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Photobiomodulation with 630 plus 810 nm wavelengths induce more in vitro cell viability of human adipose stem cells than human bone marrow-derived stem cells

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ABSTRACT

The goal of the current experiment is to explore the influence of combined and/or single applications of red and near infrared (NIR) photobiomodulation (PBM) at different wavelengths, energy densities and times on cell viability, population doubling time (PDT), and apoptosis of in vitro cultures of human bone marrow-derived mesenchymal stem cells (hBM-MSCs) and h adipose-derived stem cells (hASCs).

Both in vitro hBM-MSCs and hASCs were irradiated with 36 protocols using two different laser types (helium-neon [He-Ne] and diodes), four different laser wavelengths (He−Ne laser, 630 nm, 810 nm, 630 + 810 nm); three different energy densities (0.6 J/cm^2, 1.2 J/cm^2, 2.4 J/cm^2); and three different PBM times (1, 2, and 3).

One-way ANOVA analysis showed that PBM with the 630 nm red laser significantly stimulated cellular viability of both hBM-MSCs and hASCs. The 630 nm red laser significantly decreased PDT of hBM-MSCs. One-way ANOVA demonstrated that the 630 + 810 laser significantly stimulated cellular viability, and significantly decreased PDT and apoptosis of hBM-MSCs and hASCs. Two-way ANOVA analysis showed that PBM with the 630 nm red laser and 630 + 810 nm laser significantly stimulated cellular viability of hASCs compared to the control hASCs, and experimental and control hBM-MSCs.

Our study demonstrated that PBM with the combined 630 + 810 nm lasers significantly stimulated cell viability, and significantly decreased PDT and apoptosis of hBM-MSCs and hASCs in vitro. We reported new in vitro evidence where PBM administered at 630 nm (one and two times, 0.6 and 1.2 J/cm^2) and 630 + 810 nm (three times, 2.4 J/cm^2) significantly increased hASC cell viability compared to its control and the PBM-treated hBM-MSC groups.

1. Introduction

Under normal circumstances, repair of injured skin occurs without complications. However, in certain circumstances, chronic ulcers may develop and present both a threat to the patient and treatment challenge for the health care provider [1]. Chronic wounds (ulcers) result in an annual expenditure of more than $25 billion in the US. More than 6,500,000 patients have chronic ulcers due to the increasing prevalence of people diagnosed with diabetes mellitus (DM) each year in the US [2]. Chronic wounds attributed to diabetic foot ulcers (DFUs) are a routine clinical challenge in the US [3,4].

Adipose-derived stem cells (ASCs) are a general, useful agent in regenerative medicine [5]. Bone marrow-derived mesenchymal stem cells (BM-MSCs) were previously the most frequent source of MSCs. However, extraction of bone marrow is a painful, aggressive technique for patients. On the other hand, adipose tissue is the extra fat that can be extracted via noninvasive procedures [6].

Repair of injured skin requires synchronized interaction among cells, cytokines, and extracellular matrix (ECM) elements. Central to this course are endogenous MSCs, which organize the repair course by

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