Hindawi
Oxidative Medicine and Cellular Longevity
Volume 2023, Article ID 9817831, 2 pages
https://doi.org/10.1155/2023/9817831

Editorial

Insights into Photobiomodulation and Oxidative Stress: Physiological, Pathological, and Therapeutic Impact

Andrey J. Serra,[1] **Renato Araujo Prates**,[2] **Michael Hamblin**,[3] **and Stella Sousa Vieira**[1]

[1]*Federal University of São Paulo, São Paulo, Brazil*
[2]*Biophotonics Applied to Health Sciences Postgraduate Program of Nove de Julho University (UNINOVE), São Paulo, Brazil*
[3]*Harvard Medical School, Boston, USA*

Correspondence should be addressed to Andrey J. Serra; andreyserra@gmail.com

Received 27 February 2023; Accepted 27 February 2023; Published 16 May 2023

This special issue in Oxidative Medicine and Cellular Longevity journal has included studies that evaluated the repercussion of photobiomodulation (PBM) in oxidative stress in broad physiological and pathological settings. The articles included were addressed to examine the effects of PBM under experimental conditions and to explore the clinical PBM impact. Two review articles were published considering the role of PBM therapy as a new strategy to potentiate the actions of mesenchymal stem cells (MSCs) and to improve postinfarction cardiac remodeling.

The first study in this special issue was published by Rajendran et al. to investigate the PBM effects on viability, morphology, migration, and antioxidant enzymes in adipose-derived stem cells (ADSCs). Authors considered four ADSC models (i.e., normal, wounded, diabetic, and diabetic wounded) to examine the impact of the laser diode at 660 nm (fluence of 5 J/cm^2 and power density of 11.2 mW/cm^2) or 830 nm (fluence of 5 J/cm^2 and power density of 10.3 mW/cm^2). In vitro diabetic model was achieved by growing the ADSCs in media with an additional D-glucose. A "wound" model was created on the cell monolayer before cell irradiation by using a sterile 1 mL pipette. The laser was applied directly from above towards cells via fiber optic, and analyses were carried out on cells incubated 24 h postirradiation. Cell viability has been mainly affected by the wavelength of 660 nm. Interestingly, irradiated ADSCs had greater cell migration, completed wounds, and were with no nuclear fragmentation signal. Upon treatment with PBM at 660 or 830 nm, diabetic and diabetic wounded cell models had higher survival signal of AKT and lower oxidative stress. These findings were accompanied by a higher content of antioxidant enzymes. Then, the researchers concluded the PBM can activate AKT signaling in ADSCs to promote wound healing under hyperglycemic conditions because of maintaining normal redox balance.

Shaikh-Kader et al. evaluated the effect of PBM (wavelength: 660 nm; energy density: 5 J/cm^2) on levels of cox-2, IL-6, and TNF-α in fibroblast cell culture models. Researches have used a similar method to the study above in fibroblast culture (normal, normal density, wounded, diabetic, and diabetic wounded) treated with PBM (wavelength: 660 nm; energy: 5 J/cm^2). The PBM has increased fibroblast proliferation and accelerated wound closure as well as increased cell viability in the diabetic wounded group at 0 and 24 h postirradiation. Moreover, cox-2, IL-6, and TNF-α were altered in PBM-treated fibroblasts as a time-dependent effect. Finally, these findings support the idea that PBM can alter the secretome of inflammatory mediators, which may be involved in cell viability and proliferation.

An in vitro study proposed by Amaroli et al. examined the effect of 980 nm diode laser light on mitochondrial activity. Working with bovine liver-isolated mitochondria irradiated in continuous wave mode, the authors documented that 0.1 W uncoupled the respiratory chain and induced higher oxidative stress and inhibition of ATP production. On the other hand, 0.8 W kept mitochondria coupled and increased ATP production by increments in complex III and IV activities. This finding was accompanied by an increase in oxidative stress that

was likely a consequence of the increased oxygen consumption and mitochondrial isolation protocol. Therefore, this study shows window effect of the laser light to improve ATP production and mitochondrial oxygen consumption.

An experimental study proposed by Zhang et al. was addressed to examine the role of melatonin in monochromatic light combination-induced bursa B-lymphocyte proliferation in chickens. Thus, chicks were exposed to monochromatic red, green, value or white lights, and several light combinations. The light upregulated the melatonin plasma level and antioxidant enzyme ability. Green plus blue light resulted in increased bursa follicle area, lymphocyte density, B-lymphocyte proliferation, PCNA-positive cells, and cyclin D1 expression. Findings from this study suggest that the combination of green and blue light-induced B-lymphocyte proliferation is modulated by melatonin in chickens by reducing oxidative stress and activating the Mel1a/PI3K/AKT and Mel1c/PKC/ERK pathways.

Another experimental study carried out by Zhang et al. examined whether PBM could affect glutamatergic dysfunction in mice with chronic unpredictable mild stress-induced depression. The PBM repercussion was evaluated in a chronic unpredictable mild stress and a depressive mouse model subcutaneously injected with corticosterone. In vitro experiments were performed to evaluate PBM neuronal action mechanisms. It has been reported that the PBM reduced extracellular glutamate content via upregulation of glutamate transporter-1 and rescued astrocyte loss in the cerebral cortex and hippocampus. The PBM also alleviated dendritic atrophy and upregulated the expression of α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptors on the postsynaptic membrane, ultimately exhibiting behaviorally significant antidepressant effects. In vitro findings based on the PBM properties on upregulation of glutamate transporter-1, Akt/NF-κB signaling pathway, and PKA activation. Therefore, this study shows that PBM may be a useful therapy for controlling the progression of depression.

There is considerable data showing a beneficial effect of PBM on physical performance. In a clinical trial included in this special issue, Pinto et al. applied PBM combined with a static magnetic field (PBMT-sMF) to assess recovery, physical performance, and biochemical and molecular changes in CrossFit® athletes. The PBMT-sMF was applied at different times, referring to the workout of the day. PBMT-sMF enhanced the performance on functional tests when applied before or after a workout. This procedure also resulted in less creatine kinase, catalase, and superoxide dismutase activities and interleukin 6, thiobarbituric acid, and carbonylated protein levels. Therefore, the major strength of this study was to show that the use of PBMT-sMF can be useful in increasing functional capacity and decreasing inflammatory, muscle damage, and oxidative stress biomarkers in CrossFit® athletes.

Two systematic reviews were published in this special issue of the journal. First, Mansano et al. clarified the progress of knowledge for the effects of the light-emitting diode on mesenchymal stem cells (MSCs). The reviewed studies showed clear actions of the light-emitting diode on cellular viability, differentiation, metabolism, proliferation, and secretion of growth factors. From a clinical perspective, evidence was found to suggest that a red light-emitting diode with radiant exposure up to 7.2 J/cm2 can be an effective method to boost MSC therapy. Second, Gao et al. reviewed studies examining the role of PBM in infarcted myocardium. The dataset showed that PBM therapy can promote ATP synthesis and angiogenesis, inhibit the inflammatory response, improve heart function, and reduce infarct size.

We hope that this special issue has been successful in providing new insights into the impact of PBM in the oxidative stress on several physiology and disorders conditions. Editors considered the interdisciplinary nature of the manuscripts to expand fundamental concepts, i.e., experimental and clinical researches as well review highlights.

Disclosure

The funding sources listed do not influence the selection of data presented in this editorial.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

Authors' Contributions

Andrey Jorge Serra and Stella de Sousa Vieira wrote the editorial; Renato de Araujo Prates and Michael Hamblin revised the editorial.

Acknowledgments

The guest editorial team would like to thank all authors of the contributed papers to this special issue. We are very grateful to the reviewers, who have spent their time, to assess the manuscripts. Andrey Jorge Serra is a research fellow from the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (no. 21/05084-4) and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (no. 306385/2020-1). Renato Prates thanks are due to CNPq (304003/2020-4).

Andrey J. Serra
Renato Araujo Prates
Michael Hamblin
Stella Sousa Vieira