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TGF- β Pathway Modulation: A Key Mechanism of Photobiomodulation Induced Tenogenesis

ABSTRACT:

The transforming growth factor-beta (TGF- β) pathway is a pivotal regulator in directing adipose-derived stem cells (ADSCs) toward tenogenic lineage, making it a vital focus in tendon tissue engineering. Concurrently, photobiomodulation (PBM) has gained attention as a non-invasive technique to influence cell behavior and support tissue repair. Its potential to interact with signaling mechanisms during stem cell differentiation is of growing interest, though its specific effects on TGF- β -driven tenogenic differentiation remain insufficiently understood.

This research explores the influence of PBM on the tenogenic commitment of ADSCs via modulation of the TGF- β signaling cascade. ADSCs were maintained in 2D culture and subjected to green light PBM (525 nm, 5 J/cm²), with analyses conducted on Day 10. Cell viability and metabolic activity were assessed through biochemical assays, while gene expression profiling, focusing on tenogenic and TGF- β -related markers, was performed using qPCR. Histological techniques further validated protein expression and extracellular matrix development.

Initial data reveal that PBM supports tenocyte differentiation by enhancing the expression of key markers such as SCX and TNMD, and encouraging collagen synthesis, all while preserving cellular health. These outcomes indicate that PBM could effectively aid tendon-like tissue development by influencing TGF- β signaling. Continued research will aim to uncover the molecular basis of this modulation and refine PBM parameters for clinical applications, offering valuable insights for non-invasive tendon regeneration strategies.

Keywords: Photobiomodulation, TGF- β -pathway, qPCR, Adipose-derived stem cells (ADSCs), Tenogenic differentiation

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