

# Improvement of Pain and Disability in Elderly Patients with Degenerative Osteoarthritis of the Knee Treated with Narrow-Band Light Therapy

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**Objective:** To evaluate the effects of low-power light therapy on pain and disability in elderly patients with degenerative osteoarthritis of the knee.

**Design:** Partially double-blinded, fully randomized trial comparing red, infrared, and placebo light emitters.

**Patients:** Fifty patients with degenerative osteoarthritis of both knees were randomly assigned to three treatment groups: red (15 patients), infrared (18 patients), and placebo (17 patients). Infrared and placebo emitters were double-blinded.

**Interventions:** Self-applied treatment to both sides of the knee for 15 minutes twice a day for 10 days.

**Main Outcome Measures:** Short-Form McGill Pain Questionnaire, Present Pain Intensity, and Visual Analogue Scale for pain and Disability Index Questionnaire for disability were used. We evaluated pain and disability before and on the tenth day of therapy. The period from the end of the

treatment until the patient's request to be retreated was summed up 1 year after the trial.

**Results:** Pain and disability before treatment did not show statistically significant differences between the three groups. Pain reduction in the red and infrared groups after the treatment was more than 50% in all scoring methods ( $P < 0.05$ ). There was no significant pain improvement in the placebo group. We observed significant functional improvement in red- and infrared-treated groups ( $p < 0.05$ ), but not in the placebo group. The period from the end of treatment until the patients required retreatment was longer for red and infrared groups than for the placebo group ( $4.2 \pm 3.0$ ,  $6.1 \pm 3.2$ , and  $0.53 \pm 0.62$  months, for red, infrared, and placebo, respectively).

**Conclusions:** Low-power light therapy is effective in relieving pain and disability in degenerative osteoarthritis of the knee. *J Am Geriatr Soc* 40:23-26, 1992

Degenerative osteoarthritis (DOA) is the most common rheumatic disorder of man and causes pain and disability especially in elderly people.<sup>1</sup> Autopsy surveys show that degenerative changes in joints begin as early as the second decade of life.<sup>2</sup> Roentgenographic studies conducted in the United States showed osteoarthritic changes in 4 percent of persons under 24 years of age and 85 percent at 75 to 79 years of age. Symptomatic manifestations of osteoarthritis increase with aging, reflecting disease changes that begin in early life and progress slowly over a period of many decades.<sup>3,4</sup>

Pain relief is the most important goal in management of DOA. To provide optimal analgesic care the treatment should be individualized. Attention must be paid to the pharmacokinetics and pharmacodynamics of drugs in the elderly, especially interactions with other medications and adverse effects on concomitant diseases.<sup>5-7</sup> To avoid or to reduce difficulties concerned with drug therapy, non-pharmacologic methods such as heat or cold treatment, TENS therapy, biofeedback, and physical exercises are frequently used.<sup>4,5</sup>

Principles of phototherapy were established at the end of the nineteenth century by N. R. Finsen, a Nobel Prize winner, for application of light treatment in skin

diseases.<sup>8</sup> Phototherapy is now employed in the treatment of psoriasis,<sup>9</sup> kernicterus,<sup>10</sup> and as photodynamic therapy (PDT) in the treatment of cancer.<sup>11</sup> Phototherapy was advanced with the introduction of laser treatment, initially in surgery.<sup>12</sup> The development of the infrared (830 nm) gallium-aluminum-arsenide and of the red (633 nm) helium-neon low-power laser, introduced phototherapy in wound healing and analgesia. Many investigators have described successful pain treatment in a variety of diseases.<sup>13,14</sup>

The purpose of this study was to evaluate the impact of red or infrared light emitters on pain relief, functional disability, and sparing of analgesic drug therapy in elderly patients with DOA of the knee.

## METHODS

The study was conducted at the Phototherapy Clinic of "Shmuel Harofe" Geriatric Medical Center from October 1989 to March 1990.

**Subjects** We recruited 50 patients (34 women, 16 men) aged 55 to 86 years (mean age  $68 \pm 8.7$  years). All patients fulfilled criteria for the diagnosis of DOA of both knees and had suffered from pain for at least 3 months. All patients signed an informed consent approving the procedures applied in this study. The following patients were excluded: patients with cancer, any acute disease, uncontrolled diabetes mellitus, untreated hypertension, neurological deficits (motor or sensory), psychotic disorders, dementia, mental retardation.

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dation or other organic mental disorders. Patients already on treatment for more than 6 weeks continued their medication with drugs that could interfere with the intensity of pain, such as antidepressants, minor tranquilizers, or analgesics.

**Study Design** Three types of light emitters were used: red, infrared, and placebo. The placebo emitter was like the infrared emitter in appearance but did not emit light. The study was conducted in double-blinded fashion for the infrared and placebo emitters but not for the red emitter where light is visible and produces a different treatment experience. All light emitters were supplied by AMCOR LTD. (Table 1). The emitters used in the double-blinded groups had code numbers, and their characteristics were unknown to the patients and medical staff. The patients were randomly divided into red, infrared, and placebo treatment groups.

Pain was evaluated by Short-Form McGill Pain Questionnaire (SF-MPQ), by Present Pain Intensity (PPI) Questionnaire, and by Visual Analogue Scale (VAS).<sup>15</sup> The main component of the SF-MPQ has 15 descriptors (11 sensory and four affective) that are scored from 0 to 3 (0 = none, 1 = mild, 2 = moderate, 3 = severe). The data obtained provide information on the sensory, affective, and total intensity of pain. PPI and VAS provide indices of total intensity of pain. PPI is scored from 0 to 5 (0 = no pain, 1 = mild, 2 = discomforting, 3 = distressing, 4 = horrible, 5 = excruciating). VAS is scored from 0 to 10 (0 = no pain, 10 = worst possible pain), and the patients are requested to record the impact of pain on this scale.

Patients' functional ability was measured by the Disability Index Questionnaire (DIQ).<sup>16</sup> DIQ has nine general components (dressing and grooming, arising, walking, hygiene, reach, grip, outside activity, and sex activity), each of which has one or more specifications. Each question is scored from 0 to 3 (0 = without difficulty, 1 = with difficulty, 2 = with some help from another person, 3 = unable to do). The index is calculated by adding the scores of the components and dividing it by the total number of components answered.

**Treatment** The treatment was applied at both sides of the knee for 15 minutes twice a day. Every treatment was composed of 7.5 minutes of continuous wave (CW) application and 7.5 minutes of pulse treatment. Total delivered energy was similar for the red emitters (10.3 joule) and the infrared emitters (11.1 joules). Energy

TABLE 1. LIGHT EMITTERS SPECIFICATION

	Red CW	Red Pulse	IR CW	IR Pulse
Output power (mW)	18	75	25	270
Illuminated area (cm <sup>2</sup> )	2	2	2	2
Power density (mW/cm <sup>2</sup> )	8	34	11	122
Pulses per second		100		100
Duty ratio (%)		10		1
Pulse time (ms)		1		0.1
Delivery energy (J/min)	1.08	0.45	1.5	0.16

CW = Continuous Wave; IR = Infrared.

density calculated as J/cm<sup>2</sup> was 5.1 for the red emitters and 5.6 for the infrared emitters.

At follow-up in May 1991 we summed up the interval that elapsed from the end of the study until the patient's request to be retreated because of pain.

**Data Analysis** Baseline characteristics of the groups were compared by one-way analysis of variance and unpaired *t* test. The data obtained from DIQ, SF-MPQ, PPI, and VAS before treatment, and the data obtained from the same tests after treatment, were evaluated using paired *t* tests.

## RESULTS

**Baseline Characteristics** The patients were randomly divided into three groups: red light group, 15 patients (10 women, five men); infrared light group, 18 patients (13 women, five men); and placebo group, 17 patients (11 women, six men). There was no significant age difference between the groups ( $P = 0.88$ ).

Pain evaluation before treatment, using SF-MPQ sensory, affective, and total components, did not show statistically significant between-group differences ( $P = 0.46$ ,  $P = 0.89$ ,  $P = 0.69$ , respectively). No differences in pain evaluation between the groups before treatment were found using the PPI and VAS methods ( $P = 0.13$  and  $P = 0.49$ , respectively). The degree of disability before treatment, evaluated by the DIQ method, was not statistically different between the three groups ( $P = 0.68$ ).

**Pain Evaluation after Treatment** Significant pain reduction (Table 2) was found in the red- and infrared-light groups, but not in the placebo-treated group, in

TABLE 2. MEAN PAIN RATING VALUES OBTAINED WITH SHORT-FORM MCGILL PAIN QUESTIONNAIRE (SF-MPQ), PRESENT PAIN INTENSITY (PPI) AND VISUAL ANALOGUE SCALE ADMINISTERED BEFORE AND AFTER TREATMENT WITH RED, INFRARED OR PLACEBO LIGHT EMITTERS

Pain Test	Red (n = 15)	Infrared (n = 18)	Placebo (n = 17)
SF-MPQ/Sensory			
Before (SD)	10.40 (8.98)	10.78 (6.28)	8.11 (4.75)
After (SD)	4.53 (6.98)	5.27 (5.06)	8.94 (4.84)
P value	0.0001	0.00001	0.1635
SF-MPQ/Affective			
Before (SD)	3.93 (3.69)	4.27 (2.94)	4.47 (3.31)
After (SD)	1.60 (2.72)	1.88 (2.32)	4.00 (3.20)
P value	0.001	0.0002	0.1635
SF-MPQ/Total			
Before (SD)	14.27 (11.81)	15.06 (7.71)	12.47 (7.62)
After (SD)	6.13 (9.63)	7.33 (6.65)	13.06 (7.42)
P value	0.00001	0.00001	0.3220
PPI			
Before (SD)	3.13 (0.99)	3.66 (0.68)	2.88 (1.11)
After (SD)	1.40 (0.98)	1.16 (0.92)	2.82 (0.88)
P value	0.00001	0.00001	0.7175
VAS			
Before (SD)	6.53 (2.47)	7.16 (2.22)	6.23 (2.41)
After	3.33 (2.38)	3.22 (2.62)	6.29 (2.22)
P value	0.00001	0.00001	0.8484

TABLE 3. MEANS DISABILITY INDEX VALUES OBTAINED WITH DISABILITY INDEX QUESTIONNAIRE (DIQ) ADMINISTERED BEFORE AND AFTER TREATMENT WITH RED, INFRARED, AND PLACEBO LIGHT EMITTERS

DIQ	Red (n = 15)	Infrared (n = 18)	Placebo (n = 17)
Before (SD)	0.663 (0.854)	0.617 (0.56)	0.817 (0.68)
After (SD)	0.395 (0.571)	0.314 (0.35)	0.758 (0.62)
P value	0.0070	0.0001	0.2440

all three pain evaluation methods applied in this study ( $P < 0.05$ ). No significant difference in pain relief was shown between the group treated with red light and the one treated with infrared light.

**Disability Evaluation after Treatment** We observed significant functional improvement in both the red- and infrared-light groups as assessed by the DIQ method (Table 3,  $P < 0.05$ ). No such improvement was observed in the placebo group. Disability indexes showed no difference between the red and infrared groups after the treatment.

**Follow up** After the end of the study, patients treated with red and infrared light emitters requested retreatment because of pain within 1 to 12 months ( $4.2 \pm 3.0$  and  $6.1 \pm 3.2$  months for red and infrared, respectively). The pain relief period was significantly longer for these two groups in comparison to the placebo group ( $0.53 \pm 0.62$  months,  $P < 0.05$ ). The difference in the period of pain relief in the red and infrared groups was not significantly different ( $P = 0.41$ ).

All patients treated with the placebo emitters required analgesic treatment within 2 months from the end of the study (9 immediately, 7 within 1 month and 1 within 2 months). Only seven patients in the other two groups required analgesic treatment within 2 months after the end of treatment. The remainder required treatment only after long periods: 15 within 6 months, 10 within 10 months, and one was free of pain 12 months after the treatment.

## DISCUSSION

This study shows the efficacy of phototherapy in DOA in late middle-aged and elderly patients. Patients treated with red or infrared light emitters reported more than 50% pain relief after 10 days of treatment. Pain relief continued for an average of 4 to 6 months after the treatment. Our results are similar to those reported by Trelles et al.<sup>17</sup> They studied the impact of infrared diode laser (860 nm, 60 mW, CW) on pain, inflammation, joint mobility, and treatment tolerance in patients with DOA. Their study showed significant improvement immediately after 4 weeks of twice weekly treatment and 4 months later.

The exact mechanism of pain reduction by phototherapy is not completely understood. Many investigators have observed an anti-inflammatory effect of phototherapy in studies conducted in patients with rheumatoid arthritis.<sup>18-20</sup> A recent histochemical study

has shown a marked increase of prostaglandin  $I_2$  following phototherapy, and consequently inhibition of platelet aggregation and vasodilatation.<sup>21</sup> Improvement of local circulation leads to reduction of edema and better oxygenation of tissues and thus may result in reduction of pain. Lack of Na-K-ATPase activity seems to increase nociceptive impulse transmission; an increase in Na-K-ATPase following phototherapy may be a factor in pain attenuation.<sup>22</sup> Thus, phototherapy could produce pain relief by one or a combination of these mechanisms: anti-inflammatory effect, circulation enhancement, and analgesic effect.

We observed the same degree of improvement in pain relief and functional ability in the red- and infrared-treated groups. Patients treated with placebo emitters did not report any changes in pain, except for a small (10%) and statistically insignificant ( $P = 0.163$ ) degree of pain relief reported in the affective component of the SF-MPQ.

The red- and infrared-treated groups showed significant improvement in functional disability, more than 40%, perhaps due to the reduction in pain intensity and possibly also contributed to by a direct effect of phototherapy on knee mobility. The placebo-treated patients did not show significant functional improvement, and the observed slight improvement (7%) probably reflected a placebo effect (use of the emitters).

In conclusion, this study showed that short-time application of phototherapy is effective in pain relief and in improvement of functional ability in elderly patients with DOA. Thus, phototherapy can be an important adjunct in the treatment of this disease, especially in patients with adverse side effects to drug treatment. Our personal experience suggests that phototherapy can be used conjointly with analgesics to reduce their dosage. These encouraging results might prompt further, long-term studies to validate this treatment and to establish more detailed indications for the use of phototherapy in DOA.

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