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# Effect of Photobiomodulation on Mesenchymal Stem Cells

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## Abstract

***Objective:*** The purpose of this study was to review available literature about the effect of photobiomodulation (PBM) on mesenchymal stem cells (MSCs). ***Background data:*** The effects of coherent and noncoherent light sources such as low-level lasers and light-emitting diodes (LEDs) on cells and tissues, known as PBM, form the basis of photomedicine. This treatment technique effects cell function, proliferation, and migration, and plays an important role in tissue regeneration. Stem cells have been found to be helpful elements in tissue regeneration, and the combination of stem cell therapy and laser therapy appears to positively affect treatment results. ***Materials and methods:*** An electronic search in PubMed was conducted of publications from the previous 12 years. English language articles related to the subject were found using selected key words. The full texts of potentially suitable articles were assessed according to inclusion and exclusion criteria. ***Results:*** After evaluation, 30 articles were deemed relevant according to the inclusion criteria. The energy density of the laser was 0.7–9 J/cm$^2$. The power used for visible light was 30–110 mW and that used for infrared light was 50–800 mW. Nearly all studies showed that low-level laser therapy had a positive effect on cell proliferation. Similar outcomes were found for LED; however, some studies suggest that the laser alone is not effective, and should be used as an adjunct tool. ***Conclusions:*** PBM has positive effects on MSCs. This review concluded that doses of 0.7–4 J/cm$^2$ and wavelengths of 600–700 nm are appropriate for light therapy. The results were dependent upon different parameters; therefore, optimization of parameters used in light therapy to obtain favorable results is required to provide more accurate comparison.

**Keywords:** light-emitting diode (LED) lasers, low-level laser therapy, photobiomodulation, photochemotherapy, semiconductor

## Introduction

Human organ tissue can be lost from injury, congenital defect, or disease.[1] Impaired tissue should be replaced by normal healing or by autograft, xenograft, or allograft, depending upon the defect size. Healing can be facilitated using guided tissue engineering approaches. These approaches are useful when the defect size is relatively small, because they persuade cells to migrate from surrounding host tissue to prepared scaffolds. This procedure can be influenced by the availability of a proper cell source, distance required for cell migration from surrounding host tissue (depending upon the size of the defect), cell response to migration, blood supply for cell nutrition, and growth factors.

When there is a large defect or impaired cell supply, cell transplantation, which requires progenitor cell sources, is needed, and cell expansion must provide a sufficient number of cells. Autologous cells from the host can be used; however, there are limitations on donor sites and the extended time required for cell expansion. Allogeneic or xenogeneic cells are not limited in quantity or expansion time; however, an immunological response should be expected, because of the differing genetic content and matching human leukocyte antigens (HLAs).[1–3]

Another method is new tissue engineering. Three requisites can be used to regenerate tissue in this manner. First, a scaffolding is required to support cells seeded *in vitro*. The architecture of the scaffold should be effective for cell response and tissue formation.[4] Second is the use of growth factors (GF) delivered through the scaffold as a drug delivery system to encourage cells for engineering tissues. The third approach is the use of cell sources. Primary cells are used for tissue regeneration. This process focuses on three types of stem cells, depending upon on the cell origin and experimental manipulation: embryonic stem cells (ESC), adult stem cells derived from embryos and adult tissue, and induced pluripotent stem cells (iPSC) derived from adult somatic cells by genetic manipulation. ESC and iPSC are pluripotent stem

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