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PHOTOBIOMODULATION IN ORAL MEDICINE: A REVIEW

[1*]Jyoti Kiran, [2]Vishal Mehrotra, [3]Kriti Garg, [4]Rahul Srivastava, [5]Shazia Aslam and [6]Kasif Iqbal

[1,5,6]PG Student,[2]Prof. & HOD, [3]Reader, [4]Prof., Dept. of Oral Medicine and Radiology, Rama Dental College Kanpur.

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***Corresponding Author**
Jyoti Kiran
PG Student, Dept. of Oral Medicine and Radiology, Rama Dental College Kanpur.

ABSTRACT

Photobiomodulation (PBM) or low-level laser therapy (LLLT) in dentistry is an evolving science, with an increasing number of controlled clinical studies exploring its potential as a treatment modality. In literature, a great number of works are reported showing the advantages of PBM use in many oral diseases such as recurrent aphthous stomatitis, pemphigus vulgaris, oral lichen planus, burning mouth syndrome, xerostomia etc. The review's aim is to describe the possible applications of PBM in oral medicine, giving practitioners simple guide for practice.

KEYWORDS: Photobiomodulation, low level laser therapy, oral medicine.

INTRODUCTION

Photobiomodulation (PBM), also known as low-level laser therapy (LLLT) or cold laser therapy, was developed in 1967 by Endre Mester, who was the first to describe the "biostimulation" effect of lasers.[1] Mester et al., in 1968, as the first researchers reported stimulatory (e.g., wound healing) and inhibitory (e.g., pain treatment) effects of low-dose laser radiation. Subsequently, with the progress of laser science, it was found that in addition to lasers as coherent radiations, noncoherent radiations (such as light-emitting diodes or LEDs) have biostimulatory properties; hence, the terms of low-dose light therapies and PBMT were used for this group of treatments. Today, the term photobiomodulation (PBM) provides a more accurate interpretation of low-power laser therapies due to the fact that it includes a wide range of electromagnetic radiations such as broadband lights, LEDs, and lasers.[2,3]

PBM is a drug-free, non-invasive clinical application of red (600–700 nm) and near infrared light (NIR) (700– 950 nm), usually produced by low-to-mid power coherent lasers or non-coherent light-emitting diodes [LED], with a power density (irradiance) between 1 mW and 5 W/cm2 over injuries or lesions to improve wound and soft tissue healing, reduce inflammation, and give relief for both acute and chronic pain.[4,5] PBM has approval from the Food and Drug Administration (FDA), Health Canada, Conformite Europeenne, and numerous other health regulatory agencies from many countries worldwide.[5] PBM is characterized by a biphasic dose response (Arndt-Schultz Law), where a "therapeutic window" within a certain dose range exists; too small a dose gives no effect, and doses over that range are inhibitory.[6,7,8]

MECHANISM OF ACTION

PBM is based on a photochemical mechanism where the energy is transferred to the intracellular mitochondrial chromophores that are light-absorbing molecules such as endogenous porphyrins and respiratory chain components such as cytochrome c oxidase capable of transferring the absorbed laser energy to the mitochondria; at this level, laser energy is converted into metabolic energy by the respiratory chain with the production of adenosine triphosphate (ATP).[9,10] The primary photo acceptors of PBM for visible light are the mitochondrial respiratory chains, and for infrared light are the calcium channels located at the cellular membrane.[11,12]

EFFECTS OF PBM

The photochemical reactions at the base of PBM can define three different clinical effects, namely the stimulation of healing, the anti-inflammatory effect, and the painkilling action, which are as follows.[13]

Stimulation of wound healing

In vitro and in vivo studies on animals and humans have shown the efficacy of PBM in promoting DNA synthesis, neo angiogenesis, keratinocyte, fibroblast, and endothelial cell proliferation, maturation and migration, collagen synthesis and deposition, activation of macrophages, revascularization and contraction of the wound by means of myofibroblast transformation and neurogenesis.[14,15]

Anti-inflammatory effect

PBM is able to modulate cytokine release by decreasing the tissue levels of TNF-α and increasing the levels of IL-1β, to regulate inflammation-induced angiogenesis, and to act on endothelial cells.[16] PBM also seems to contribute to the reduction of edema.[17]

Analgesic-painkiller effect

PBM defines the reduction of acute and chronic pain through a conduction block and an alteration of nociceptors A-delta and C, with action at the level of the central nervous system through ascending and descending transmission.[17] In fact, PBM is able to modulate peripheral nervous system signalling, defining at the central nervous system level, the pain modulation effect.[18]

ROLE OF PHOTOBIOMODULATION IN ORAL MEDICINE

BURNING MOUTH SYNDROME

Burning Mouth Syndrome (BMS) is a chronic and painful intraoral disorder in the absence of any signs of disease in the mouth. Patients with BMS also suffer from unremitting mucosal pain, xerostomia, and dysgeusia in addition to burning sensation. In the treatment of BMS, various therapies, such as the use of antidepressants, antipsychotics, antiepileptics, analgesics, B complex, and dietary supplements are used. However, the achievement of a definitive therapeutic approach is still debatable. One of the treatment methods that has been given a great deal of attention in recent years is the use of PBMT as a nondrug and non-invasive method.[19-22] The possible mechanisms associated with a reduction in symptoms could be the analgesia induced by serotonin and b-endorphin production, and through the inhibition of neural activity when very high energies are used.[23,24] The highest power used is in the study by Yang and Huang, using an 800 nm 1.5 W laser, applying 105 J to each cm2 of the affected area, which was clinically very effective.[24] In recent literature it was quoted that there is 80.4% reduction in the intensity of symptoms of BMS after laser treatment (once per week for 3 consecutive weeks with an infrared laser; 790 nm, 120 mW, 1.2 J/point [3–9 points], 6 J/ cm2.[23]

In a recent study by Pezelj-Ribaric et al., 40 levels of pro-inflammatory tumor necrosis factor-α and interleukin-6 cytokines in whole, unstimulated saliva in patients with BMS before and after treatment with PBM were shown to be significantly decreased in the experimental group, which highlights the anti-inflammatory property of PBM.[25] Based on

these studies, PBM can be considered a promising therapy for BMS owing to a lack of side-effects and due to the relative ineffectiveness of other treatment modalities.

ORAL LICHEN PLANUS

Oral lichen planus (OLP) is an inflammatory disease that can be painful, and mainly occurs atrophic and erosive forms. Jajarm et al., in their study reported the successful treatment of erosive lichen planus patients with the 630-nm diode laser twice daily. They demonstrated that PBM was as effective as topical corticosteroid therapy without any adverse effects, and could be considered an alternative treatment for erosive-atrophic OLP in the future.[26]

XEROSTOMIA

Lack of secretion or reduction of saliva is one of the most common problems in the elderly, which greatly affects the quality of life, causing discomfort while talking, swallowing, understanding tastes and food flavours, burning sensation in the oral mucosa, and increasing the vulnerability of oral mucosa to trauma due to different causes. Various therapeutic approaches, such as the use of systemic sialogogues, electrical stimulation, acupuncture, as well as artificial saliva are available. However, regarding healthy acinar cells, the best way to increase the flow of saliva is by stimulating this group of cells. PBM, which is based on changes in biochemical and photophysical processes, can have an excitatory effect on the activity of salivary gland cells.[27-32] In a study by Loncar et al., laser light from a pulsed GaA laser operating at 904 nm was applied bilaterally on each salivary gland area: extraorally on the parotid and submandibular gland areas, and intraorally on the sublingual gland area. The operational probe distance from the irradiated area was 0.5 cm, resulting in an irradiance of 246 mW/cm2. An average energy density of 29.5 J/cm2 per exposures for 120 s daily was done for 10 consecutive days. The results indicated that the effects of PBM on salivary glands were not only stimulating, but also regenerative to a degree, as the glandular response to the same amount of applied laser energy increased linearly over time.[33] Simoes et al.72 also reported that diode laser is beneficial in patients after therapeutic head and neck irradiation (660 nm, 6 J/cm2 , 0.24 J, 40 mW).[34]

RECURRENT APTHOUS STOMATITIS

Recurrent Apthous Stomatitis **(**RAS) is a common and painful mucosal disorder and has a negative impact on quality of life and interferes with daily activities such as eating, swallowing, or talking.[35,36] The etiology of RAS is still unknown, however, family history, allergies, vitamin B12 deficiency, or hormonal imbalance are among the most crucial causes

of RAS. In study by Aggarwal et al 5 laser diode at 810 nm at 0.5 W was given for 45 second in four sessions resulting in relieving pain and reducing the healing time during the treatment of apthous ulcers.[37] Findings from clinical studies indicate that the use of PBM therapy can be effective in pain reduction and wound healing without adverse drug-related side effects.

PEMPHIGUS VULGARIS

Pemphigus vulgaris (PV) is a rare, potentially life-threatening, autoimmune-blistering disease of the skin and mucous membranes. Oral lesions in PV could be so painful during the active period of the disease, in that it could interfere with eating, drinking, and even speaking.[38,39] A pilot before–after clinical trial of a single session of non-thermal, non-ablative CO2 laser therapy (NACLT) in oral lesions of PV was carried out by Zand et al. Immediately after NACLT, the severity of idiopathic (non-contact) and contact pain dramatically declined. The results of that pilot study suggested that a single session of NACLT could reduce pain in oral lesions of PV immediately and significantly, without visible side-effects.[40]

CONCLUSION

According to the clinical results of the articles examined in this study, PBMT can be effective in improving symptoms or in the complete treatment of oral diseases mentioned in this study. However, to have a more precise conclusion and to achieve an effective treatment protocol, it is necessary to conduct more longitudinal and randomized clinical studies.

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