Effect of Infrared Laser on Wound Healing in Burnt Children

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ABSTRACT

The purpose of this study was to determine whether Infrared (IR) laser bio-stimulation accelerates the rate of healing of burnt children. Twenty burnt patients from Kasr El-Ainy Hospital (Burn Unit), ranging in age between 10 and 13 years participated in the study. They were randomly divided into two groups of equal number (control and study) groups. Patients in the control group received daily treatment of physical therapy program, comprising positioning, stretching and remedial exercises. On the other hand, patients belonging to the study group were exposed to the same physical therapy program in addition to IR laser for the burnt area for 10 minutes for each area. Treatment continued for both groups of patients for eight successive weeks. The wound surface area was assessed before and after the suggested period of treatment, using the metric graph paper method. The passive range of wrist dorsi-flexion was also assessed, using a LCD goniometer. Furthermore, the present pain intensity scores were assessed. The collected data after termination of the suggested period of treatment of both groups revealed significant improvement in the study group, utilizing the IR laser therapy, compared to those of the control group. Furthermore, a similar improvement was also noted in comparing the results of the study group, before and after treatment. Such an improvement included reduction of the wound area and pain intensity scores in addition to an increase in the wrist dorsi-flexion ROM. So, it should be stressed that utilization of IR laser irradiation in combination with the traditional physical therapy modalities is more effective in treating burnt areas than using traditional modalities only.

INTRODUCTION

The recovery of the burnt skin, and the consequent musculo-skeletal problems formulates a major problem in the physical therapy field. Thermal injury primarily results in destruction of skin and secondarily involves function of the musculo-skeletal system. The degree of musculo-skeletal impairment is determined by the depth and extent of burn injury[7].

The skin is the largest organ of the human body. Burn injury causes destruction and disturbance of normal physiologic functions of the skin. It is difficult to estimate the problems of burnt patient, especially psychological and economical problems[28].

Burn injuries vary in severity, depending on the amount of total body surface area (TBSA) that has been damaged. Even the smallest burn causes discomforts that can be relieved by rapid first aid. The severe or dangerous burn, involving more than 30% of the TBSA, may be life threatening. Maintaining joint movement and maximizing functional ability in patient with a major burn

presents a formidable challenge to physical therapists. A comprehensive team approach to burn and early therapeutic intervention can reduce the possibility of joint dysfunction[13]. Laser therapy plays an important role in regeneration and healing not only in wounds but also in burns[24].

Physical therapists identified a variety of wounds, which respond well to low-intensity laser treatment. They ranked the efficacy of laser above that of other commonly used electro-therapeutic modalities such as interferential, short wave and most notably ultrasound[4]. Bio-stimulated fibroblast cultures, taken from human embryo, have been treated with He-Ne laser. The fibroblast cell, when stimulated four times at 24-hours interval, showed increased bending ability to the lectin, which emphasized laser biostimulation effect[18].

Aim of the work:

To investigate quantitatively the effect of infra red laser therapy on the enhancement of recovery of wounds and pain reduction in burnt children.

SUBJECTS, MATERIALS AND METHODS

SUBJECTS

Twenty burnt children (9 males and 11 females), with age ranged from 10 to 13 years were included in this study. They were collected randomly from the burn unit in Kasr El-Ainy Hospital, as having burn in their upper extremities (in the palmer surface of the forearm). As a result of their burn, they were suffering from a decrease in wrist dorsi-flexion ROM and pain. Medical specialist before the study routinely conducted medical evaluation of all patients. None of them reported a history of other skin abnormalities in the area to be treated. No associated injuries, anemia or pathological conditions have been identified. They were randomly classified into two groups, each comprised 10 patients: the control and the study groups.

MATERIALS

a) For treatment:

Infra red laser unit (Laser LTU 904H): The laser unit is a small hand-held machine class-1 laser product, under the existing requirements of the US Food and Drug Association Regulation. It is manufactured by Laserex Technology Ltd., Australia. It sends invisible light waves into the tissues to a depth of 20-30 mm.

b) For evaluation:

- Sterilized transparency film.
- Fine tipped transparency marker.
- Carbon papers.
- Metric graph papers (1mm).
- White papers.
- LCD goniometer.
- Present pain intensity scale (Form 1).

Form (1): Shows the Present pain intensity scale

Grade	Definition
0	No pain
1	Mild pain
2	Moderate pain
3	Severe pain
4	Unbearable pain

Adopted from Sriwatanabul et al (1982)[27]

METHODS

For evaluation:

The measurements of burn wound surface area were conducted before and after

eight weeks of treatment. The investigator placed a plastic sheet over the burn (after being cleaned with anti-septic solution) and traced the burn s parameters with a fine tipped transparency marker. The carbon paper was placed over the metric graph paper, then traced transparency film was placed over a carbon paper, with a white paper in between. The tracing was transcribed onto the metric graph paper and the number of square mm on the metric graph paper was calculated, within the wound tracing. The measurement for each wound was repeated for three times and the mean value was recorded as the actual reading.

The measurement of wrist dorsi-flexion ROM was achieved while the patient was in sitting position, resting his/her forearm pronated on a table. The fixed arm of the goniometer was placed parallel to the ulnar side. The wrist joint was moved passively, within the limit of pain, to the maximum available dorsi-flexion range. Then, the degree of wrist dorsi-flexion was recorded.

Assessment of the present pain intensity (PPI) for each subject was done before and after treatment for both groups through the PPI scale (Form1)[27].

For treatment:

Patients belonging to the control group received a physical therapy program, which comprised positioning, splinting and remedial exercises, aiming for relieving pain, decreasing muscle spasm and preventing contracures. Duration of each session lasted for an hour. On the other hand, the study group patients were exposed to the same line of treatment in addition to IR laser bio-stimulation for the burnt area. The patient was placed in the supine position. The investigator stood beside the patient and the unit head was placed perpendicular to the burn area. The head of laser unit was cleaned with sterilized solution before and after application for each patient. The burn area was divided into equal zones. The main power switch was turned on. The Hi/Lo power switch was turned to Hi position. Time of treatment was 10 minuets for each zone.

All patients were treated for five days per week, for eight successive weeks. All of them, whether from the control or the study group, received equivalent nursing care.

RESULTS

The collected data were statistically treated to show the mean, standard deviation and standard error of the mean for both groups. The student test was then utilized to examine the significance of treatment in each group. It revealed no significant difference between both groups before the application of treatment ($t < 0.05$), which insures homogenous sampling.

As shown from table (1) and fig. (1), the mean values of wound surface area in the study group before treatment was 148.8 ± 31.08 mm, which decreased after eight weeks of the combined treatment to 104.2 ± 41.66 mm^2. The mean difference was 44.6 mm^2, representing a percentage of change of 29.97%, suggesting a highly significant improvement ($t = 6.5947 < 0.001$). Concerning the control group, the mean value of wound surface area was 137.7 ± 30.38 mm
treatment, which decreased to 128.5 ± 26.22 mm^2 after treatment, with a mean difference of 9.2 mm^2. The percentage of change was 6.68%, which suggests a significant improvement ($t = 2.7446 < 0.05$).

Table (1): The mean values of wound surface area in both groups (in square mm) before and after eight weeks of treatment as well as the percentage of change.

Comparison	Study		Control	
	Before	After	Before	After
Mean	148.8	104.2	137.7	128.5
SD	± 31.08	± 41.66	± 30.38	± 26.22
MD	44.6		9.2	
%of Change	29.97 %		6.68 %	
t	6.5947		2.7446	
p	< 0.001		< 0.05	

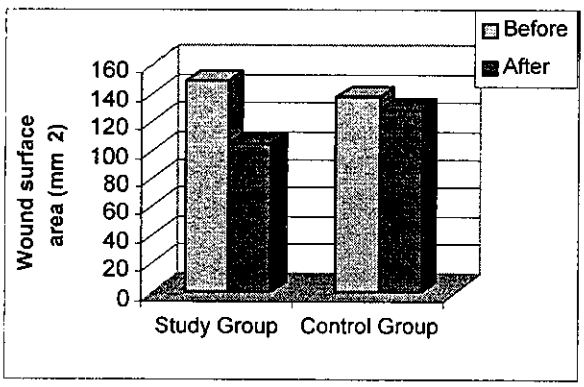

Fig. (1): The mean values of wound surface area in both groups before and after treatment.

Table (2): The mean values of wrist dorsi-flexion ROM in both groups (in degrees) before and after eight weeks of treatment as well as the percentage of change.

Comparison	Study		Control	
	Before	After	Before	After
Mean	47.0	55.2	45.1	46.3
SD	± 5.185	± 9.211	± 4.886	± 5.021
MD	8.2		1.8	
%of Change	17.45 %		3.33 %	
t	5.7108		3.1364	
p	< 0.001		< 0.02	

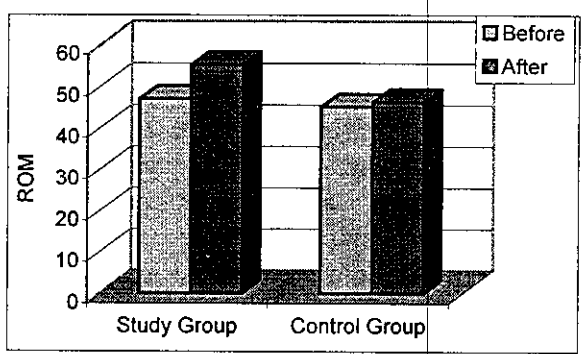

Fig. (2): Shows the mean values of wrist dorsi-flexion ROM in both groups (in degrees) before and after treatment.

The results obtained from table (2) and fig. (2), present the mean value of wrist dorsi-flexion ROM in the study group. It was 47.0 ± 5.185° before treatment, which increased after the suggested period of treatment to 55.2 ± 9.211°, with a mean difference of 8.2°. Such an increase had a percentage of change of 17.45%, which indicated a highly significant difference (t = 5.7108 < 0.001). The mean values of wrist dorsi-flexion ROM in the control group increased also from 45.1 ± 4.886° before treatment with the traditional physical therapy methods to 46.3 ± 5.021° after treatment, forming a mean difference of 1.8 and a percentage of change of 3.33%, suggesting a significant difference (t = 3.1364 < 0.02).

As shown from table (3) and Fig. (3), the mean value of PPI score before treatment in the study group was 3.3 ± 0.675, which decreased eight weeks after treatment to be 2.4 ± 0.516.

Similarly, in the control group, the mean value of PPI scores before treatment decreased from 3.2 ± 0.632 before treatment to 2.6 ± 0.699 after treatment, representing a percentage of reduction in both groups was 27.27% and 18.75%, respectively. Significant differences were found in both groups, but in favor of the study group (t= 5.0111 < 0.001 and 2.7113, respectively).

Table (3): The mean values of present pain intensity (PPI) in both groups (in grades) before and after eight weeks of treatment as well as the percentage of change.

Comparison	Study		Control	
	Before	After	Before	After
Mean	3.3	2.4	3.2	2.6
SD	0.675	0.516	0.632	0.699
MD	0.9		0.6	
%of Change	27.27 %		18.75 %	
t	5.0111		2.7113	
p	< 0.001		< 0.05	

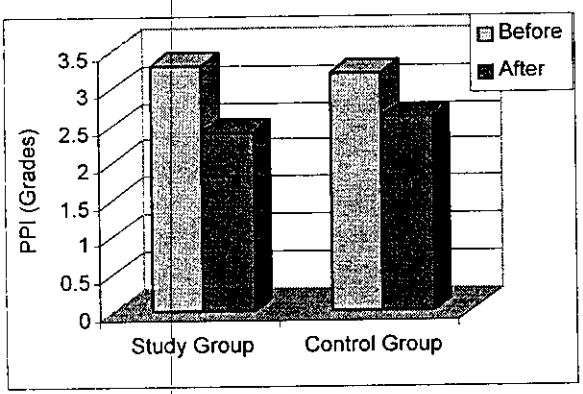

Fig. (3): The mean values of present pain intensity (PPI) in both groups (in grades) before and after treatment.

DISCUSSION

Healing of wounds is the main problem for the physical therapist, which deals with many functional problems of burnt patients. The ultimate goals of wound management are to allow a wound to close as rapidly as possible, to resemble the original tissue as near as possible and to produce the least amount of scarring[23].

Laser may be an effective adjunct modality to promote wound healing. Increased rates of epidermal regeneration, collagen synthesis, granulation tissue formation and wound closure have been reported with low intensity laser application on wounds and burns[10]. Several researchers investigated the bio-stimulation effect of laser and revealed many positive effects of the rays, including acceleration of wound healing[20,21], pain reduction and retardation of skin cancer[9].

It would be expected that the perception of pain would be reduced by techniques aimed at increasing the concentration of inhibitory neuro-transmitters and/or reducing the concentrations of excitatory neuro-transmitters. It was also reported that infra-red laser stimulates the gate control to inhibit pain pathways[16,17,26].

The findings of this study indicated considerable differences in measuring mean values of burn size in the control group patients after treatment, as compared with the pre-treatment values. A significant difference was also recorded between the mean values of both the study and control groups at the end of treatment.

The results of the present piece of work coincide with those reported by Hardy et al.,[12], Lam et al.,[19], Abergel et al.,[1], Patterson and Blaylock[22] and Baxter et al.,[5]. In their study, increased tensile strength was recorded in skin wounds of rabbits, bio-stimulated daily with pulsed IR laser for a period of 21 days. However, non-stimulated wounds on the contra-lateral side in the same animal also showed an increase in tensile strength[6].

The present results also came in agreement with the results of (Hunter et al.,[14] and Basford et al.,[3]). They stated that enhanced rates of wound and burn healing were reported in rats and guinea pigs with low-intensity laser therapy.

Averabakh et al.,[2] attributed the effect of laser therapy in promoting wound healing to be due to an increase in fibroblast proliferation (fibroplasia) and faster collagen synthesis. The promoted wound healing in the present study may be due to the ability of immune cells to combat invading pathogens. Baxter[4] stated that

the immune system is an important and integral part of the healing process. The lymphocytes, in particular, are responsible for the release of soluble mediators of immunity and of tissue repair.

Another factor, which might have affected the burn size and rate of healing, is the formation of the prostaglandin (PG). This explanation was an observation reported by Hunter et al (1984)[14]. In 1988, Enwemexa[8] added that such an improvement might be attributed to increasing ATP synthesis by enhancing electron transfer in the inner membrane of the mitochondria.

The mechanism for the acceleration of wound healing with low-energy laser bio-stimulation involved acceleration of the messenger ribo-nucleic acid (mRNA) transcription rate of the collagen gene or other enzymatic changes, following bio-stimulation[1]. It has been revealed that bio-stimulated full thickness skin wounds daily in rats with ruby and He Ne laser caused faster healing of wounds. They also found an increased collagen in wounds, treated with He Ne laser compared to wounds treated with ruby laser. The maximum effect was observed at an energy density of 4 J/cm[15].

On the contrary, the results of this piece of work disagreed with those of Santoianni et al., (1984)[25] and Hallman et al., (1988)[11], who failed to find, accelerated, wound healing after laser application.

CONCLUSION

From the results of this study, it can be concluded that application of IR laser therapy is a valuable method for treating and improving the healing process and the subsequent pain reduction among patients, suffering from superficial and deep thermal burns.

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الملخص العربي

تأثير أشعة الليزر تحت الحمراء على التئام جروح الحروق عند الأطفال

تهدف هذه الدراسة إلى تقويم تأثير أشعة الليزر تحت الحمراء على التئام جروح الحروق وتخفيف الألم، فقد تم إجراء هذا البحث على عشرين طفلا من مرضى الحروق تراوحت أعمارهم من ١٠ إلى ١٣ عاما، قسمت العينة عشوائيا إلى مجموعتين ضمت كل مجموعة عشرة مرضى: المجموعة الضابطة و المجموعة محل البحث ، عولجت المجموعة الأولى (الضابطة) باستخدام العلاج التقليدي في مثل هذه الحالات وهو يتكون من بعض الأوضاع العلاجية و التعليق بالإضافة إلى التمرينات العلاجية، بينما تم علاج المجموعة الأخرى (محل البحث) بواسطة نفس الأساليب السابقة مع استخدام أشعة الليزر تحت الحمراء على مكان الجرح، وقد تم إجراء الاختبارات المناسبة للمجموعتين لقياس مساحة المنطقة المصابة باستخدام طريقة الرسم البياني مع قياس مدى حركة فرد مفصل الرسغ بالإضافة الى قياس مدى شدة الألم قبل و بعد ثمانية أسابيع متصلة من العلاج، وقد أظهرت النتائج حدوث تحسن ذو دلالة إحصائية في مرضى المجموعتين بعد انتهاء فترة العلاج ، مع وجود فروق واضحة لصالح المجموعة محل البحث. وبذلك يعد العلاج باستخدام أشعة الليزر تحت الحمراء علاجا فعالا للمساعدة في التئام الجروح وتخفيف الألم الناجم من الحروق لدى الأطفال.