Heidi Abrahamse, Biomed Res, Volume 30
DOI: 10.4066/biomedicalresearch-C1-025

Heidi Abrahamse

University of Johannesburg, South Africa

Potential use of photobiomodulation in stem cell therapy

Regenerative medicine and tissue engineering (TE), combines key elements such as biomaterials, stem cells and bioactive agents (e.g. growth factors), in parallel with recent biotechnological advances. A constant and reliable source of autologous stem cells with pluripotent potential and readily available will be required for these future cell-based. Bone marrow stem cells (BMSCs) have been extensively studied but clinical application of these cells has presented problems including low cell number upon harvest, pain and morbidity to the donor. Adipose tissue is derived from the mesenchyme and contains an easily isolated supportive stroma containing stem cells, microvascular endothelial cells and smooth muscle cells. Adipose derived stem cells (ADSCs) isolated from adipose tissue are isolated with ease and in large amounts. Stem cells have two major characteristics of self-renewal and differentiation into one or more types of specialized cells. These cells are now being used to treat several degenerative diseases due to their ability to differentiate into different cell types. Photobiomodulation (PBM) or low intensity laser irradiation (LILI) can positively affect human ADSCs by increasing cellular proliferation, viability and protein expression. These characteristics improves their potential in TE applications as the initial cell number could be increased before commencing differentiation leading to a higher yield of differentiated cells. Photobiomodulation at different intensities has been shown to inhibit as well as stimulate cellular processes. Studies on photobiomodulation and stem cells have shown that low-level lasers increase adenosine triphosphate (ATP) production and migration. Photobiomodulation also promote the proliferation of rat mesenchymal bone marrow and cardiac stem cells *in vitro* and can thus be used to stimulate the *in vitro* production of higher stem cell numbers. The addition of specific growth factors could enhance the differentiation of the stem cells into different cell types that could, in turn, be used in TE applications and reconstructive surgery. However, to be effective for use in TE, certain criteria need to be met including that the cells of interest must be at high concentrations, harvested easily and be multipotent while being able to differentiate into the required tissue and then transplanted safely and effectively back into a host. The potential augmentation of low intensity laser irradiation on ADSCs to differentiate into smooth muscle cells (SMCs) with the view of using as therapeutic modality in regenerative medicine has been the key focus of our research. The effect of different wavelengths of irradiation, as well as different fluences were used to identify laser parameters affecting viability and proliferation of ADSCs. Throughout the project, suitably recognized stem cell markers were used to characterize and confirm stem cells as well as potential differentiation. In addition, dose responses were performed to determine suitable growth factors and concentrations that would induce differentiation. Our results confirm that laser irradiation induce increased viability and proliferation as well as improve the differentiation potential of ADSCs. Methodology used include, ATP content and optical density, flow cytometry, fluorescence microscopy and real-time quantitative polymerase chain reaction RT- qPCR profiles. This further highlights the significant role that LILI has to offer in the use of ADSC therapy in regenerative medicine.

Speaker Biography

Heidi Abrahamse is currently the director of the laser research centre, University of Johannesburg and Department of Science and Technology/National Research Foundation SARChI chair for laser applications in health. Her research interests include photobiology and photochemistry with specific reference to photodynamic cancer therapy, stem cell differentiation and wound healing. She has supervised 40 masters; 15 doctorates and 12 post-doctorate fellows and has published over 150 peer reviewed accredited journal publications, 42 accredited full paper proceedings and 11 chapters. She serves on the editorial boards of 8 peer-reviewed internationally accredited journals while acting as reviewer for over 30 journals. She is also the co-editor in chief of the international accredited journal photomedicine and laser surgery.

e: habrahamse@uj.ac.za

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