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Lasers Med Sci. 2016 May;31(4):767-77. doi: 10.1007/s10103-016-1923-x. Epub 2016 Mar 17.

Photobiomodulation on human annulus fibrosus cells during the intervertebral disk degeneration: extracellular matrix-modifying enzymes.

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Abstract

Destruction of extracellular matrix (ECM) leads to degeneration of the intervertebral disk (IVD), which is a major contributor to many spine disorders. IVD degeneration is induced by pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β), which are secreted by immune cells, including macrophages and neutrophils. The cytokines modulate ECM-modifying enzymes such as matrix metalloproteinases (MMPs) and tissue inhibitors of metalloproteinases (TIMPs) in human annulus fibrosus (AF) cells. The resulting imbalance in catabolic and anabolic enzymes can cause generalized back, neck, and low back pain (LBP). Photobiomodulation (PBM) is known to regulate inflammatory responses and wound healing. The aim of this study was to mimic the degenerative IVD microenvironment, and to investigate the effect of a variety of PBM conditions (wavelength: 635, 525, and 470 nm; energy density: 16, 32, and 64 J/cm(2)) on the production of ECM-modifying-enzymes by AF cells under degenerative conditions induced by macrophage-conditioned medium (MCM), which contains pro-inflammatory cytokines such as TNF-α and IL-β secreted by macrophage during the development of intervertebral disk inflammation. We showed that the MCM-stimulated AF cells express imbalanced ratios of TIMPs (TIMP-1 and TIMP-2) and MMPs (MMP-1 and MMP-3). PBM selectively modulated the production of ECM-modifying enzymes in AF cells. These results suggest that PBM can be a therapeutic tool for degenerative IVD disorders.

KEYWORDS: Extracellular matrix; Human annulus fibrosus; Inflammation; Intervertebral disk degeneration; Photobiomodulation

PMID: 26987527 DOI: 10.1007/s10103-016-1923-x

[Indexed for MEDLINE]