Low Level Laser Therapy—a conservative approach to the burn scar?

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Abstract

Burn scars are known to be difficult to treat because of their tendency to worsen with hypertrophy and contracture. Various experimental and clinical efforts have been made to alleviate their effects but the problem has not been solved. Since patients keep asking for Low Level Laser Therapy (LLLT) and believe in its effectiveness on burn scars, and since former studies show contradictory results of the influence of LLLT on wound healing, this prospective study was designed to objectify the effects of LLLT on burn scars.

Nineteen patients with 19 burn scars were treated with a 400 mW 670 nm Softlaser twice a week over 8 weeks. In each patient a control area was defined, that was not irradiated. Parameters assessed were the Vancouver Scar Scale (VSS) for macroscopic evaluation and the Visual Analogue Scale (VAS) for pruritus and pain. Photographical and clinical assessments were recorded in all the patients.

Seventeen out of 19 scars exhibited an improvement after treatment. The average rating on the VSS decreased from 7.54 ± 2.13 to 4.68 ± 2.05 points in the treated areas, whereas the VSS in the control areas decreased from 6.42 ± 2.86 to 5.88 ± 2.72. A correlation between scar duration and improvement through LLLT could be found. No negative effects of LLLT were reported. The present study shows that the 400 mW 670 nm softlaser has a positive, yet sometimes limited effect on burn scars concerning macroscopic appearance, pruritus, and pain.

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1. Introduction

One of the major goals of surgical burn treatment must be the avoidance of excessive scarring. Once scars have formed, they are known to be difficult to treat because of their tendency to worsen with hypertrophy and contracture. Various experimental, conservative clinical and surgical efforts have been made but the problem has not been solved yet. Therapies such as surgical excision, dermabrasion, compression with silicone, and corticosteroids do not provide optimal results in the treatment of burn scars [1–4].

As a clinician one makes the frequent observation that patients with burn scars often undergo a treatment with Low Level Laser Therapy (LLLT) by general practitioners or dermatologists after discharge from hospital. Being involved in the primary treatment as burn surgeons we are frequently confronted with the patients’ question about the effectiveness of this ‘paramedical’ strategy for burn scars.

Low-level lasers are defined by a power density at less than 500 mW/cm\textsuperscript{2} [5–8]. According to experimental studies, low-level laser radiation activates individual cells via three principal effects:

1. The photobiological action mechanism via activation of the respiratory chain. Primary photoacceptors are terminal oxidases as well as NADH-dehydrogenase.
2. Activation of other redox chains in cells. In phagocytic cells irradiation initiates a nonmitochondrial respiratory burst (production of reactive oxygen species, especially superoxide anion) through activation of NADPH-oxidase located in the plasma membrane of these cells. The irradiation effects on phagocytic cells depend on the physiological status of the host organism as well as on radiation parameters.
3. Indirect activation of cells via secondary messengers released by directly activated cells. Reactive oxygen species produced by phagocytes, lymphokines and cytokines produced by various subpopulations of lymphocytes, or NO produced by macrophages or as a
result of NO-hemoglobin photolysis of blood cells [5].

In clinical studies, many investigators have found contradictory results of the effects of LLLT on wound healing. In laboratory animals accelerated wound closure, increased wound epithelialisation and improved tensile strength of scars were seen [9–12]. Many other studies showed no improvement of the healing process through LLLT and the above mentioned effects could not be reproduced. Recently, an experimental study on rats was published with no significant improvement of the healing of burns injuries after LLLT [13].

However, the benefits of LLLT in wound healing are still controversial and in spite of many discussions about possible effects of low power laser light and widespread clinical application by general practitioners and dermatologists, the effects of LLLT on burn scars have not been the subject of clinical studies in human beings up to now.

This present prospective study was designed to objectify the effects of LLLT in the avoidance, prophylaxis, and treatment of burn scars.

2. Materials and methods

After approval by the Local Ethics Committee, 19 patients (14 male, 5 female, aged 18–77 years, mean 38 ± 2 years) were included in the study (patient characteristics are summarized in Table 1). In each patient one burn scar was selected as lesion that should be irradiated, and one similar burn scar was defined as a control area that should stay untreated.

All patients had suffered from burn scars within 1–194 months prior to presentation. None of the patients had received treatments with corticosteroids, dermabrasion, compression with silicone or excision before LLLT; none of the treated lesions had been initially treated with grafts. Before the treatment 12 patients reported pruritus and pain; one patient suffered from pain only, whereas two patients suffered from isolated pruritus.

2.1. Administration of Low Level Laser Therapy (LLLT)

LLLT was administered on an outpatient basis following security guidelines for low-level lasers (security glasses; warning light outside the door of treatment room during radiation). A softlaser (Helbo®; Gallspach, Austria; Fig. 1) with a continuous laser power diode output of 400 mW, emitting red laser light with a wavelength of 670 nm and a defocused laserbeam forming a circle, was used for radiation. The applied energy density (dose) was 43 J/cm² and the laserbeam was adjusted to correspond to the size of the lesion. Radiation time and distance between diode and wound varied with the size of the lesion as a result of the defocused laserbeam. The treatment was performed twice a week, with a minimum interval of 3 days, over 8 weeks.

Clinical documentation was obtained by macroscopic evaluation according to the Vancouver Scar Scale (VSS) [14,15], which considers height, pliability, pigmentation, and vascularity. To objectify pruritus and pain patients were asked to rate both symptoms using the Visual Analogue Scale (VAS).

Digital photographs were made of the lesions using the same camera, identical settings, and lighting. Macroscopic evaluation was performed by an independent physician before and after the complete treatment. Concurrently patients rated their pruritus and pain.

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M, male; F, female; F, face; T, trunk; E, extremities.
2.2. Statistical analysis

The mean values for points on the VSS of treated and untreated areas, as well as of treated scars younger and older than 12 months, were compared. To objectify pruritus and pain, the mean values for points on the VAS before and after LLLT were compared. Data of the burn scars went through statistical analysis using the Statistica software package (Statsoft®; USA). Unless otherwise stated, data is presented as mean ± S.D. For analysis a two-tailed paired t-test was used. \( P < 0.05 \) was considered as the level of significance.

3. Results

Seventeen out of 19 lesions showed macroscopic improvement after the treatment (expressed in points on the Vancouver Scar Scale) (Fig. 2); two lesions did not improve. Before the treatment the scars that were to be radiated were classified on an average of 7.10 ± 2.13 points on the VSS. This number decreased to 4.68 ± 2.05 points after the treatment. The respective data of the control areas were 5.86 ± 2.71 points before and 5.40 ± 2.66 points after the treatment (Fig. 3). None of the scars became worse. A significant difference in improvement between burn scars younger and older than 12 months could be found in the VSS: lesions deriving from a thermal trauma less than 12 months prior to LLLT showed better results (Fig. 4).

All but one of the patients, who had reported pain or pruritus before the treatment, experienced relief of their symptoms through LLLT (Fig. 5). The mean on the VAS decreased from 3.89 ± 3.07 to 1.42 ± 1.67 for pain and from 4.36 ± 3.26 to 1.31 ± 1.88 for pruritus. In words this means that three patients were cured completely of pain and pruritus, three patients reported complete cessation of pruritus, and one patient reported cessation of pain. Negative effects of LLLT were neither seen nor reported by the patients.

4. Discussion

It is a general phenomenon that patients who suffer from clinical symptoms which are difficult to treat have the tendency to switch to 'paramedic’ therapies. At present LLLT is still to be considered ‘paramedic’. As clinicians we have to be able to advise our patients if this particular therapy is helpful or might worsen their symptoms.

Recent studies in laboratory animals show diverging results of the effects of LLLT [9,11,13,16]. Nevertheless, the present study clearly shows that LLLT has a beneficial effect on burn scars in human beings. In general, the scars became softer and more pliable. The irradiation gave them relief from pruritus and pain and sometimes improved the pattern of scars within the mesh grafts (Fig. 6). Nevertheless, these effects are sometimes limited and a complete disappearance of the scars cannot be expected. Patients in this...
Fig. 2. Patient with burn scar on the neck after nonoperative treatment. (A) Before treatment (7 points on Vancouver Scar Scale). (B) After 8 weeks of treatment (5 points on Vancouver Scar Scale rating).
study with burn scars not older than 12 months had a greater benefit from the treatment. All the results were proven to be significant after statistical analysis.

The dose, interval, and duration in the present study were set according to the experiences with the same laser in other applications [17,18]. The control areas were chosen to be in the same individual, as it is common for studies with burn patients [19].

The soft laser that was used for the present study had a maximum power output of 400 mW. The lasers generally used in private offices are so called ‘minilasers’ (softlasers in pen size; laserbeam with constant spot <1 cm²) which are

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Fig. 3. Average rating of the scars according to the Vancouver Scar Scale before and after treatment.

Fig. 4. Average rating of the irradiated scars according to the Vancouver Scar Scale. Difference between scars older and younger than 12 months.

Fig. 5. Average rating of the pain and pruritus rated by a visual analogue scale before and after treatment.

Fig. 6. Disappearance of the pattern of mesh grafts during treatment with LLLT: (A) Before; (B) after.
4–100 times less powerful (maximum power output ranging from 10 to 100 mW).

Compared to the softlaser that was used for the present study minilasers cannot adapt to the size of a lesion because they are focused, and moreover they have to be held by hand instead of being fixed in a mechanical arm. Even if a lesion was scanned by hand with the minilaser’s spot, radiation time would be in hours to apply the same dose that was used in our study. Radiation time in our study never exceeded 10 min.

For all these reasons it is doubtful if comparable effects can be achieved with ‘minilasers’.

Furthermore, there needs to be a discussion of conflicting data in the recent literature concerning LLLT because of the systemic effect that has been supposed by some authors [10,16–22]. In many studies treated and untreated areas in the systemic effect that has been supposed by some authors [11,13,16]. Our study also defined a control area in the same individual that remained untreated and found a significant difference between treated and untreated areas. In the special situation of burn patients with different scar formations, the design of the present study is the better alternative.

Although patients in the present study had to come to the clinic twice a week over 8 weeks and effects of the treatment were not visible immediately, no patient quit the study. This is probably due to a side effect that a lot of ‘paramedic’ therapies have in common. Patients who have survived a severe trauma and are then discharged from hospital are left alone in a difficult period of rehabilitation. A longtime treatment such as LLLT provides them with a physician who continuously takes care of their problems after the acute phase of burn treatment. The present study suggests that a planned regime of treatment with LLLT can have significant benefit for a considerable proportion of patients during the rehabilitation stage.

References


