Photobiomodulation (PBM) / Low Level laser Therapy (LLLT)

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Notes: A selection of papers demonstrating positive impact of PBM on Stem Cells, with important application in regenerative medicine

Adjunctive laser-stimulated stem-cells therapy to primary reperfusion in acute myocardial infarction in humans: Safety and feasibility study.

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BACKGROUND: Low-level laser therapy (LLLT) has photobiostimulatory effects on stem cells and may offer cardioprotection. This cell-based therapy may compliment primary percutaneous coronary intervention (PPCI) in patients with ST-segment elevation myocardial infarction (STEMI). OBJECTIVE: In this randomized control trial, our primary objective was to determine the safety and feasibility of LLLT application to the bone marrow in patients with STEMI undergoing PPCI. METHODS: We randomly assigned patients undergoing PPCI to LLLT or non-laser therapy (NLT). In the LLLT group, 100 s of laser therapy was applied to the tibia bone prior to PPCI, as well as 24 and 72 h post-PPCI. In the control group, the power source was turned off. The primary outcome was the difference in door-to-balloon (D2B) time, and additional outcomes included differences in circulating cell counts, cardiac enzymes, and left-ventricular ejection fraction (LVEF) at pre-specified intervals post-PPCI. RESULTS: Twenty-four patients were randomized to LLLT (N = 12) or NLT (N = 12). No adverse effects of the treatment were detected. The D2B time was not significantly different between the groups (41 ± 8 vs 48 ± 1 min; P = 0.73). Creatinine Phosphokinase area under the curve, was lower after LLLT (22 ± 10) compared to NLT (49 ± 12), but this was not statistically significant (P = 0.08). Troponin-T was significantly lower after LLLT (2.7 ± 1.4 ng/mL) in comparison to NLT (5.2 ± 1.8 ng/mL. P < 0.05). At 9 months, LVEF improved in both groups without a significant difference between LLLT (55 ± 9%) and NLT (52 ± 9%; P = 0.90). CONCLUSION: LLLT is a safe and feasible adjunctive cell-based therapy to PPCI that may benefit ischemic myocardium.

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Photobiomodulation Therapy Promotes Expansion of Epithelial Colony Forming Units.

Khan I, Arany PR

OBJECTIVE: This preliminary study examines the effects of low-dose light therapy, also called Photobiomodulation (PBM) therapy, on epithelial colony forming units (eCFUs) in epithelial cells from skin and mucosa to assess their potential to contribute to tissue regeneration. Also, preliminary comparison of basic PBM parameters such as wavelengths, light sources, and dose were evaluated in promoting eCFUs. BACKGROUND DATA: Regenerative medicine is at the brink of exploiting the tremendous potential offered by advances in stem cell biology. The two distinct aspects for utilization of stem cells, either resident (endogenous) or transplanted (exogenous), rely on cells amenable to expansion and being directed toward mature, functional tissues. Despite major progress in fundamental understanding of stem cell pluripotency, there remain fundamental challenges in applying these insights into clinical practice. METHODS: PBM treatments with various devices, wavelengths, and doses were used on two epithelial cell lines and colony forming assays were performed. RESULTS: This study noted a dose-dependent effect of 810nm laser on increasing eCFUs, either in terms of size or numbers. Comparisons of different wavelengths and light sources noted better efficacy of collimated and coherent lasers compared to LEDs and broad-band light. CONCLUSIONS: PBM therapy promotes expansion of eCFUs that represent progenitors and stem cell populations capable of contributing to tissue repair and regeneration. Further exploration of the precise mechanisms would allow optimization of PBM clinical protocols to harness the regenerative potential of stem cells for wound healing and other clinical regenerative applications.

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Hypoxia and laser enhance expression of SDF-1 in muscles cells.

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Targeted homing of transplanted mesenchymal stem cells (MSCs) is a decades old discussion in regenerative medicine. It has been proved that stromal cell-derived factor-1 (SDF-1alpha) is a potent chemoattractant of MSCs. Therefore, different strategies have been used to increase secretion of SDF-1alpha in damaged tissues to elevate targeted homing of MSCs. Previous studies have revealed that increased SDF-1alpha expression in hypoxic necrotic tissues and also low-level laser exposure enhanced angiogenesis in injured tissues. Herein, human skeletal and cardiac muscle cells (HSKM and HCM) were treated with hypoxia and low level laser to see their effects on expression of SDF-1alpha and on MSCs migration towards these treated cells. The optimal treatment conditions were determined by investigating the cellular viability after treatment. Real-Time PCR and Western blot analysis were done to study the expression of SDF-1alpha in treated cells. Migration potential of MSCs toward hypoxic and laser treated cells was investigated via migration assay. MTT assay revealed that laser and hypoxia treatment had no effect on the viability of HCM, HSKM compared with Glioblastoma cells. Real-Time PCR showed 16- and 90-fold elevation in mRNA of SDF-1alpha in HSKM and HCM cells, respectively, in laser treated with 12 J/cm2 intensity. In these two groups, selected as optimal conditions, HIF-1alpha expression showed maximum fold changes that might be partly because of response to treatments help to SDF-1alpha expression. It can be concluded that hypoxia and laser treatments may recruit MSCs and applied as a useful strategy for the further targeted stem cell homing.

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Effect of low-level laser irradiation on proliferation and viability of human dental pulp stem cells.

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A positive effect of low-level laser irradiation (LLLI) on the proliferation of some cell types has been observed, but little is known about its effect on dental pulp stem cells (DPSCs). The aim of this study was to identify the lowest energy density able to promote the proliferation of DPSCs and to maintain cell viability. Human DPSCs were isolated from two healthy third molars. In the third passage, the cells were irradiated or not (control) with an InGaAlP diode laser at 0 and 48 h using two different energy densities (0.5 and 1.0 J/cm(2)). Cell proliferation and viability and mitochondrial activity were evaluated at intervals of 24, 48, 72, and 96 h after the first laser application. Apoptosis- and cell cycle-related events were analyzed by flow cytometry. The group irradiated with an energy density of 1.0 J/cm(2) exhibited an increase of cell proliferation, with a statistically significant difference ($p < 0.05$) compared to the control group at 72 and 96 h. No significant changes in cell viability were observed throughout the experiment. The distribution of cells in the cell cycle phases was consistent with proliferating cells in all three groups. We concluded that LLLI, particularly a dose of 1.0 J/cm(2), contributed to the growth of DPSCs and maintenance of its viability. This fact indicates this therapy to be an important future tool for tissue engineering and regenerative medicine involving stem cells.

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Low-Power Laser Irradiation Suppresses Inflammatory Response of Human Adipose-Derived Stem Cells by Modulating Intracellular Cyclic AMP Level and NF-kappaB Activity.

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Mesenchymal stem cell (MSC)-based tissue regeneration is a promising therapeutic strategy for treating damaged tissues. However, the inflammatory microenvironment that exists at a local injury site might restrict reconstruction. Low-power laser irradiation (LPLI) has been widely applied to retard the inflammatory reaction. The purpose of this study was to investigate the anti-inflammatory effect of LPLI on human adipose-derived stem cells (hADSCs) in an inflammatory environment. We showed that the hADSCs expressed Toll-like Receptors (TLR) 1, TLR2, TLR3, TLR4, and TLR6 and that lipopolysaccharide (LPS) significantly induced the production of pro-inflammatory cytokines (Cyclooxygenase-2 (Cox-2), Interleukin-1beta (IL-1beta), Interleukin-6 (IL-6), and Interleukin-8 (IL-8)). LPLI markedly inhibited LPS-induced, pro-inflammatory cytokine expression at an optimal dose of 8 J/cm(2). The inhibitory effect triggered by LPLI might occur through an increase in the intracellular level of cyclic AMP (cAMP), which acts to down-regulate nuclear factor kappa B (NF-kappaB) transcriptional activity. These data collectively provide insight for further investigations of the potential application of anti-inflammatory treatment followed by stem cell therapy.

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