Photomedicine and Laser Surgery
Volume 34, Number 11, 2016

Pp. 509–515
DOI: 10.1089/pho.2015.3978

Differentiation Potential of Adipose-Derived Stem Cells When Cocultured with Smooth Muscle Cells, and the Role of Low-Intensity Laser Irradiation

Bernard Mvula, MTech, and Heidi Abrahamse, PhD

Abstract

Objective: The aim of the study was to investigate the differentiation potential of adipose-derived stem cells (ADSCs) when cocultured with smooth muscle cells (SMCs), and to determine the role of low-intensity laser irradiation (LILI). ***Background data:*** ADSCs isolated from adipose tissue are isolated with ease and in large amounts. SMCs constitute most parts of the intestinal, urinary, reproductive, and cardiovascular systems. LILI has been found to have positive effects on different cell types, including ADSCs. ***Methods:*** The study used ADSCs (Stempro Adipose Derived Stem Cells-R7788-115) and SMCs (SKU-T-1 American Type Culture Collection HTB-114) cell lines. These cell lines were cocultured in a 1:1 ratio with and without growth factors and then exposed to LILI using 636 nm at 5 J/cm^2. ***Results:*** Cell viability and proliferation increased significantly in the cocultured groups that were exposed to LILI alone, as well as in combination with growth factors. Further, there was a significant decrease in the expression of stem cell markers with a concomitant increase in SMC markers. ***Conclusions:*** These results suggest that ADSCs have the ability to differentiate into SMCs when cocultured with SMCs, whereas LILI potentially augments the differentiation potential and need. This further highlights the significant role that LILI has to offer ADSC therapy in regenerative medicine.

Keywords: photobiology, photobiomodulation, photochemistry, phototherapy, stem cells

Introduction

ADIPOSE-DERIVED STEM CELLS (ADSCs) are mesenchymal stem cells that have been isolated from adipose tissue in large amounts, and are able to self-renew and differentiate into one or more specialized cells.[1,2] ADSCs have a doubling time of 2–4 days, depending upon the culture medium and passage number.[3] Stem cells reside in a niche, and there are several factors that regulate their characteristics. Some of these characteristics include cell interactions, interactions between themselves and other cells, and interactions between stem cells and the extracellular matrix.[4] Stem cells play important roles in regenerative medicine. Scientists have postulated that stem cells could play such roles through paracrine pathways by secreting cytokines and growth factors.[5,6] ADSCs are able to stimulate the stem cell niche to produce stem cells that could be differentiated into the required cells. The ADSCs could also produce antioxidants, free radical scavengers, and heat shock proteins to the ischemic area, thereby recovering the damaged cells. Mitochondria could also be delivered to the damaged cells,[7] and, finally, the ADSCs could differentiate into the required lineage.[5]

Studies have shown that mesenchymal stem cells can differentiate into smooth muscle cells (SMCs).[8] These cells are part of the cardiovascular, intestinal, urinary, and reproductive systems of the body, and, therefore, are important in controlling diseases affecting these organs.[9,10] These cells play important roles in angiogenesis and vasculogenesis during embryonic development.[9] ADSCs have been differentiated into cardiomyocytes in a cardiac microenvironment when cocultured directly or indirectly with cardiomyocytes.[11]

''Laser'' is an acronym of light amplification by stimulated emission of radiation. It is monochromatic, coherent, and directional. Low-intensity laser irradiation (LILI) is a form of phototherapy that involves application of monochromatic light in the range of 630–905 nm wavelengths.[12] It has had stimulatory effects on many cells, including ADSCs. It has been shown to increase viability and proliferation of ADSCs.[13] Studies on LILI and stem cells have shown that LILI can change the metabolism of stem cells and increase adenosine triphosphate (ATP) production, and, therefore, increase migration of the cells.[14] It has also been found to accelerate wound healing as well as promoting angiogenesis.[15,16] Therefore, LILI may play an auxiliary

Laser Research Centre, Faculty of Health Sciences, University of Johannesburg, Johannesburg, South Africa.