EFFECT OF LOW POWER GALLIUM ARSENIDE LASER ON HEALING OF VENOUS ULCERS

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Abstract. The healing of venous ulcers of the leg with and without gallium arsenide laser treatment was studied in 42 patients randomly divided into two groups. One group received standard conservative treatment and gallium arsenide laser, and the other received the same standard treatment and placebo laser treatment. There were no differences in results between the two groups.

Key words: low power laser, wound healing, venous ulcer, gallium arsenide.

Since the introduction of laser and laser therapy, medical lasers have become easier to use, cheaper, and more widely available to the medical community than in the past (6, 9). The high power (10–100 W) applications, mainly with carbon dioxide (CO₂) and Nd-YAG lasers that are used for surgical cutting and haemostasis, are well known; however, less dramatic but potentially important biological effects at powers as low as fractions of mW have also been reported (9).

Low energy laser generally has an output of 1–10 mW (4). The depth of penetration of unfocused (laser) light hitting the human skin increases with the wavelength (10). The depth of penetration is defined as l/e or 37% of the inclining light. The penetration depth for gallium arsenide laser is 1.4 mm (1), and it therefore seems appropriate for the treatment of skin ulcers.

Wound healing was one of the first areas in which the effect of low energy lasers was investigated. Improvements in the early phases of wound healing have been widely reported in small animals such as rabbits and rodents, as well as in ulcers in human skin (4, 8, 11). Unfortunately many of the studies were poorly controlled or inadequately described, and some similar effects from non-coherent monochromatic light sources have been seen (4). We therefore thought that it would be of interest to study the effects of low energy laser in a group of patients with venous ulcers of the leg, and have compared regular conservative treatment and Ga-As laser with regular treatment and placebo laser.

PATIENTS AND METHODS

Forty-two patients with venous leg ulcers were referred from departments of internal medicine and surgery, and primary health care centres. Patients were excluded if they had a skin allergy to the standard treatment, evidence of peripheral arterial disease, rheumatoid arthritis or diabetes mellitus, a venous ulcer directly caused by trauma, or ankle pressure below 75 mmHg.

The patients were randomised by permuted blocks to either a laser group or a placebo group.

The laser group comprised 21 patients (11 women and 10 men; mean age 60 years, range 43–77) with a mean ulcer area of 12 cm² (range 4–52). Three ulcers were deep (>1 cm) and 18 were superficial (≤1 cm). The placebo group consisted of 21 patients (12 women and 9 men; mean age 61 years, range 46–76) with a mean ulcer area of 14 cm² (range 3–44 cm²). One ulcer was deep, the others superficial.

A GaAs laser (Irradia) was used. The wavelength was 904 nm, average output 4 mW, peak power 10 W, pulse frequency 3 800 Hz and duration 180 nsec, and divergence 70 mrad. Energy density was 1.96 J/cm². The output was checked and measured every two weeks by Martinsson AB, Stockholm.

The placebo laser unit was of the same brand but the invisible GaAs laser light had been removed so that nobody involved in the study could tell the difference between the two.

Treatment regimens

At every session the active or placebo laser was held perpendicular to the surface of the wound for 10 min.
The patients were treated twice weekly for 12 weeks, unless ulcers healed sooner. Conservative treatment consisted of cleaning the wound with normal saline and applying a paste bandage covered by an elastic diachylon bandage with a pressure of roughly 15-25 mmHg. An exercise programme was given on a standard instruction sheet.

**Evaluation of results**

Every patient had a baseline tracing of the ulcer area made. The ulcers were classified as deep (>1 cm) or superficial (≤1 cm), and the tracings were identified by code numbers to exclude observer bias. The Wilcoxon rank sum test was used to compare the percentage change in area of ulceration. The cumulative percentages of healed ulcers in the two groups were compared by lifetable analysis. Enough patients were studied to detect a 40% increase of ulcer healing with 80% power (p<0.05).

**RESULTS**

Ten of the 42 patients were withdrawn from the study after randomisation (Table I). Ulcers healed within 12 weeks in four patients in each group (Table II). The rate of healing between the two groups did not differ significantly.

When the decrease in ulcer area against time for all patients who completed the trial was compared, there was no significant difference between the groups at any stage of the study (Table II).

**DISCUSSION**

Wound healing was one of the first areas in which the effect of low energy lasers was investigated (4). Improvements in the early phases of experimental wound healing were widely reported in rabbits and rodents (4, 11). Species-specific effects may be important. In human and pig skin healing by wound contraction is much less important than it is in rats and other loose-skinned animals. Other similarities between pig and human integument include skin thickness and turnover times (3, 8, 12). The potentially non-responding swine may therefore prove to be a better model than rats and other rodents for the prediction of results in humans (8). On the other hand, Anneroth et al. (2) could not improve wound healing with GaAs lasers in rats. Other studies have shown that low energy lasers may have a stimulatory effect on fibroblast proliferation and wound healing (7). In particular, low energy laser irradiation at energies of 1-5 J/cm² was reported to increase collagen production by human fibroblasts as well as to stimulate production of Type I and III procollagen messenger RNA (5).

In 1985 Mester et al. reported that low energy laser treatment had been successfully used to treat ulcers that did not respond to conventional care (13). They reported that 78% of 1120 treated ulcers had healed, from 12 to 16 weeks. Unfortunately, efforts at controlling the treatments were minimal and the patients were inadequately described. In the present study there was no significant difference between the effects of GaAs laser and placebo in the treatment of venous ulcers of the leg. This may be the result of the mode of laser used, the dosage, the duration of irradiation, the treatment intervals, or the state of the wounds. It is important to remember that wounds vary as far as blood and nutrient supply, degree of healing, neovascularisation and degree of inflammation are concerned.
Laboratory studies have shown that low energy laser may affect cell function, but how and if these effects might accelerate wound healing has not been settled (14). Before a new treatment is introduced into practise it should have been shown to be beneficial, and ideally be either better than—or at least equal in efficacy to—alternative methods. The present results do not support the use of low energy GaAs laser in the treatment of venous leg ulcers.

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REFERENCES