Short communications | Journal of Emergency Medicine: Open Access

Photobiomodulation as a potential therapeutic strategy in COVID-19 management

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Submitted: 2023, Aug 01; **Accepted**:2023, Aug 19: **Published**: 2023, Sep 15

Citation: Su, C. T., (2023). Photobiomodulation as a potential therapeutic strategy in COVID-19 management *J Emerg Med OA, 1*(1) 63-66.

Abstract

The current outbreak of coronavirus disease 2019 (COVID-19) constitutes a global emergency. While numerous medications are employed in the treatment of COVID-19 patients, they may elicit a range of adverse effects. Photobiomodulation therapy (PBMT) is advocated for its noninvasive, painless, and secure biostimulative properties. Notably, recent findings indicate that PBMT has demonstrated promising clinical outcomes in COVID-19 patients. Those who received PBMT exhibited swift recovery with no discernible side effects during the clinical study. PBMT exhibits significant potential for anti-inflammatory and immunomodulatory effects, and these mechanisms are elucidated in this study. The present work suggests that PBMT holds tremendous potential for application in at-home patient care. Furthermore, PBMT can serve as an alternative and complementary therapy within the realm of clinical research practices.

Keywords: Covid-19, Photobiomodulation, Biostimulation, Anti-Inflammatory, Immunomodulatory

1. Introduction

Coronavirus disease 2019 (COVID-19) is caused by the rapidly spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a global emergency due to its potential to induce severe acute respiratory distress syndrome and fatality. Numerous therapeutic drugs have been considered for COVID-19 treatment, including Remdesivir, Lopinavir-Ritonavir, Hydroxychloroquine, Chloroquine, Oseltamivir, Azithromycin, Corticosteroids, Nitric Oxide (NO), Nonsteroidal anti-inflammatory drugs, angiotensin-converting enzyme inhibitors, and angiotensin receptor blockers [1, 2]. However, the safety and efficacy of these drugs in treating COVID-19 patients remain contentious. One promising investigational treatment is photobiomodulation therapy (PBMT). PBMT is a light-based therapy that utilizes low-intensity laser or light-emitting diode radiation on targeted tissues, modulates various cellular functions, encompassing metabolic effects [3], anti-inflammatory responses [4, 5], and immunomodulation [6].

PBMT has garnered interest for its immunomodulatory and substantial anti-inflammatory properties. Skobelkin et al. demonstrated heightened immunoglobulin activity (IgA, IgM, and IgG) in 60 oncologic patients following the application of He-Ne laser (632.8 nm) and 890 nm laser to the tumor area or lymph nodes [6]. Omi et al. indicated that 585 nm laser could enhance the activity of both T helper 1 and T helper 2 in adult skin [7]. Moreover, 904 nm laser radiation was found to increase the diameter of blood vessels (veins, arteries, and lymphatics) [8]. Experimental models and clinical trials have substantiated PBMT's capacity to modulate the immune system and lymphatic vessels [6, 7].

Sakurai et al. demonstrated that 830 nm laser radiation can decrease the production of prostaglandin E2 (PGE2) and mRNA levels of cyclooxygenase-2 (COX-2) induced by lipopolysaccharide in human gingival fibroblasts [9]. Oliveira et al. reported a significant reduction in interleukin-1β (IL-1β), IL-6, IL-8, keratinocyte-derived chemokine, and tumor necrosis factor alpha (TNF-α) levels in bronchoalveolar lavage fluid and serum following 830 nm laser radiation [10]. Additionally, the upregulation of heat-shock proteins (HSP) 70 and HSP90, known to promote proinflammatory cytokines IL-6 and TNF-α, was investigated [11]. The mechanisms of HSP may elucidate PBMT's action, including the inhibition of genetic expression of proinflammatory cytokines [12]. More recently, Nejatifard et al. summarized that PBMT could significantly reduce pulmonary edema, neutrophil influx, intracellular adhesion molecule levels, and macrophage inflammatory protein 2 (MIP-2) levels [13]. Therefore, PBMT holds immense potential for physiological modulation.

Recent studies have suggested that PBMT may be used as an adjuvant or alternative therapy in COVID-19 patients [14, 15]. A 57-year-old male with severe COVID-19 received PBMT, resulting

in a reduction of ground-glass opacities [14]. Additionally, PBMT was administered to COVID-19 pneumonia cases, leading to rapid recovery with no reported long-term sequelae, even after 5 months [15]. These findings demonstrate the long-term efficacy of PBMT in physiological modulation for patients. Optimal wavelengths and doses of PBMT have been shown to enhance cellular functions, including the activation of anti-inflammatory factors [4, 5], immunoglobulins [6], growth factors [16], and interleukins [4, 7, 10]. Sherafat suggested that PBMT has the potential to reduce viral load in COVID-19 patients and control the inflammatory response [17]. Mokmeli and Vetrici emphasized that the total cost of a laser device is cheaper than that of IL-6 antagonist injections for COVID-19 treatment [18]. Therefore, PBMT is a suitable complementary and alternative method within the COVID-19 treatment protocol. Recently, long-term health maintenance using PBMT was applied to a lung adenocarcinoma patient (stage IVa) at home [19], who has been undergoing PBM on lung meridian for nearly 3 years (32 months) without experiencing any side effects. According to the Arndt-Schulz Law, a moderate dose of PBM can activate cellular functions, while high energy densities can inhibit cellular functions due to the dose-dependent relationship and biological response [20]. The biphasic dose response of PBM has been observed in experimental models. However, it cannot be directly concluded that high dose accumulation occurs in the human body for patients receiving long-term PBM radiation (e.g., once or twice a day). We suggest that health maintenance can be achieved by applying PBMT daily or on weekends, even for COVID-19 patients. PBMT has great potential to be used in patients directed at home.

Determining the optimal PBM dose in specific tissues is a crucial issue. The dose for the 830 nm laser has been established, allowing it to penetrate approximately 1 cm of the orbicularis oris [21]. These results can be applied to deeper acupoint applications. Moreover, the optimal dose of 830 nm laser in the orbicularis oris can be achieved by adjusting the focal point of the lens [22]. Nevertheless, individual variations, including tissue thickness, skin color, body mass index, age groups, and lifestyles, can influence optical characteristics. Additionally, the skin's barrier function should be considered, as different skin conditions can affect light propagation and dose determination. Further research is needed to explore the skin's barrier function and individual differences regarding PBMT. Furthermore, designing suitable light sources for at-home patient use should consider potential infection risks in immunocompromised patients [23].

The potential mechanisms of PBM are summarized in Figure 1, along with the radiation areas (nasal cavity, throat, lung area, and armpit) applicable to COVID-19 patients. This method could be integrated into preventive medicine practices. While PBMT evidence has shed light on these effects, further studies are warranted to elucidate the molecular mechanisms involved.

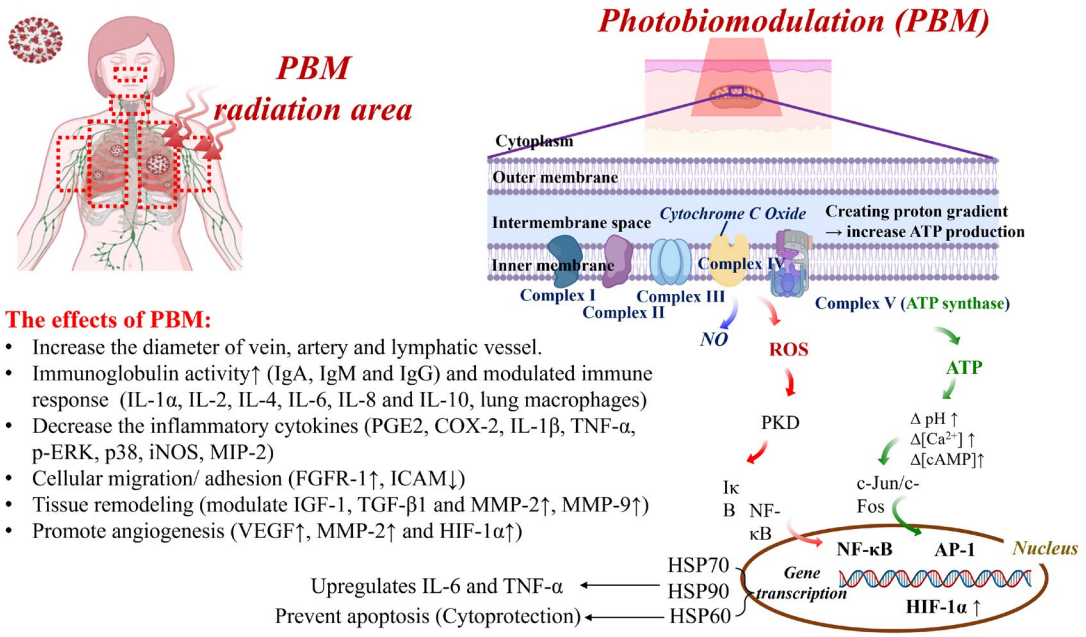

Figure 1: The mechanisms of PBM and the radiation area applications (p-ERK and p38: Expression of mitogen-activated protein kinases; iNOS: inducible nitric oxide synthase; FGFR-1: Fibroblast growth factor receptor 1; IGF-1: Insulin-like growth factor 1; TGF-β1: Transforming growth factor beta; MMP-2 and MMP-9: Matrix metalloproteinase-2; VEGF: Vascular endothelial growth factor; HIF-1α: Hypoxia-inducible factor 1-alpha; ROS: Reactive oxygen species; ATP: Adenosine triphosphate; PKD: Protein kinase D; IκB: I kappa B; NF-κB: Nuclear factor kappa B; cAMP: Cyclic adenosine monophosphate; c-Jun: a protein that in humans is encoded by the JUN gene; c-Fos: a proto-oncogene that is the human homolog of the retroviral oncogene v-fos; AP-1: Activator protein 1). Schematics were created with BioRender.com.

Conflict of interest Statement: The author declares that they have no conflict of interest.

Funding Sources: This research received no external funding.

Author Contributions: Conceptualization, investigation, review, writing and editing were performed by Chuan-Tsung Su.

Data Availability Statement: Data used to support the findings of this study are included in the article.

Reference

1. Salian VS, Wright JA, Vedell PT, et al. COVID-19 transmission, current treatment, and future therapeutic strategies. Mol Pharm 2021;18:754–771.
2. Wu R, Wang L, Kuo HCD, et al. An update on current therapeutic drugs treating COVID-19. Curr Pharmacol Rep 2020;6:56–70.
3. Bicknell B, Liebert A, Johnstone D, et al. Photobiomodulation of the microbiome: implications for metabolic and inflammatory diseases. Lasers Med Sci 2019;34:317–327.
4. da Cunha Moraes G, Vitoretti LB, de Brito AA, et al. Low-level laser therapy reduces lung inflammation in an experimental model of chronic obstructive pulmonary disease involving P2X7 receptor. Oxid Med Cell Longev 2018;2018:1–8.
5. Zeng YJ, Lin YH, Wang YC, et al. Laser acupuncture-induced analgesic effect and molecular alterations in an incision pain model: a comparison with electroacupuncture-induced effects. Lasers Med Sci 2018;33:295–304.
6. Skobelkin OK, Michailov VA, Zakharov SD. Preoperative activation of the immune system by low reactive level laser therapy (LLLT) in oncologic patients: a preliminary report. Laser Ther 1991; 3:169–175.
7. Omi T, Kawana S, Sato S, et al. Cutaneous immunological activation elicited by a low-fluence pulsed dye laser. Br J Dermatol 2005;153:57–62.
8. Convissar RA. Principles and practice of laser dentistry, 2nd ed.; Mosby Elsevier: Saint Louis, MO, USA, 2015.
9. Sakurai Y, Yamaguchi M, Abiko Y. Inhibitory effect of low-level laser irradiation on LPS-stimulated prostaglandin E2 production and cyclooxygenase-2 in human gingival fibroblasts. Eur J Oral Sci 2000;108:29–34.
10. Oliveira Jr MC, Greiffo FR, Rigonato-Oliveira NC, et al. Low level laser therapy reduces acute lung inflammation in a model of pulmonary and extrapulmonary LPS-induced ARDS. J Photochem Photobiol B Biol 2014;134:57–63.
11. Kakimura JI, Kitamura Y, Takata K, et al. Microglial activation and amyloid-β clearance induced by exogenous heat-shock proteins. FASEB J 2002;16:601–603.
12. De Filippis A, Perfetto B, Guerrera LP, et al. Q-switched 1064 nm Nd-Yag nanosecond laser effects on skin barrier function and on molecular rejuvenation markers in keratinocyte-fibroblasts interaction. Lasers Med Sci 2019;34:595–605.
13. Nejatifard M, Asefi S, Jamali R, et al. Probable positive effects of the photobiomodulation as an adjunctive treatment in COVID-19: A systematic review. Cytokine 2021;137:1–9.
14. Sigman SA, Mokmeli S, Monici M, et al. A 57-year-old African American man with severe COVID-19 pneumonia who responded to supportive photobiomodulation therapy (PBMT): first use of PBMT in COVID-19. Am J Case Rep 2020;21:e926779-1–e926779-7.
15. Vetrici MA, Mokmeli S, Bohm AR, et al. Evaluation of adjunctive photobiomodulation (PBMT) for COVID-19 pneumonia via clinical status and pulmonary severity indices in a preliminary trial. J Inflamm Res 2021;14:965–979.
16. Luo L, Sun Z, Zhang L, et al. Effects of low-level laser therapy on ROS homeostasis and expression of IGF-1 and TGF-β1 in skeletal muscle during the repair process. Lasers Med Sci 2013; 28:725–734.
17. Sherafat SJ, Mokmeli S, Rostami-Nejad M, et al. The Effectiveness of Photobiomudulation Therapy (PBMT) in COVID-19 Infection. J Lasers Med Sci 2020;11:S23–S29.
18. Mokmeli S, Vetrici M. Low level laser therapy as a modality to attenuate cytokine storm at multiple levels, enhance recovery, and reduce the use of ventilators in COVID-19. Can J Respir Ther 2020;56:25–31.
19. Su CT, Wu JH. Management of combined therapy (Ceritinib, A. cinnamomea, G. lucidum, and Photobiomodulation) in advanced non-small-cell lung cancer: a case report. Life 2022;12:1–8.
20. Huang YY, Chen ACH, Carroll JD, et al. Biphasic dose response in low level light therapy. Dose-Response 2009;7:358–383.
21. Su CT, Chen CM, Chen CC, et al. Dose analysis of photobiomodulation therapy in stomatology. Evid Based Complement Alternat Med 2020;2020:1–12.
22. Su CT, Chiu FC, Ma SH, et al. Optimization of photobiomodulation dose in biological tissue by adjusting the focal point of lens. Photonics 2022;9:1–10.
23. Fornaini C, Merigo E, Huffer KW, et al. At-home photobiomodulation treatments for supportive cancer care during the COVID-19 pandemic. Photobiomodulation Photomed Laser Surg 2021;39:81–82.