Effect of Photobiomodulation Therapy on the Increase of Viability and Proliferation of Human Mesenchymal Stem Cells

Kamila Pasternak-Mnich,[1]* Barbara Ziemba,[2] Aleksandra Szwed,[3] Karolina Kopacz,[4] Marek Synder,[5] Maria Bryszewska,[3] and Jolanta Kujawa[1]

[1]*Department of Medical Rehabilitation, Faculty of Health Sciences, Medical University of Lodz, 251 Pomorska St., 92-213, Lodz, Poland*

[2]*Department of Clinical Genetic, Medical University of Lodz, 251 Pomorska St., 92-213, Lodz, Poland*

[3]*Department of General Biophysics, University of Lodz, 141/143 Pomorska St., 90-236, Lodz, Poland*

[4]*"DynamoLab" Academic Laboratory of Movement and Human Physical Performance, Medical University of Lodz, 251 Pomorska St., 92-213, Lodz, Poland*

[5]*Medical Faculty, Clinic of Orthopedics and Pediatric Orthopedics, Medical University of Lodz, 251 Pomorska St., 92-213, Lodz, Poland*

Background and Objectives: We have investigated how low intensity laser irradiation emitted by a multiwavelocked system (MLS M1) affects the viability and proliferation of human bone marrow mesenchymal stem cells (MSCs) depending on the parameters of the irradiation.

Study Design/Materials and Methods: Cells isolated surgically from the femoral bone during surgery were identified by flow cytometry and cell differentiation assays. For irradiation, two wavelengths (808 and 905 nm) with the following parameters were used: power density 195, 230, and 318 mW/cm^2, doses of energy 3, 10, and 20 J (energy density 0.93–6.27 J/cm^2), and in continuous (CW) or pulsed emission (PE) (frequencies 1,000 and 2,000 Hz).

Results: There were statistically significant increases of cell viability and proliferation after irradiation at 3 J (CW; 1,000 Hz), 10 J (1,000 Hz), and 20 J (2,000 Hz).

Conclusions: Irradiation with the MLS M1 system can be used in vitro to modulate MSCs in preparation for therapeutic applications. This will assist in designing further studies to optimize the radiation parameters and elucidate the molecular mechanisms of action of the radiation. Lasers Surg. Med.

Key words: differentiation; mesenchymal stem cells; MLS M1 system; photobiomodulation therapy (PBMT); proliferation; viability

INTRODUCTION

Adult stem cells were discovered during the 1960s. Mesenchymal stem cells (MSCs) are self-renewing, multipotent, and non-hematopoietic adult cells that can differentiate into different types of tissues. Sources of MSCs include the bone marrow, adipose tissue, brain, endometrium, articular cartilage, peripheral blood, menstrual blood, synovial fluid, skin and foreskin, permanent dental pulp, full placenta, fetal membrane, subamniotic umbilical cord lining membrane, amniotic membrane, amniotic fluid, and the annulus fibrosus and nucleus pulposus of the intervertebral disc [1–5]. Under the influence of different factors, MSCs can differentiate into osteoblasts, chondrocytes, white and brown adipocyte cells, and myoblasts. MSCs can secrete factors that induce cell proliferation, their paracrine mechanisms leading to natural repair processes and immunomodulation [6–12]. They can also reverse apoptosis and cell damage (cardiomyoblasts, neurons, and lung fibroblasts) [1,13]. They can migrate and cross the blood-brain barrier [1].

They can differentiate into neurons, glial and endothelial cells, their differentiation has been regulated at the transcriptional and post-transcriptional levels by molecular signals from the extracellular environment [13]. Differentiation capacity depends on the molecular and functional characteristics of the stem cells as well as on the gender and the donor's age [14]. Human bone marrow MSC's from healthy donors maintain their properties for only the first 4 passages [15]. Levels of their specific markers decrease significantly with successive passages, their metabolism becomes compromised, the cells thereby losing their growth capacity and migration potential. Glucose consumption decreases and becomes more anaerobic [15]. MSCs can migrate from the bone marrow or peripheral blood to injured tissue due to metalloproteinases, proteolytic enzymes that allow them to traverse the

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*Correspondence to: Kamila Pasternak-Mnich, Clinic of Medical Rehabilitation, Medical University of Lodz, 251 Pomorska St., 92-213 Lodz, Poland.
E-mail: kamila.pasternak@umed.lodz.pl

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