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Effects of 780-nm Low-Level Laser Therapy with a Pulsed Gallium Aluminum Arsenide Laser on the Healing of a Surgically Induced Open Skin Wound of Rat

Mohammad Bayat, Ph.D., Afsaneh Azari, M.Sc., and Mohammad Ghasem Golmohammadi, Ph.D.

Abstract

Objective: The aim of the present investigation is to evaluate the effects of a 780-nm low-level laser on open skin wound healing. ***Background Data:*** Optimal parameters of low-level laser therapy (LLLT) for wound healing are discussed. ***Methods:*** One full-thickness skin wound was surgically induced in the dorsum skin of 30 rats. The rats were divided into two groups. Rats in the experimental group were daily treated with a gallium aluminum arsenide (GaAlAs) laser ($2\,J/cm^2$, $\lambda = 780\,nm$, pulse frequency of 2336 Hz). Rats in the sham-exposed group received LLLT with switched off equipment. After 4, 7, and 15 days, wounds were checked by histological and biomechanical methods. Data were analyzed by the Mann–Whitney *U*-test. ***Results:*** Fibroblasts, endothelium of blood vessels, blood vessel sections, and maximum stress were significantly increased, whereas macrophages were significantly decreased, compared with those of the sham-exposed group. ***Conclusion:*** Pulsed LLLT with a 780-nm GaAlAs laser significantly accelerates the process of healing of surgically induced, full-thickness skin wounds in rat.

Introduction

Approximately, 50 million surgical procedures are performed each year in the United States alone.[1] Fifty million additional traumatic wounds are added to the burden of acute wound morbidity.[2] Recovery from these operations and injuries conservatively costs 250 million patient-days in lost productivity and billion of dollars in lost supplemented earnings. The costs increase when acute wound complications occur.[3]

Low-level laser therapy (LLLT) as a therapeutic modality was introduced by the work of Andre Mester and his colleagues, who described improvement in wound healing with the application of a low-energy ($1\,J/cm^2$) ruby laser.[4,5] Cameron and colleagues reported that the frequency of the laser light, as well as the type of tissue being irradiated, determines the depth to which light penetrates. Laser produced by a gallium aluminum arsenide (GaAlAs) laser penetrates deeper, whereas laser light with shorter wavelength, such as the red light produced by a He–Ne laser, penetrates less deeply.[6] A review of the literature revealed that LLLT with pulsed GaAlAs lasers increased higher fibroblast count than in control in vitro;[7–9] increased collagen deposition, greater proliferation of myofibroblast[10] and acceleration of wound closure[11] in experimental cutaneous wounds; and increased the healing of human crural wound[12] and human superficial wound.[13]

The benefits of continuous diode lasers in wound healing are controversial. Although a few studies have reported positive effects for continuous delivery of diode laser on the cutaneous wound-healing process,[14–16] many other authors have found no improvement in this process using continuous diode lasers.[17–22] Because of these contradictory results, there is still no consensus on the effects of LLLT in the wound-healing process. Recent studies have used various diode lasers with different wavelength, laser power, and stimulus dose. Regarding the type of laser and sufficiency of wavelength, no clear recommendations have yet been made.

On the other hand, a low-level pulsed-diode GaAlAs laser with a wavelength of 780 nm has not been examined in the wound-healing process. Recent investigations have not studied wound healing using a 780-nm pulsed-diode GaAlAs laser with a 2336-Hz frequency. Therefore, the aim of the present study was to examine the influence of a pulsed-diode GaAlAs laser with a wavelength of 780 nm and a 2336-Hz frequency on the healing of a full-thickness skin wound in rats.

Physical Therapy Research Group, Academic Center for Education, Culture, and Research, Iran Medical Science Branch University, Vanak, Tehran, Iran.