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Research Article

Effects of laser therapy on chronic skin ulcers healing interventions for Sudanese patients

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ABSTRACT

Background: The purpose of this study is attempting to the assessment of the effectiveness of low level laser therapy (LLLT) with specific parameters in the treatment of selected Sudanese patients based on clinical records of different skin ulcers and diabetic's wounds in Khartoum state hospitals. Thus, the effect of the laser treatment using bio - stimulation effects on tissues in infrared laser and in the visible region depends on frequencies, power density and time of exposure rate on skin diseases.
Methods: It is prospective clinical descriptive, interventional study on seven selected males and females of different ages depend on clinical and positive smear LD bodied, which was confirmed at Omdurman tropical disease hospital. Low power laser Omega-XP with tunable wavelengths 820 nm, 780 nm, 675 nm and constant parameters were applied for medical treatment.
Results: Utilization of laser dosage (energy density) of 40 J/cm^2 and 1.6 w/cm^2 power density of the wavelength 820 nm and 30 J/cm^2 energy density and power density of 0.24 w/cm^2 of 780 nm wavelength, in addition to energy density of 8 J/cm^2 and power density of 0.24 w/cm^2 and 0.40 w/cm^2 and energy density of 1.6 J/cm^2 for the 675 wavelength was applied. In this study, we used the bio-stimulation effect of LLLT to enhance healing through immune modulation. However, the application of low level diode laser in the treatment of diabetic wounds can be accompanied by low energy density and short wavelength to give better results in a short time and a good diagnostic accuracy for its potentiality in the field.
Conclusions: Consequently, the brown skins in Sub-Saharan region for different tissues of Sudanese diabetic patients of chronic skin ulcer can be treated with different wavelengths and energy relative to tissues softening and laser parameters of that optimum values were obtained. The assessment of skin regeneration using laser therapy expose that the quality of growth, the reasonable period of healing and decreases the risk skin infection were achieved. The process of diabetic wounds curing and de-pigmentation, potential resident of decreasing pain and an efficient adjunct to a standard wound management was obtained.

Keywords: Low level laser therapy, Skin ulcer, Pigmentation, Laser power, Fluence

INTRODUCTION

Utilization of laser technology in therapeutic application is increasing the understanding of using the techniques in different medical field. Lasers are used in technology for a variety of invisible and visible light experiments and also enthusiasts in the field of therapeutic application mainly in dermatology.[1] Human skin is affected basically by light and infrared radiation, so that it's necessary to avoid the horrific impact that casing by direct radiation on human tissues.[2] Lasers in medicine apply to human tissues based on tissues interaction and absorption of radiation. A laser is affected due to skin color range and conditions in term of improving previous scarring relative to causes in acne, psoriasis and eczema.[3]

The medicinal treatment has an impact resulting in human skin color and the properties of energy absorption. Presently, doctors and medical practitioners have increased the demand for laser sources in mostly a process that assists in the treatment of skin diseases; particularly in the area of conventional medicine have less response.[4]

The infrared low level laser is used in dermatology relating to skin color, which stimulates new tissue growth.[4] Laser radiation is smoothed tissues and existing scarring excellent cosmetic effect and cellular effects discourage scar tissues on the skin, mostly for brown and dark skins colored in dermatology. Laser radiation can cause serious harm when hitting human skin even for a short period of time and severe burns.[5]

Currently, the laser in medicine is becoming a highly promising technique through the photo-thermal method in dermatology application. Photo-thermal effect in tissues is achievable by using laser infrared radiation that case effect on tumors, which occur photochemical sensitizers adept of cure tumor destruction.[6] Low level laser therapy used has emerged to be highly promising for skin ulcer treatment, which employs infrared radiation and light absorbing by tissues for achieving the photo-thermal effect on tumors.

The wavelength region selection and suitable laser power and exposure time are the essential parameters to decrease the possibility of infection in clinical medical treatment.[2] The bio-stimulation is processed by the main advantage of infrared laser treatment of soft tissue injuries like bruises and strains in medical application with incredible precisions. Infrared lasers penetrate below the skin that affected by photo-thermal process and enhanced the process of microcirculation, reduction causes of the pain, inflammation and immune response.[7]

In the soft tissue, laser radiation stimulates acupuncture pressure points in injury area, which provides incredible effect on pain relief for acute.[8,9] Biological tissues are absorbed a laser beam intensity relative to the spectral region and permit selective damage to specific components of a target tissue through interaction occurrences photochemical, photo thermal and ionization.[10,11] Tissues are absorbed photon of laser radiation that produces a thermal effect on outer electrons or molecular vibrations enough to raise the temperatures of the tissues, which are stabilized structures of bimolecular, concluded to forces of weak van deer Waals.[12,13]The tissue temperature increasing in the range of 10°C to 20°C in renting temperature is influenced in damaging the tissue and increasing thermal injury that proportional to the magnitude and temperature rise to a certain level required for immediate photocoagulation lesion.[14,15]

Sunlight is darkened natural skin color and other factors such as ambient temperature, infection, skin cancer that modify skin color, in addition to the social influence of skin color and sexual selection that varied across culture and over time.[16] The blood vessels underneath the human skin are reflecting the skin color varies from black to white owing to the presence of melanin in the skin that mainly connected to genetics.[10] The sub-Saharan African population variance in higher with skin reflectance values in the range of 19 to 46 compared to European and East Asian population of the skin reflectance in the range of 62 to 69 and 50 to 59 respectively.[15] Most people skin is affected in uneven area or appear darker of lighter due to ethnic background or skin color and skin pigmentation disorders occur due to too much or little melanin, so that the more melanin the more solar radiation can be absorbed.[17] The skin of the back of the hand, forearms, chest and face is influenced by direct exposure to sunlight and causes discoloration of the skin darkened area or brown spot that accumulates over the time.[18,19]

The primary and secondary activity for the production of lipid per-oxidation and anti-peroxide protective enzymes was investigated by Grigoreva and colleagues. The laser was irradiated to the blood of diabetes people for 60 minutes, which are decreased activity of processes of free radical oxidation compared with blood samples taken before laser irradiations due to the effect of LLLT on anti-peroxide enzymes.[12,20]

METHODS

This work has been carried out in an attempt to assess the utilization of low level laser therapy in medical treatment in the Clinic of Laser Institute, Alias Center Khartoum, under supervision of medical doctors of the institute of the laser, Sudan University of Science and Technology, Khartoum, Sudan. Patients were referred from the Khartoum Teaching Hospital for Skin Diseases and from Khartoum North Hospital, Omdurman Dermatology Clinics and Tropical Disease Hospital in Omdurman, which are treated under conventional medical treatment for more than one year with the slow response of healing before Laser LLLT treatment.

The target was seven Sudanese patients' of both genders five males and two females treated using laser radiation for the study. The clinical treatment was included various analytical methods such as illustrations and intervention study and in addition to assessment of laser parameters. The treatment relative to the skin ages, skin color range and tissue types conducted for males and females in the range of 20 to 40 years so as to obtain optimum laser parameters.

Ethical consideration

All patients in the present study signed a written informed consent before being in the study. They were notified of the possible side effects and hazards of laser therapy. The procedure of laser treatment was attributed to the patients and the side effect which can be expected, e.g. Discomfort hyper pigmentation, so that the patient's consent was approved. Approval for this study was granted by the research, ethical committees at the Sudan University of Science and Technology.

The Gallium-aluminum-arsenide semiconductor diode laser Omega XP type machine was used in laser medical treatment, while the laser in visible an infrared wavelength region of 200 mW output power, which produces non ionizing radiation of tunable wavelengths 820 nm, 780 nm and 675 nm. The advantages of laser machine are producing laser pulsed at frequencies of 2.5 Hz, 10 Hz, 20 Hz,73 Hz, 146 Hz,700 Hz, 1 KHz, 5 KHz, 10 KHz offering a wide range of laser radiation can be used broadly in medical treatment. The Omega diode laser has a beam test detector in addition to different types of modes of operation such as standard mode, multiples mode, and acupuncture mode. A probe of 675nm wavelength in the visible region is the source of power density 0.4 w/cm^2 and in near infrared probe of wavelength 820 nm is the cluster probe with power density 1.6 w/cm^2, in addition to acupuncture probe of wavelength 780 nm with power density 0.8 w/cm^2 were used for the treatment.

The laser beam was applied to the skin in a stationary condition and skins tightening, which are typical for diabetic's patients. The ultrasonic gel was used before the beginning of the laser irradiation area that covered with thin layers and the thickness governs prior to treatment. Specific areas for treatment were marked for simplifying the treatment and the radiation beam passes in an average of three times on specific areas. The pictures of the skin surface of identical area were taken before and after treatment and after second coming treatment for comparison and that as evidence for wounds assessment and photography record. The dose radiation was adapted according to the condition and penetration through tissue, which more lesions needed to achieve the required energy density due to tissue type of the skin color range. Soft Skin such as internal area in hand, usually lower energy is required in this area and lower the fluency to avoid skin damage. Treat at 90 degrees ensures full power was applicable to the tissues and treatment at least two per week. Method of clinical treatment of non-contact was used for all treatments, and the distance of handling was maintained approximately 0.5cm from the surface of the lesion.

The exposure time of dose radiation is effecting on skin

treatment such as swelling or excessive red in that case the fluence must be lowered. Subsequently, tissues treated with laser radiation must be cooled for 10 minutes. The laser wipes probes with antiseptic were managed before and after the lesion treatment. Safety protection relating to Class 3B laser regulations was implemented.

Moreover, the wound characteristic primary evaluation of outcome treatment was included the following parameters such as length, width, deep amount of tissues effect and progress of the healing. The wounds will be evaluated at the beginning of the study, each two weeks during the intervention and at the end of the study period or healing of the ulcer, for pre and post comparison.

A treatment category in three parts relative to the patients multiple numbers of lesions. Firstly, lesion treated twice per week for a maximum of 12 sessions. Secondly, lesions were treated by laser in addition to penicillamine and the laser twice per week for a maximum 12 sessions. Finally, lesions treated with penicillamine alone 2 capsules per day before meals by one hour, in addition to the laser treatment.

RESULTS

Seven patients were included in this study under medical treatment using LLLT sessions, where the data relative to personal, detailed, medical history, family history are assessed due to the morphology of the lesion in addition to laser parameters and variation of lesions and complication in each follow up visit. Accordingly, all patients in study have associated diseases were tumors, accident and diabetics gets treatment before LLLT treatment in the form of antiseptic, antibiotic and other herbal and native treatment, in addition, only one patient of the study group has got other concomitant diseases (rheumatoid arthritis). The skin structure of the infected area was examined after treatment with high resolution digital photograph image and subsequently to evaluate skin surface parameters such as the length of the creases, roughness and color area of evidence healing.

The radiation dose of laser at low level is affecting in stimulating on cells and on the other hand the high dose rates damaging the cells. Therefore, these conditions controlling the dose are necessary for a positive effect in laser therapy. Treatment sessions were done in frequency of two sessions per weeks, however the photographs of the lesions were taken before and after treatment to assess the effect of LLLT laser safety.

Standard mode used in the treatment is a single probe of wavelength 820 nm, 25 seconds duration and frequency of 73 Hz with Fluence (energy density) of 40 joules/cm2 on the skins less than one centimeter in length. The cluster probe of wavelength 780 nm and 2 minutes duration time and frequency 73 Hz with Fluence of 30 - 32 joules/cm^2 was used. Different probe of 675 nm wavelengths, frequency73 Hz, Fluence of 8 J/cm^2 and 1.6 J/cm^2 was applied for LLLT treatment.

Figure 1: (a) Before treatment and (b) after ten sessions of treatment.

Figure 2: (a) Before and (b) after ten sessions of treatment.

Figure 3: (a) Before and (b) after ten sessions of treatment.

Figure 4: (a) Before and (b) after ten sessions of treatment.

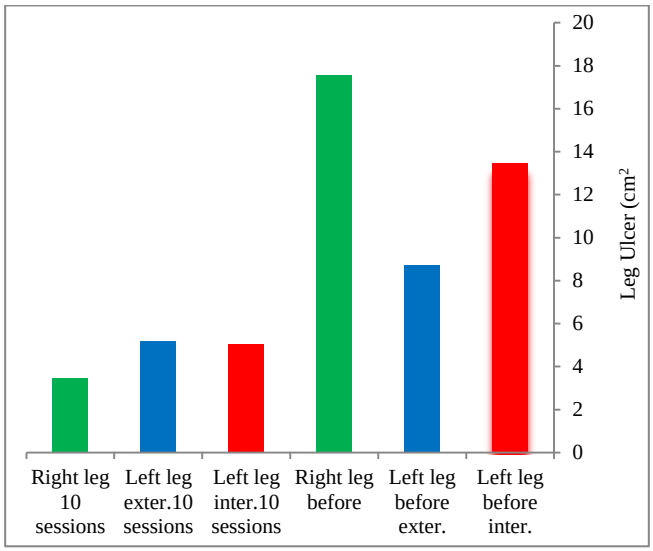

Figure 5: Three patients leg ulcers and area in the body before treatment and after 10 sessions.

DISCUSSION

The assessment of patient's treatments included power density, energy density, time of exposure, ulcer area and the rates of healing, so that result obtained optimized relative to analysis and dissection of the result and response to the treatment. The Figures 1-4 show the wounds of 4 patients before and after LLLT treatment improvements, while Figure 5 display areas healings progress of the other 3 patients after ten lesions and before the treatment.

A 50 year old male was treated with LLLT a wound of 2 cm × 2 cm had insulin depended diabetes mellitus with an ulcer on the right medial leg. The graft was the wound completely healed using a power density of 0.24 w/cm^2 and Fluence (energy density) of 8 J/cm^2.

An upper hand of 40 years old female had an insulin dependent diabetes mellitus was treated the wound of 4cm×2cm using LLLT. The ulcer managed conventionally twice per week and in 2 months the wound was totally healed using a power density of 0.40 w/cm^2 and energy density of 1.6 J/cm^2.

LLLT treatment of 3.2 × 4 cm an ulcer on the left foot of 22 years old male had an insulin dependent mars was managed conventionally twice per week. The wound was completely headed in 14 months lesions using a power density of 0.24 w/cm2 and energy density of 32 J/cm^2.

An ulcer 2.5×2.5 cm wound on the left foot of 45 years old male had insulin depended diabetes mellitus was treated twice per week using LLLT. The wound was completely healed in 11 months duration using a power density of 1.6w/cm^2 and energy density 40 J/cm^2. The Figure 5 is displayed graphically the area of wounds healing progress after 10 laser sessions compared before treatment, which reflects the fast curing with respect to time of diabetic's patients.

The impact of laser in infrared region has deferred than laser in the light region and that effect appeared in the time of the dose radiation due to the case of the skins under study. However, optimum laser parameters of Sudanese diabetic patients with brown skins in Sub-Saharan region of different skins color ranges and different tissues in the human body has been obtained, with less time of treatment compared to conventional medical treatment and good result in chronic skin ulcer wounds, and safely outcome of laser power. This study revealed that the low level therapy can treat ulcers effectively and complications of LLLT are minor transient and flexible for the treatment.

CONCLUSION

Exploration technique of phototherapy in medicine and surgery is of major interest, and there is a growing use of lasers in the treatment of various conditions and disorders, including the treatment of diabetic wounds. We concluded that good results have been achieved with low laser therapy for skin regeneration where the quality of growth and duration of healing is optimum. Low level laser therapy is highly accepted techniques in the medical field and for treatment in dermatology of impaired wound healing and decreases the risk skin infection and speeding up the process of curing. Using lasers as a source of photo bio-stimulation is an attractive branch in medicine for the future. The study has shown less-side effects of diabetic wounds and de-pigmentation, an efficient adjunct to a standard wound management, with the added potential resident of decreasing pain. There is a need to develop alternative treatment modalities which can improve the endogenous capacity of the healing process, particularly during conditions with improved wound healing, for Sub-Saharan patients with brown skins of different skins in color compared to Asian and European.

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