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Original Research

Photobiomodulation of Matrix Metalloproteinases in Rat Calcaneal Tendons

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Abstract

Objective: The main objective was to verify the modulatory effects of MMP-1, MMP-3, and MMP-13 levels on the partially injured calcaneal tendons of rat exposure to photobiomodulation.
Background: Photobiomodulation has been shown to have anti-inflammatory and regenerative effects on tendon injuries. However, there is still uncertainty regarding the beneficial effects in matrix metalloproteinase (MMP) levels, especially MMP-1, -3, and -13.
Materials and methods: Sixty-five male Wistar rats were used. Sixty were submitted to a direct trauma on the calcaneal tendons and were randomly distributed into the following six groups: LASER 1, 3, and 7 (10 partially injured calcaneal tendons in each group treated with photobiomodulation for 1, 3, and 7 days, respectively) and Sham 1, 3, and 7 (same injury, with simulated photobiomodulation). The remaining five animals were allocated to the normal group (no injury or treatment procedure). The 780 nm low-level laser was applied with 70 mW of mean power and 17.5 J/cm^2 of fluency for 10 sec, once a day. The tendons were surgically removed and analyzed for MMP-1, MMP-3, and MMP-13 through immunohistochemistry.
Results: MMP-3 levels remained close to normal in all experimental groups ($p > 0.05$); however, reductions ($p < 0.05$) in MMP-1 and MMP-13 levels were detected in the groups submitted to one, three, and seven low level laser therapy applications.
Conclusions: The photobiomodulation protocol was able to reduce MMP-1 and MMP-13 levels in injured calcaneal tendons.

Keywords: calcaneal tendon, matrix metalloproteinases, inflammation, photobiomodulation, tendinopathy

Introduction

The acute and degenerative calcaneal tendon injuries demand deeper understanding and greater precision in the measurement of various aspects of associated dysfunction.[1] This injury presents a significant burden in clinics, representing 45% of musculoskeletal lesions.[2–4] There are conditions that make this repair process slow and difficult, one of which is the presence of several pro-inflammatory and degenerative factors in injured tendon tissue,[5–8] such as matrix metalloproteinases (MMPs), that are attracted and activated by other pro-inflammatory factors and may further aggravate the injuries and perpetuate the changes in the injured tendon.[8–14]

MMPs are a family of zinc- and calcium-dependent endopeptidases active at a neutral pH. It has important functions in the maintenance, remodeling, and degradation of the tendon matrix and its activity is inhibited by tissue inhibitors of metalloproteinases (TIMP).[15] Further, the synthesis of MMPs may change substantially in the presence of inflammatory processes in injured tendons. This can be the case especially in the presence of primary pro-inflammatory factors seen in the early stages of calcaneal tendon injuries, which stimulate the increase in MMPs' synthesis.[12,16–20]

In addition, MMP-1 and MMP-13 levels are upregulated in injured tendon tissue, especially those submitted to shear stress[21]; therefore, MMP-3 may play a role in the normal maintenance and remodeling of tendons.[15] The presence of

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