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Low-Level Laser Therapy Along With Intravascular Laser in Deep Pressure Ulcer Resistant to Conventional Therapies

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Abstract

Introduction: Pressure ulcer is a common and troublesome complication in patients with spinal cord injury (SPI). The purpose of this case report was to describe the treatment of chronic pressure ulcer in a patient with SPI using low-level laser therapy (LLLT).
Case Presentation: The patient was a 45-year-old male with T8 complete paraplegia; he had developed severe pressure ulcer. The authors used LLLT as a complementary treatment. They used 980 nm, continuous 6 J/cm^2 for margins and 655 nm, continuous 1.8 J/cm^2 for bed of the ulcer, along with intravascular laser therapy. After 24 sessions of LLLT and z-plasty surgery, the ulcer healed completely.
Conclusions: LLLT is effective in tissue regeneration and increasing blood flow; this gives faster healing process of the wounds and faster cell proliferation. This treatment may be effective even in deep pressure ulcers.

Keywords: Pressure Ulcer, Decubitus Ulcer, Low-Level Laser Therapy, Intravascular Laser Therapy, Spinal Cord Injury, Wound Healing

1. Introduction

Pressure ulcer is defined as any degenerative change due to pressure upon tissues. Pressure ulcer is a problem that threatens every patient with spinal cord injury (SPI). Near 85% of patients with SPI develop a pressure ulcer during their lives and 8% of them die due to this disorder (1, 2). It increases the cost and duration of hospitalization and impairs the quality of life. Precipitating factors for ulcer formation are numerous. Intrinsic factors are obesity, diabetes, malnutrition and sensory, motor and autonomic impairment. Extrinsic factors include direct trauma, friction, and pressure (3).

These ulcers are regions of localized damage to the skin and its underlying tissues and usually develop over bony prominences such as heels and sacrum (2, 4-6). These ulcers cause great suffer for patients and their caregivers. Its prevalence depends on patient's factors like age, physical impairment, and treatment setting. Although there are numerous pharmacological, surgical and physical therapies for treatment of these ulcers, healing of pressure ulcer still takes a long time and some ulcers do not heal completely (7, 8).

Low-level laser therapy (LLLT) has been used for pain relief, wound healing and control of inflammation since 1960s. This kind of laser promotes fibroblast proliferation, collagen synthesis and epithelialization (9). At cellular level, laser bio-stimulation increases succinic dehydrogenase activity and alters the prostaglandin level, which promotes wound healing (10). It increases adenosine diphosphate (ATP) synthesis and energy production, prevents cellular necrosis, and stimulates fibroblast and macrophage proliferation (9, 11, 12). LLLT may be applied locally, intravascularly or combined together. Intravascular irradiation of blood (ILIB) is a safe and effective method for laser therapy, especially when systemic effects are needed. It improves bio-stimulation, the rheological properties of blood and microcirculation, and has immunocorrective, antibacterial, anti-inflammatory and vasodilative effects (13-15).

Here, for the first time, we report the result of using LLLT along with ILIB in treating chronic deep pressure ulcer in a patient with SPI Due to Iran-Iraq war.

2. Case Presentation

2.1. Methods

The case of the study was a 45-year-old male with spinal cord injury. He was injured in 1988 in Iran-Iraq war in the T8 level with complete cut of spinal cord with recurrent ulcers at the sacral area from the first year after the injury. The present wound diameter was 3 × 7 cm^2 with 5

cm depth since eight months before. He was hospitalized several times, but antibiotic therapy, dressing with fibrinolysin and surgery were not effective.

Finally, the patient was referred to Milad hospital and admitted in the surgical ward. On arrival, the patient had fever and based on positive cultures of *Staphylococcus aureus*, he was treated with cefazolin 1 g IV every six hours with gentamicin 80 mg every eight hours and metronidazole 250 mg every eight hours. In the paraclinical tests conducted at the beginning of admission, patient had white blood cell (WBC) count = 5600/cu mm, erythrocyte sedimentation rate (ESR) = 71 mm/hour and the positive C-reactive protein (CRP).

Informed consent was obtained from the patient and the study protocol conforms to the ethical guidelines of the 1975 declaration of Helsinki. Based on the ulcer situation, treatment with low-level laser using AZOR2K (Russia) started with the following protocols:

1) 980 nm, continuous mode and a dose of 6 J/cm^2 for margins of the ulcer (protocol 1).

2) 655 nm, continuous mode and dose of 1.8 J/cm^2 for bed of the ulcer (protocol 2).

3) By the Quanta-C apparatus (Italy), dilution method and dose of 4 J/cm^2, the buttock area was scanned (protocol 3).

4) Intravenous laser using 650 nm, power: 1.5 mW (Mulat, Russia) for 15 to 20 minutes (Protocol 4).

Intravenous laser was performed through a sterile, disposable catheter in cubital vein in the forearm. A sterile disposable optic fiber was passed through the catheter and 1 - 2 mm of its tip was in the vein. This is a safe process just like a serum injection and indices systemic effects.

Laser therapy sessions were every other day for 12 sessions and then twice a week until complete recovery. Immediately after the first LLLT session, debridement surgery was applied. Fibrinolysin ointment dressing was made daily after washing with normal saline and povidone iodine. After two sessions of laser therapy, wound perfusion improved and after the 12th session, the wound diameter reduced to the 3×5 cm^2 with a depth of 1 cm. Wound infection was eradicated and its culture was negative. Z-plasty surgery was applied using a flap of 7×3 cm^2 from the buttock and then laser therapy with protocols 1, 3 and 4 continued. Ten days after the surgery, the wound was relatively good and sutures were drawn alternately and five days after that, due to complete healing, the rest of sutures were drawn. LLLT was performed until complete epithelialization (24 sessions of LLLT).

Paraclinical tests were performed at the end of treatment; WBC = 6300/cu mm, ESR = 17 mm/hour, and CRP was negative. In the one-year follow-up, the patient had no recurrent ulcer in the buttock area (Figure 1).

The combination of laser therapy with conventional therapy and surgery increases the process of wound healing remarkably, particularly in resistant wound cases. In other words, it accelerates the reconstruction of blood vessels and increases the lesion revascularizations, increases the production and formation of granulation tissue in the wound, eradicates microbial flora, sterilizes the wound pathogens, and facilitates graft surgery repairing success. This process not only leads to a better healing of ulcers, but also prevents recurrent ulcers due to improvement of perfusion in the treated area.

3. Discussion

LLLT has an effective role on tissue regeneration and increasing blood flow, gives faster healing process to the wounds, and facilitates cell proliferation. Although, there are controversies mainly related to the dosage of the laser used (16). Energy density and exposure time are important parameters in the infectiveness of LLLT. Variation of exposure time and irradiance may account for conflicting results in the literature. In complicated cases like chronic disease, ILIB with systemic effects accelerates the healing process. Our previous study showed that using LLLT along with ILIB improved the healing process in diabetic patients (17) and was useful in diabetic patients and patients after coronary artery bypass grafting surgery (18-20). As the patient had been paralyzed since 10 years ago and perfusion in the buttock area as well as the immune system function were impaired, we used LLLT to accelerate wound healing and ILIB to improve perfusion and immune system function. The method we used was completely effective in treatment of deep chronic nonhealing pressure ulcer in this case.

Lanzafame et al. compared different energy densities on mice. They reported fastest healing time in the group treated with 8 mW1/day treatment using 670 nm light (21). Lanzafame et al. studied the effect of exposure time and irradiance during LLLT as important factors in healing of pressure ulcer in murine model. They reported that variation of irradiance and exposure time may account for conflicting results in literature and suggested that further studies were needed (21).

Schindl et al. reported the efficacy of helium neon laser in treatment of chronic nonhealing ulcers (12). Gupta et al. showed the effectiveness of LLLT in healing of venous ulcers (11). Our previous study showed significant effects of LLLT on healing of grade 2 - 3 ulcers in diabetic patients (17).

Taly et al. in a randomized double-control trial studied the effect of multi-wavelength light therapy in the treatment of pressure ulcer in patients with spinal cord disorders. They reported significant reduction of time for stage

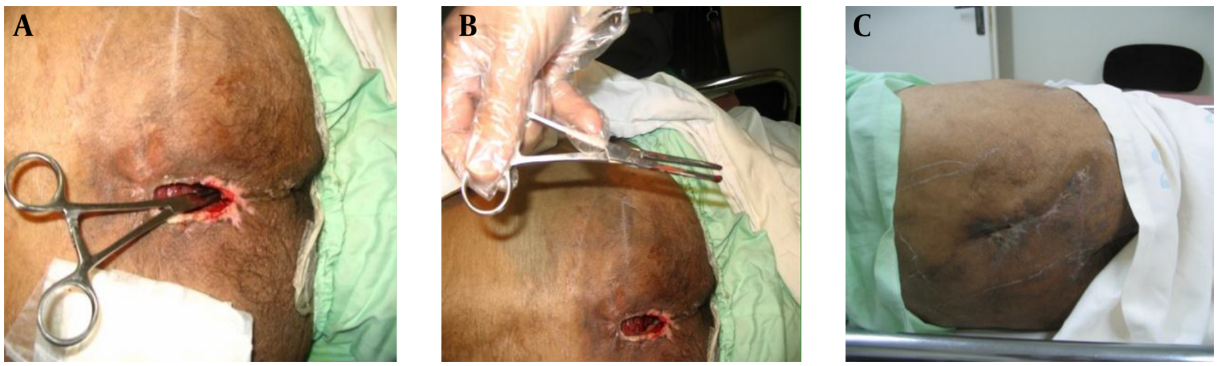

Figure 1. A and B, pressure ulcer with 5 cm depth since eight months before; C, after 24 sessions of LLLT and Z-plasty surgery.

3 and 4 ulcers to improve to stage 2 in the light group (22). Lucas et al. evaluated the effect of LLLT in the management of stage 3 pressure ulcer. They found no evidence that LLLT was an effective adjuvant for the treatment of decubitus ulcer (23). Nussbaum et al. compared ultrasound/ultraviolet-C and laser for the treatment of spinal cord injured patient with pressure ulcer. Their results showed that using ultrasound/ultraviolet-C treatment combined with standard wound care had advantage to standard wound care combined with laser therapy and laser therapy had advantage over standard wound care alone (3). Cullum et al. in a systemic review of wound care management, compared electrotherapy, electromagnetic therapy, ultrasound, and laser therapy for the treatment of pressure ulcers. They reported that there is insufficient reliable evidence to conclude that these therapeutic modalities were effective in treating chronic ulcers (24)

The precise treatment protocols and dosage formulations in laser therapy have not been provided so far; however, it seems that the protocol used by our method was very effective, but certainly the extension of this protocol to all pressure ulcers in patients with spinal cord injury requires more studies.

3.1. Suggestions

1) Applying LLLT with other therapies routinely used in wound care may be effective.

2) With an appropriate sample size, the effects of laser in the treatment of bed sores should be assessed in further studies.

3) Comparing the present protocol with other conventional protocols in terms of effectiveness is proposed.

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Footnote

Authors' Contribution: Nooshafarin Kazemikhoo: treating the patient, writing the manuscript; Mohammad Reza Rahbar: writing the manuscript; Seyed Mohammad Akrami: writing the manuscript.

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