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RESEARCH ARTICLE

Synergistic effects of low-level laser and mesenchymal stem cells on functional recovery in rats with crushed sciatic nerves

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Abstract

Transplantation of mesenchymal stem cells (MSCs) has been proposed to exert beneficial effects on peripheral nerve regeneration after a peripheral nerve injury, but the functional recovery in the denervated limb is still limited. In this study, we used low-level laser therapy (LLLT) as an adjunct therapy for MSC transplantation on the functional recovery of crushed sciatic nerve in rats. Peripheral nerve injury was induced in 48 Sprague–Dawley rats by crushing the unilateral sciatic nerve, using a vessel clamp. The animals with crushed injury were randomly divided into four groups: control group, with no treatment; MSC group, treated with MSC alone; LLLT group, treated with LLLT alone; and MSCLLLT group, treated with a combination of MSC and LLLT. The sciatic function index (SFI), vertical activity of locomotion (VA) and ankle angle (AA) of rats were examined for functional assessments after treatment. Electrophysiological, morphological and S100 immunohistochemical studies were also conducted. The MSCLLLT group showed a greater recovery in SFI, VA and AA, with significant difference from MSC, LLLT and control groups ($p < 0.05$). Moreover, markedly enhanced electrophysiological function and expression of S100 immunoreactivity, as well as fewer inflammatory cells and less vacuole formation were also demonstrated after nerve crush injury in the MSCLLLT group when compared with the groups receiving a single treatment ($p < 0.05$). MSC transplantation combined with LLLT could achieve better results in functional recovery than a conventional treatment of MSC or LLLT alone. LLLT has a synergistic effect in providing greater functional recovery with MSC transplantation after nerve crush injury. Copyright © 2013 John Wiley & Sons, Ltd.

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1. Introduction

Injuries of peripheral nerves are common and debilitating, resulting in considerable long-term disability (Noble *et al*., 1998). While regeneration of peripheral nerves may eventually occur, it is slow and frequently incomplete, misdirected or associated with debilitating neuropathic pain (Navarro *et al*., 2007). Understandably, therefore, numerous attempts have been made to enhance and/or accelerate the recovery of injured peripheral nerves. Stem/precursor cells from different sources are being studied for their potential application in the scenario of peripheral nerve injury. Transplant cells, the most promising candidate, are derived from easily accessible sources, such as embryonic, neural and mesenchymal stem cells (MSCs). They have all been demonstrated to act as a nerve guide and direct the outgrowing nerve fibres towards the distal nerve stump, and have been proposed to exert beneficial effects on peripheral nerve regeneration (Cho *et al*., 2011; Murakami *et al*., 2003; Pan *et al*., 2006, 2007). Although regimens of stem cell implantation can elicit

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