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Suppressive effects of low-power laser irradiation on bradykinin evoked action potentials in cultured murine dorsal root ganglion cells

Keita Jimbo, Kosuke Noda, Kazuo Suzuki, Kentaro Yoda*

Department of Bio-Medical Engineering, Tokai University, 317 Nishino, Numazu 410–03, Japan

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Abstract

The effects of Ga-Al-As diode laser (830 nm, 16.2 mW) irradiation on the distal portion of the processes of cultured murine dorsal root ganglion (DRG) neurons associated with C-fibers were studied by patch-clamp whole-cell recording of membrane potentials at the cell body. The chemical as well as laser light stimulations were limited to the processes of the neuron isolated from the cell body with a separator. The action potentials elicited by bradykinin (BK) in the cell body were reversibly suppressed by the irradiation of laser light. The laser irradiation may block the conduction of nociceptive signals in primary afferent neurons. The present experimental method offers a simple and easy to use procedure for studying the pain relief effects by laser irradiation. © 1998 Elsevier Science Ireland Ltd.

Keywords: Low-power laser; Cultured neurons; Dorsal root ganglion; C-Fibers; Bradykinin; Action potential; Pain relief

Low-power laser irradiation has been used for the treatment of various kinds of pain [12,13]. However, the mechanisms of the pain relief effects of laser irradiation have not yet been completely understood in spite of the intensive studies by many groups. The mechanisms proposed so far are diverse and include: (1) an increase in peripheral blood flow [5], (2) the inhibition of release of algesic substances at the nerve endings [7], (3) changes in conductivity of primary afferent neurons [10,14,16–18], and (4) an activation of descending inhibitory pathways from higher centers [8,15]. In the traditional studies most experiments were carried out with animals or human volunteers. Therefore, the experimental systems were too complex to estimate the dose of laser irradiation and the intensities of noxious stimuli. To avoid the complexities, the utilization of cultured cells as experimental systems is beneficial though it has some limitations.

The purpose of the present study is to establish a simple experimental system suited for the fundamental studies on pain relief effects of laser irradiation. In the present study, a combination of the cultured murine dorsal root ganglion (DRG; peripheral afferent neuron) neuron and bradykinin (BK; algesic compound) was selected as a model for pain relevant system. In the clinical laser therapy, the cell bodies of peripheral afferent neurons are not stimulated by laser light but nerve fibers are stimulated. In the present experiments the processes of neuron were stimulated separately from the cell body using a separator, and the effects of Ga-Al-As diode laser irradiation to the processes were analyzed by intracellular recording of membrane potentials at the cell body. Free nerve endings in the peripheral tissue are activated by algesic substances released from cells damaged by noxious stimuli. In particular, BK is produced at injury sites by enzymatic cleavage from large plasma proteins, exciting peripheral unmyelinated C-fibers and thin myelinated A-δ fibers [2]. BK is known to depolarize cultured nociceptive neurons [1,4].

Young adult (7–8 weeks) male mice (Jcl:ICR) were killed by deep anesthesia with diethyl ether. About 40–45 DRGs were aseptically removed from a mouse. DRGs were dissociated in 2 ml of Ham's F12 medium with 0.2% col-

* Corresponding author. Tel.: +81 559 681111 ext. 4529; fax: +81 559 681156; e-mail: kyoda@wing.ncc.u.-tokai.ac.jp

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