Low-Power Laser Therapy in Rheumatoid Arthritis

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Abstract. Thirty-five patients suffering from rheumatoid arthritis were allocated at random to treatment with either a low-power laser (3.58 J cm^{-2}, continuous wave 820 nm) or a placebo in a 4-week, double-blind study. Eight finger joints (2nd–5th metacarpo- and proximal interphalangeal joints) of the most affected hand were treated. In the laser group the grip strength and finger flexibility improved, the swelling of the joints declined, the morning stiffness and pain decreased. The sedimentation rate and the number of leukocytes showed a fall with a significant trend. In the placebo group there were no changes in these parameters except for the registration of pain, where a significant, less than with the laser, effect was observed. Thus, low-power laser therapy, at the chosen wavelength and energy dose, appears to be effective against the classical complaints from rheumatoid arthritis.

INTRODUCTION

About 3.2% of the adult, noninstitutionalized population suffer from rheumatoid arthritis (RA) using ARA probable RA criteria (1). The disabling course, the lack of curative medication, and the frequent side effects of the drugs normally used demand constant testing of alternative and new treatments. Low-power lasers have been used sporadically in rheumatic diseases (2–4) and for other painful conditions (5) without any observed side effects.

The aim of the present study has been to evaluate such therapy in a properly designed, double-blind, placebo-controlled study in patients suffering from rheumatoid arthritis.

SUBJECTS AND METHODS

Thirty-five patients (28 females and 7 males) with classical rheumatoid arthritis were chosen, by random selection, for treatment with either a low-power or a placebo-dummy laser. This was done after informed consent according to the Helsinki declaration II. The trial was performed as a double-blind study. Basic medication was kept unchanged throughout the entire study and only patients with a stable disease were included. Data on sex distribution, age ranges and duration of disease appear in Table 1. All participants had functional capacity between I and III according to the Steinbrocker classification (6). One female from the laser group was exluded after initial examination and therapy because of hospitalization elsewhere for a non-arthritic disease.

Table 1. Thirty-five patients with stable, classical rheumatoid arthritis randomized to treatment with either low-power or placebo-dummy laser therapy

	Low-power laser	Placebo
Number of females	14	14
Number of males	5	2
Age range females (years, mean and [range])	61.1 [29–76]	57.5 [39–70]
Age range males (years, mean and [range])	66.0 [56–73]	68.0 [66–70]
Duration of RA (years, mean and [range])	13.4 [1–45]	15.5 [4–30]

The 2nd to 5th metacarpo- and proximal interphalangeal joints of the most affected hand were treated 3 times a week for 4 weeks. Each joint was treated for 60 s on each lateral side in every session. Before the first treatment, and after 6 and 12 treatments, the following parameters were evaluated: grip strength estimated from the ability to compress a standardized balloon measuring the power in kilopascals (kPa);

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the distance (mm) between fingerpulps and palm calculated as a mean of the four ulnar pulps; the swelling of the finger joints (arbitrary units) measured by a perforated plastic scale with holes of different size; anamnestic data on morning stiffness (h) and pain (indexed by visual analog scale a.m. Huskisson (7). Blood samples were drawn at the same time, and the erythrocyte sedimentation rate (ESR, mm h^{-1}), number of leukocytes ($10^9 l^{-1}$), fraction of lymphocytes (%), plasma concentrations of fibrinogen (mmol l^{-1}) and haemoglobin (Hb, mmol l^{-1}) were measured by standard procedures in our laboratory.

The laser apparatus used was a Biotherapy 3, manufactured by Omega Universal Technologies Ltd London, UK. It was fitted with an 820 nm, polarized, 15 mW, narrow profile Ga–Al–As semiconductor laser diode. The mode was continuous wave. The beam divergence was 6 degrees and the area of the diode was 0.1256 cm^2. The placebo was a similar but disconnected diode. The diodes used were completely similar in appearance except for an inkmark with *X* or *Y*. An independent employee who did not participate in the study was the only one who knew the codes. The active laser treatment gives no signals at all (neither visible light, sounds, heat nor vibrations).

Groups were compared using the Mann-Whitney two-sample test for unpaired observations. The within-group variations were analyzed using the Friedman test for paired observations and the Page test for trends. The data from the registration of pain were compared by regression analysis on the calculated median values obtained at each event of evaluation.

RESULTS

During the trial the grip strength (Fig. 1, upper left) improved in the laser-treated group from 19.0 to 25.0 kPa ($p < 0.001$) whereas a decrease in the placebo group from 17.0 to 15.5 kPa was not statistically significant.

The swelling of the treated finger joints (Fig. 1, lower right) decreased from 9.13 to 8.25 arbitrary units ($p < 0.001$). The swelling of joints in the placebo group remained unchanged (8.63–8.50 units, n.s.).

The mean distance from the finger pulps to the palm (Fig. 1, upper right) decreased from 6.5 to 0.0 mm ($p < 0.005$) in the laser group; no significant changes were found in the placebo group (3.5–6.0 mm).

A significant decreasing trend of the duration of morning stiffness (Fig. 1, lower left) from 1.25 to 0.5 h was seen in the laser group ($p < 0.01$), whereas the trend in the placebo group was not statistically significant (1.0–0.8 h).

Fig. 2 shows the relationship between the calculated median values of pain in the treated hand prior to each event of treatment. Both the laser and the placebo group experienced a statistically significant declining pain level ($p < 0.001$), as registered by the patients themselves. However, their slopes, as calculated from linear regression analysis, ($y_{laser} = -1.39 \times +36.28$, $y_{placebo} = -0.99 \times +31.12$, $F_{slope} = 2.70$, n.s.) was significantly different ($p < 0.001$). As concerning all clinical measurements the two groups were comparable at the start.

Table 2 shows the biochemical variables evaluated thoughout the study. The variation in median values of ESR in the laser group just

Table 2. Biochemical variables before, halfway, and after 4 weeks therapy with either placebo or low-power therapy. (Values are given as medians with 95% confidence limits in brackets.)

		t_0	t_6	t_{12}
ESR (mm h^{-1})	laser	28.0 (18–49)	29.5 (12–45)	19.0 (10–40)
	placebo	24.5 (13–47)	18.3 (14–40)	25.5 (16–39)
Fibrinogen (mmol l^{-1})	laser	12.5 (9.7–13.2)	12.4 (9.1–14.1)	12.1 (9.4–13.8)
	placebo	10.2 (9.1–12.4)	10.9 (10–12.1)	10.6 (9.4–13.5)
Leukocytes ($10^9 l^{-1}$)	laser	8.8 (7.2–11.1)	8.3 (6.3–10.5)	7.7 (6.6–9.8)
	placebo	6.4 (5.3–7.3	6.0 (5.2–7.1)	6.1 (4.9–7.2)
Lymphocytes (%)	laser	19.0 (13–26)	24.0 (16–30)	21.5 (14–32)
	placebo	15.0 (10–25)	16.5 (11–25)	18.5 (12–25)
Hb (mmol l^{-1})	laser	8.1 (7.6–9.0)	8.2 (7.6–9.5)	8.1 (7.5–9.1)
	placebo	7.5 (6.9–8.3)	7.6 (7.1–8.3)	7.5 (7.0–8.1)

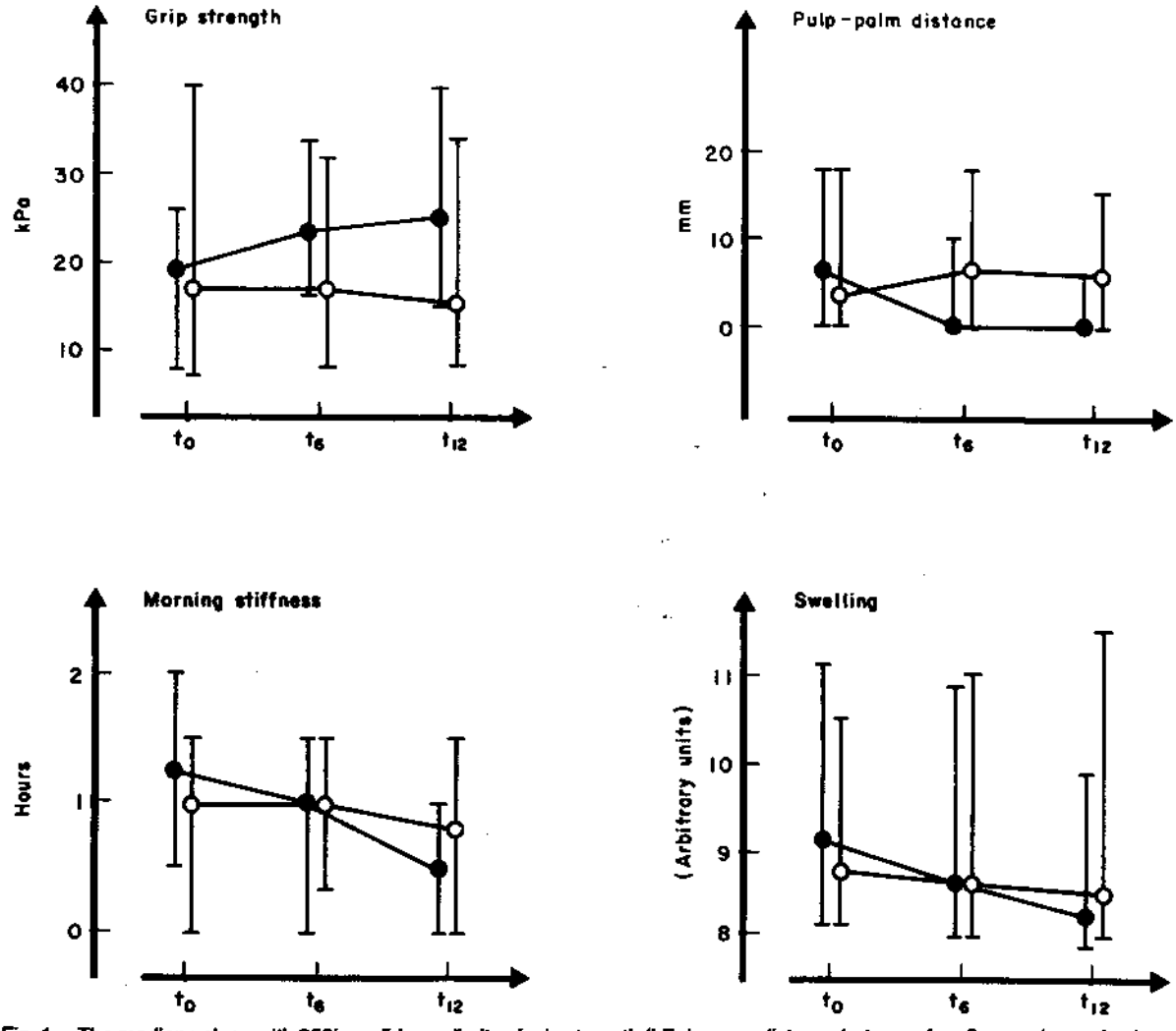

Fig. 1. The median values with 95% confidence limits of grip strength (kPa), mean distance between four fingerpulps and palm (mm), duration of morning stiffness (h), and mean swelling of four proximal interphalangeal joints (arbitrary units) in a low-power laser treated (●) and a placebo treated (○) group. t_0 indicates start, t_6 half-way (6 treatments) and t_{12} cessation (12 treatments).

failed to reach statistical significance ($p = 0.06$) but the decreasing trend was significant ($p < 0.005$). In the placebo group no such trend was observed. The same pattern was observed for the number of leukocytes ($p_{trend} < 0.02$) in the laser group. The fraction of lymphocytes was unchanged in both groups. No significant changes in Hb and fibrinogen concentrations were observed in neither the laser nor the placebo group.

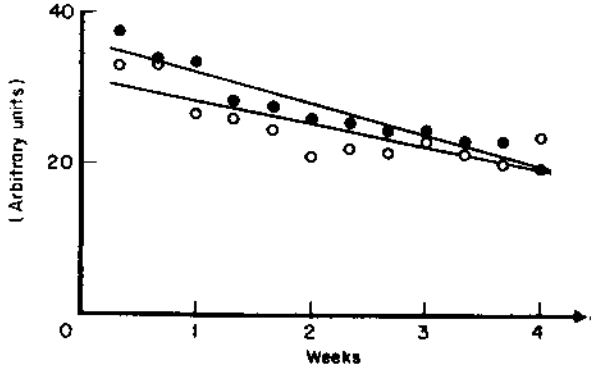

Fig. 2. The linear regression lines between number of pain evaluations (counted every second day) and the calculated median value of pain index (arbitrary units) at each evaluation in the two groups treated with either low-power laser or placebo therapy.

DISCUSSION

We have found that low-power laser therapy given to patients with rheumatoid arthritis causes a clinical improvement, as well as biochemical evidence of reduced activity in the disease.

The long-term prognosis of rheumatoid arthritis is not very encouraging whether treated medically or not (8–10). The symptoms can be relieved transiently but side effects may disturb the desired effects in many cases. Constant searching for new ways of therapy without or with minimal side effects is mandatory. The low-power laser used in our study fulfils such criteria. The treatment is atraumatic and painless, easy applicable, safe, and is not time consuming. It can be used synchronously with any other therapy. Other workers using high-power lasers (low total energy) have found that the beneficial effect, although declining, was still present after three months (3).

It has been shown that production of ATP increases during laser stimulation of tissue cells (11). Many molecules (chromophores), such as melanin, haemoglobin, beta-carotin and water, absorb light at specific wavelengths. Light given with a YAG-dye laser on the retina of rhesus monkeys, in the range between 550 and 915 nm, showed great differences in the absorption (D. Sliney; personal communication). We suggest that the local effect in rheumatic affected joints acts through a photochemical mode (12). The incoming photon energy (range 1–2 eV) is being absorbed in a chromophore specific for that wavelength. That light quanta can act as proliferative stimulus has been suggested, since AMP level changes after irradiation of hamster cells (13).

Furthermore, we propose that stimulation of macrophages (14), together with adding energy to inflamed synovial cells, may make it possible to remove the antigen-antibody complexes and to stabilize the membranes. As a matter of fact we found evidence of a systemic laser action since the ESR and the number of leukocytes showed a decreasing trend.

The improvement seen in the treated joints allow us to conclude that low-power laser therapy at the chosen wavelength and energy density can be recommended as a supplement to conventional treatment. It is supposed that the laser therapy is as effective when used on other joints. However, in such cases the energy per joint should be changed according to the size.

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