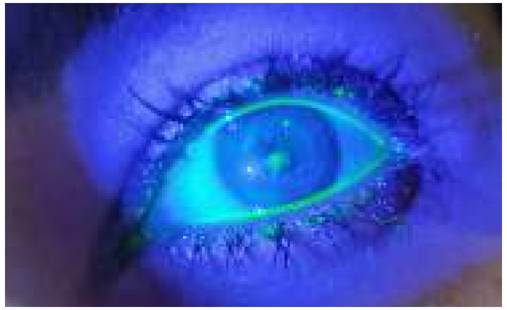
1-2-25

8-2-25

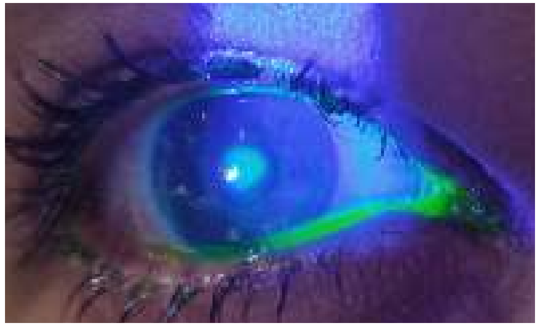
15-2-25

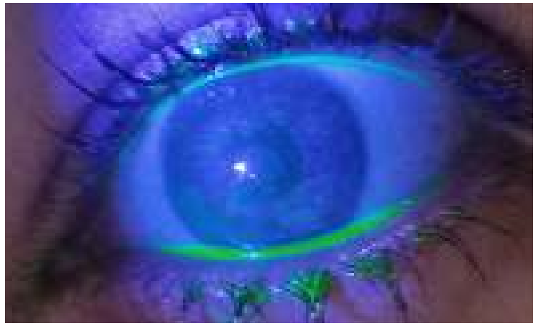
7-4-25





13-4-25





30-4-25

4-10-25

Before PRK and After the PBM

Discussion

- The three cases showed significant improvement after addition of the subthreshold diode laser micropusle.
- It is possible that the laser in this way of delivery, has an antimicrobial action, anti-inflammatory action, pain relieving action and healing promoting effect.
- It seems that its effects are on the corneal epithelium and also on the stroma, since haze after PRK has improved.

Review of Litrature

The Egyptian Journal of Hospital Medicine (April 2025) Vol. 99, Page 1952-1957

Effect of Transscleral Subthreshold Diode Laser Treatment to the Retinal Periphery in Glaucoma Patients (Photobiomodulation)

[1]Zeinab Sayed Hasan, [2]Hamed Nasr El-Din Taha, [2]Mohamed Mohamed Aly Ibrahim, [1]Sara Samir Ibrahim Abdallah

[1]Department of Ophthalmology, Faculty of Medicine (Girls) Al -Azhar University

[2]Department of Ophthalmology, Faculty of Medicine (Boys) Al -Azhar University

***Corresponding author:** Sara Samir Ibrahim Abdallah, **Mobile:** 01098093706, **Email:** Sierrasamir92@gmail.com

ABSTRACT

Background: Reducing intraocular pressure (IOP) was only established method to limit rate at which damage progresses in glaucoma, a chronic, multifactorial optic neuropathy.

Objectives: This study aimed to determine how transscleral subthreshold diode laser treatment [photobiomodulation (PBM)] affects individuals with primary open angle glaucoma.

Subjects and methods: Ophthalmology departments, Clinics at Bab El-Shariyia University Hospital, El-Zahraa University Hospital in Cairo, Egypt, respectively, served as study's locations. Thirty eyes from nineteen individuals with primary open angle glaucoma, and a visual field impairment were included in this study.

Result: There was statistically significant improvement in the studied group regarding best-corrected visual acuity (BCVA) before and after intervention. There was highly statistically significance decrease in the intraocular pressure of patients before and after intervention in the studied group and significant improvement of visual field before and after intervention.

Conclusion: Micro pulse diode laser was a safe, efficient treatment for glaucoma, according to results of our study. BCVA and a highly statistically significant drop in intraocular pressure were outcomes of intervention. Visual field improved statistically significantly, as seen by decreases in mean deviation (MD), pattern standard deviation (PSD) prior to, and following intervention.

Keywords: Transscleral subthreshold diode laser, Retinal periphery, Glaucoma, hotobiomodulation.

INTRODUCTION

Degradation of optic nerve head (ONH) and retinal nerve fibre layer (RNFL) that was both progressive functionally. After light enters retina, photoreceptors transform it into electrical signals,

Photobiomodulation (PBM) therapy was a new treatment for glaucoma that increases activity of Cytochrome C Oxidase (CCO), decreases oxidative stress, inflammation in eye, increases cell energy

applied sciences

MDPI

Review

Current Applications and Future Perspectives of Photobiomodulation in Ocular Diseases: A Narrative Review

Claudia Cannas [1], Benedetta Pintus [1], Lina Corgiolu [1], Enrico Borrelli [2], Giacomo Boscia [3], Mario Damiano Toro [4] and Giuseppe Giannaccare [1,*]

1 Eye Clinic, Department of Surgical Sciences, University of Cagliari, Via Università 40, 09124 Cagliari, Italy
2 Department of Ophthalmology, "City of Health and Science" Hospital, University of Turin, Via Cherasco 23, 10126 Turin, Italy
3 Department of Translational Biomedicine Neuroscience, University of Bari "Aldo Moro", Piazza Giulio Cesare 11, 70124 Bari, Italy; bosciagiacomo@gmail.com
4 Eye Clinic, Public Health Department, University of Naples Federico II, Corso Umberto I 40, 80138 Naples, Italy; mariodamiano.toro@unina.it
* Correspondence: giuseppe.giannaccare@unica.it

Abstract: The present article provides an overview of photobiomodulation (PBM), also known as low-level laser light therapy (LLLT), which has garnered attention in ophthalmology for its potential therapeutic benefits in various ocular diseases. Photobiomodulation involves the use of low-intensity lasers or light-emitting diodes to stimulate biological processes in target tissues without causing thermal damage. This article discusses how PBM has been explored across various ocular conditions, including ocular surface diseases, age-related macular degeneration, diabetic retinopathy, myopia, amblyopia, and glaucoma. It summarizes findings from human studies and clinical trials demonstrating positive outcomes of PBM treatment in these areas. Moreover, the article emphasizes the importance of establishing standardized treatment protocols in terms of session duration and frequency, light type, and patients' inclusion criteria to further validate the role of PBM in managing ocular diseases.

Keywords: PBM; LLLT; eye; dry eye; AMD; diabetic retinopathy; myopia

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REVIEW

Yellow Subthreshold Micropulse Laser in Retinal Diseases: An In-Depth Analysis and Review of the Literature

Claudio Iovino · Clemente Maria Iodice · Danila Pisani · Andrea Rosolia · Francesco Testa · Giuseppe Giannaccare · Jay Chhablani · Francesca Simonelli

Received: January 13, 2023 / Accepted: March 1, 2023

ABSTRACT

Yellow subthreshold micropulse laser (YSML) is a retinal laser capable of inducing a biologic response without causing thermal damage to the targeted tissue. The 577-nm YSML is delivered to the retina abiding by different protocols in which wavelength, power, duration, spot size and number of spots can be properly set to achieve the most effective and safe treatment response in various chorioretinal disorders. The ultrashort trains of power modulate the activation of the retinal pigment epithelium cells and intraretinal cells, such as Müller cells, causing no visible retinal scars. Subthreshold energy delivered by YSML stimulates the production of the heat-shock proteins, highly conserved molecules that protect cells against any sort of stress by blocking apoptotic and inflammatory pathways that cause cell damage. YSML treatment allows resorption of the subretinal fluid in central serous chorioretinopathy and intraretinal fluid in various conditions including diabetic macular edema, postoperative cystoid macular edema and other miscellaneous conditions. YSML also seems to modulate the development and progression of reticular pseu-

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COMMENT

Check for updates

Subthreshold laser therapy guidelines for retinal diseases

Jay Chhablani[1] ✉ and SOLS (Subthreshold Laser Ophthalmic Society) writing committee*

Eye; https://doi.org/10.1038/s41433-022-02136-w

Subthreshold laser therapy has been utilised in clinical practice for more than three decades, and numerous randomised and real-life studies has proven its efficacy and safety in various retinal diseases [1–10]. However, despite decades of usage, we still do not have a standard protocol for subthreshold laser applications and settings. The Subthreshold Ophthalmic Laser Society (SOLS) is comprised of global experts (10) in subthreshold lasers and has a goal to establish subthreshold laser guidelines and establish level 1 evidence on subthreshold laser in ophthalmology.

Here we report consensus guidelines by SOLS for the subthreshold laser settings and applications in diabetic macular oedema (DMO) and central serous chorioretinopathy (CSCR). These guidelines were based on 43 questions based on different aspects of subthreshold laser applications in these diseases. Responses were collected from each expert in a masked fashion in first round and two virtual meetings were performed to discuss these questions to reach final consensus.

For DMO, the experts support the role of subthreshold laser in both centre-involving and non-centre involving macular oedema in conjunction with or without anti-VEGF therapy. Subthreshold laser settings for DMO include 5% duty cycle, 200 ms pulse duration, and 150–200 µm spot size with no spacing between laser spots using integrated pattern system. SOLS experts support titration for subthreshold laser application with 50% of threshold power (achieved with subthreshold laser). SOLS experts suggest treating oedematous area with subthreshold laser, however, does not mandate focal treatment of microaneurysm. SOLS experts consider transfoveal treatment safe with settings described earlier, however, they emphasis the careful application and reconfirmation of subthreshold laser safe settings before application. Considering no visible or structural changes following subthreshold laser treatment, experts do not recommend any specific structural imaging studies to evaluate laser spots, however, autofluorescence or OCT could be carefully evaluated during follow up visits for any laser scars. Experts recommend follow-up evaluation at 6–8 weeks after subthreshold laser application, however, repeat subthreshold laser is suggested after 2–3 months of initial application, in case of poor response. Experts recommend adjunctive therapies such as anti-VEGF or steroid therapy for diabetic macular oedema as per the physician's discretion.

For CSCR, SOLS experts recommend subthreshold laser for both acute as well chronic types. Unlike conventional observation for 3–4 months for acute CSCR, considering the safety profile of subthreshold laser, SOLS experts recommend subthreshold laser application in 1 month if there is no self-resolution. For chronic CSCR, SOLS expert support subthreshold laser as first line as well as combination therapy with other treatment options. Recommended settings for subthreshold laser application are 5% duty cycle, 200 ms pulse duration and 100–200 µm spot size. Settings are same for both acute and chronic CSCR with no spacing between the spots using integrated pattern system. SOLS experts support these settings safe for the transfoveal laser application, with reconfirmation of subthreshold settings. SOLS experts suggest titration with 50% of threshold power (threshold estimation using subthreshold laser mode) (Table 1). Regarding area covered, for acute CSCR, focal leak and adjacent area should be treated with subthreshold laser. In case of chronic CSCR, SOLS experts suggest areas of focal as well as diffuse hyperfluorescence on fluorescein angiography. Considering no visible or structural changes following subthreshold laser, experts do not recommend any specific structural imaging studies to evaluate laser spots, however, autofluorescence or OCT could be carefully evaluated during follow up visits for any laser scars. Evaluation at 6–8 weeks is recommended and in case of poor response or persistence of the subretinal fluid, a repeat treatment with same settings is recommended, in addition to adjuvant treatment options as per physician discretion.

Table 1. Subthreshold laser consensus guideline settings for diabetic macular oedema and central serous chorioretinopathy by the Subthreshold Ophthalmic Laser Society (SOLS).

Subthreshold laser settings	Diabetic macular oedema	Central serous chorioretinopathy
Duty cycle	5%	5%
Pulse duration	200 ms	200 ms
Spot size	150–200 µm	100–200 µm
Spacing between spots	No	No
Titration	Yes	Yes
Titration power	50% of threshold power	50% of threshold power

These consensus guidelines do not suggest management of these disease but suggest laser application guidelines using different subthreshold laser deliver systems. These guidelines would help to establish standard subthreshold laser applications in clinical practice.

[1]University of Pittsburgh School of Medicine, Pittsburgh, PA, USA. *A list of authors and their affiliations appears at the end of the paper. ✉email: jay.chhablani@gmail.com

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REVIEW

Yellow Subthreshold Micropulse Laser in Retinal Diseases: An In-Depth Analysis and Review of the Literature

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Low-Level Laser Therapy Improves Vision in Patients with Age-Related Macular Degeneration

Boris T. Ivandic, M.D.,[1] and Tomislav Ivandic, M.D.[2]

Abstract

Objective: The objective of this study of a case series was to examine the effects of low-level laser therapy (LLLT) in patients with age-related macular degeneration (AMD).
Background Data: AMD affects a large proportion of the elderly population; current therapeutic options for AMD are limited, however.
Patients and Methods: In total, 203 patients (90 men and 113 women; mean age 63.4 ± 5.3 y) with beginning ("dry") or advanced ("wet") forms of AMD (n = 348 eyes) were included in the study. One hundred ninety-three patients (mean age 64.6 ± 4.3 y; n = 328 eyes) with cataracts (n = 182 eyes) or without cataracts (n = 146 eyes) were treated using LLLT four times (twice per week). A semiconductor laser diode (780 nm, 7.5 mW, 292 Hz, continuous emission) was used for transconjunctival irradiation of the macula for 40 sec (0.3 J/cm^2) resulting in a total dose of 1.2 J/cm^2. Ten patients (n = 20 eyes) with AMD received mock treatment and served as controls. Visual acuity was measured at each visit. Data were analyzed retrospectively using a *t*-test.
Results: LLLT significantly improved visual acuity ($p < 0.00001$ versus baseline) in 162/182 (95%) of eyes with cataracts and 142/146 (97%) of eyes without cataracts. The prevalence of metamorphopsia, scotoma, and dyschromatopsia was reduced. In patients with wet AMD, edema and bleeding improved. The improved vision was maintained for 3–36 mo after treatment. Visual acuity in the control group remained unchanged. No adverse effects were observed in those undergoing therapy.
Conclusion: In patients with AMD, LLLT significantly improved visual acuity without adverse side effects and may thus help to prevent loss of vision.

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Application of subthreshold laser therapy in retinal diseases: a review

Spencer M. Moore[1], **Daniel L. Chao**[2]

[1]School of Medicine, University of California, San Diego, La Jolla, CA, USA

[2]Department of Ophthalmology, Shiley Eye Institute, University of California, San Diego, La Jolla, CA, USA

Abstract

Introduction: Laser photocoagulation has been a valuable tool in the ophthalmologist's armamentarium for decades. Conventional laser photocoagulation relies on visible retinal burns as a treatment endpoint, which is thought to result in photocoagulative necrosis of retinal tissue. Recent studies have suggested that using subthreshold (ST) laser, which does not cause detectable damage to the retina may also have therapeutic effects in a variety of retinal diseases. Areas covered: We review the proposed biological mechanisms mediating the therapeutic effects of subthreshold laser on the retina, followed by the evidence for ST laser efficacy in retinal diseases such as diabetic macular edema, central serous chorioretinopathy, age-related macular degeneration, and retinal vein occlusion.

Expert Commentary: Multiple clinical studies demonstrate that subthreshold laser does not cause structural damage to the retina based on multimodal imaging. Evidence suggests that there is

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EDITED BY
Malgorzata Rozanowska,
Cardiff University, United Kingdom

REVIEWED BY
Michael R. Hamblin,
University of Johannesburg, South Africa
Marcela Votruba,
Cardiff University, United Kingdom

*CORRESPONDENCE
Stephanie E. Tedford
✉ setedford@lumithera.com

†These authors share first authorship

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Photobiomodulation use in ophthalmology – an overview of translational research from bench to bedside

Krisztina Valter[1,2†], Stephanie E. Tedford[3*†], Janis T. Eells[4] and Clark E. Tedford[3]

[1]Clear Vision Laboratory, John Curtin School of Medical Research, Eccles Institute of Neuroscience, Canberra, ACT, Australia, [2]School of Medicine and Psychology, Australian National University, Canberra, ACT, Australia, [3]LumiThera, Inc., Poulsbo, WA, United States, [4]College of Health Professions and Sciences, University of Wisconsin-Milwaukee, Milwaukee, WI, United States

Photobiomodulation (PBM) refers to the process in which wavelengths of light are absorbed by intracellular photoacceptors, resulting in the activation of signaling pathways that culminate in biological changes within the cell. PBM is the result of low-intensity light-induced reactions in the cell in contrast to thermal photoablation produced by high-intensity lasers. PBM has been effectively used in the clinic to enhance wound healing and mitigate pain and inflammation in musculoskeletal conditions, sports injury, and dental applications for many decades. In the past 20 years, experimental evidence has shown the benefit of PBM in increasing numbers of retinal and ophthalmic conditions. More recently, preclinical findings in ocular models have been translated to the clinic

THANK YOU FOR ATTENTION