Low-energy Helium Neon Laser Treatment of Thumb Osteoarthritis

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ABSTRACT. Basford JR, Sheffield CG, Mair SD, Ilstrup DM: Low-energy helium neon laser treatment of thumb osteoarthritis. Arch Phys Med Rehabil 68:794–797, 1987.

• Eighty-one patients with symptomatic osteoarthritis of the thumb took part in a blinded, controlled study to assess the effectiveness of 0.9mw continuous wave HeNe laser treatment. The subjects were randomly placed in either a control group or a treatment group. In each group the carpometacarpal (CMC), metacarpophalangeal (MCP), and interphalangeal (IP) joints of the most symptomatic thumb were "treated" with 15 sec irradiations at four equally spaced intervals around each joint three times a week for three weeks. The same protocol was used for both groups except that a hidden switch on the laser was placed in the "on" position for the treated group and in the "off" position for the control group. Although the laser-treated group noted slightly lessened tenderness of the treated MCP and IP joints ($p<0.01$ and 0.05, respectively, Wilcoxon signed-rank test), and a small increase in three-finger chuck pinch strength ($p<0.04$, paired *t*-test), changes in ROM, pain, joint tenderness, grip and pinch strength, activity level, and medication use, did not significantly differ between the groups. Adverse effects were rare (one in each group), minimal, and subjective. We conclude that HeNe laser irradiation at 0.9mw is safe, but that it is not an effective treatment of osteoarthritis of the thumb.

KEY WORDS: Lasers; Osteoarthritis; Treatment

Low-energy lasers are now widely used to treat a variety of musculoskeletal conditions. Although controlled evaluation of these treatments is limited, quite enthusiastic claims are made for pain, arthritic, and wound healing applications.[4,5,19] Since these devices are safe, easy to use, and relatively inexpensive, we decided to evaluate one of the commonly used lasers in a controlled, blinded study. In particular, we studied osteoarthritis of the thumbs because (1) it is a common clinical problem and (2) these superficial joints are as accessible as any to percutaneous treatment.

METHOD

After approval of the research protocol by the Institutional Review Board of our institution, adults between the ages of 23 and 75 with symptomatic osteoarthritis of the thumb were recruited via advertisements in local newsletters. Volunteers were invited to participate in the study if a nondegenerative source of their arthritis could not be found in their interview, examination, or medical records. It was also required that each volunteer (1) had been on the same medication schedule for at least two months, (2) had a stable level of activity, (3) was not pregnant, (4) had no history of light sensitivity, and (5) would be available for treatment three times a week for three consecutive weeks.

Subjects were assigned with a random numbers table into a treatment group (Group A) or a control group (Group B). Treatment for both groups was identical: 15sec of "irradiation" at four points at approximately 90° intervals around the carpometacarpal (CMC), metacarpophalangeal (MCP), and interphalangeal (IP) joints of their most symptomatic thumb. In Group A, each subject was irradiated with a 0.9mw continuous wave Helium-Neon (HeNe) (632.8nm) laser,[a] via a fiberoptic delivery system. Treatment in Group B was identical except that a concealed switch on the laser was set in the "off" position, a change which turned off the laser beam, but which did not alter the panel display. Neither the evaluator, the statisticians, nor the participants knew which subjects received laser treatment. To assure blinding, the subjects wore goggles,[b] which made it impossible to see the beam, and were instructed to look away from the treated hand during treatment.

At each session subjects were asked whether they had noted any "good" or "bad" effects since the previous treatment. At the first, third, sixth, and last treatments, they were also questioned about pain, stiffness, activity, and medication usage, and their answers were quantified with ordinal scales ranging from 0 (asymptomatic) to 4 or 5 (completely incapacitated). At the latter sessions grip strength, lateral pinch strength, and three-finger chuck pinch strength, were measured with strain gauge dynameters; CMC planar and palmar abduction, MCP flexion and extension, and IP flexion and extension, were measured with a hand-held goniometer. Joint tenderness was assessed at the same intervals by the evaluator pressing on the individual joints with his fingers, and quantifying the subjects' responses on an ordinal scale of 0 to 5. One to two months after they had completed treatment, the subjects were questioned by telephone about any late-occurring benefits or adverse effects.

Statistics

Comparisons of continuous variables between the two groups were made with two-sample *t*-tests or Wilcoxon rank-sum tests, as appropriate. Comparisons of proportions between the groups were made with chi-square tests or with the Fisher exact test.

Submitted for publication November 3, 1986. Accepted in revised form March 10, 1987.

Table 1: Subject Demographics

	Treated group (n=47)	Control group (n=34)	Difference between groups*
Age (yr)	56.5	62.8	0.02
Duration of symptoms (yr)	8.7	9.6	NS
Thumb pain severity (0 to 4)	2.1	1.9	NS
Hand pain severity (0 to 4)	1.3	1.6	NS
Activity level (0 to 5)	2.4	2.5	NS

*Wilcoxon rank-sum tests

Comparisons of ordinal variables between the two groups were also made with Wilcoxon rank-sum tests. Changes in continuous variables with time were tested with paired *t*-tests or with Wilcoxon signed-rank tests, as necessary. Changes in the occurrence of an event within a group were tested with the sign test. Changes in ordinal variables were tested with Wilcoxon signed-rank tests. Results were considered significant if the associated p was <0.05.

RESULTS

All 81 subjects completed the study and underwent the nine treatment sessions. Of these 81 patients 47 were in Group A and 34 were in Group B. A computer-generated random numbers table was used; we have no explanation for the discrepancy in the sizes of the two groups. It should be noted, however, that the subjects were intermingled throughout the experiment and no bias as to time should be expected. As table 1 shows, the groups were otherwise extremely similar, except that the treated group was slightly younger. Although not shown in the table, the groups did not differ in terms of occupation, gender, weight, handedness, home therapy programs, medication usage, family history of osteoarthritis, thumb injury, or, when available, x-rays (Wilcoxon rank-sum or chi-square tests, as appropriate).

Tables 2 and 3 show the results of serial measurements of strength, ROM, and tenderness. Changes in strength between the first and last sessions within the groups were small and reached borderline significance ($p<0.04$, paired *t*-test) only for three-finger chuck pinch in the laser-treated group (table 2). However, there was no significant difference when the changes were compared between the treatment groups (two-sample *t*-test).

Table 3 shows the results of the ROM and tenderness measurements. There was no significant change either within (paired *t*-tests), or between (two-sample *t*-tests) the groups in terms of CMC or MCP motion changes. Both groups, perhaps due to increasing confidence that the exam was not going to be painful, showed an improvement in IP flexion with time; however, the difference in improvement between the groups was not significant (two-sample *t*-test). Although MCP and IP joint tenderness decreased significantly during the experiment in the treated group ($p<0.01$ and 0.05, respectively, Wilcoxon signed-rank test), both groups improved somewhat, and no significant difference in improvement was found between the groups (Wilcoxon rank-sum test). At the end of the study there were no differences between the groups in terms of pain, activity level, morning stiffness, or medication (aspirin, nonsteriodal antiinflammatories) usage (Wilcoxon rank-sum test).

The subjects in this study, as well as those in an informal pilot study, were unable to detect whether or not the laser was activated. Adverse effects, even when interpreted in the broadest way possible, were minimal and involved only one subject in each group (table 4). One noted transient tingling over the distal superficial radial nerve distribution during treatment, and the other reported mild erythema in the treated area, which lasted less than a day and was not detectable by the experimenters. About half the subjects in each group felt that they had benefited from treatment (table 4). A few from each group insisted that other joints be treated and actively encouraged their friends to request treatment.

DISCUSSION

We chose to study osteoarthritis of the hands because it is a common problem for which current conservative treatments are of limited benefit. In addition, the joints are superficial; it seems that if any joint should respond to percutaneous treatment, it ought to be one that is near the surface. Since radiation of this wavelength and intensity penetrates the skin and transilluminates the fingers, it seems that at least some energy is delivered to the joint tissues.

We did not find that individuals with osteoarthritis of the thumb benefit significantly from the regimen used in this ex-

Table 2: Strength Changes After Treatment

	Treated group (n=47) (last-first session)	Control group (n=34) (last-first session)	Change in treated group vs change in control group*
Grasp	1.9 ± 10.1	1.8 ± 10.2	NS
Lateral pinch	0.3 ± 2.1	0.5 ± 1.4	NS
Three-finger chuck pinch	0.9 ± 2.9**	0.7 ± 2.8	NS

*two-sample *t*-tests
**paired *t*-test, $p<0.04$

Table 3: Improvement in ROM (degrees) and Joint Tenderness Between the First and Last Sessions

	Treated group (n=47)	Control group (n=34)	Change in treated group vs change in control group*
Carpometacarpal			
palmar abduction	1.2 ± 6.6	1.1 ± 6.7	NS
planar abduction	0.5 ± 6.5	0.5 ± 6.6	NS
Metacarpophalangeal			
Extension	−0.1 ± 11.1	3.7 ± 14.4	NS
Flexion	2.8 ± 9.7	2.5 ± 11.5	NS
Interphalangeal			
Extension	1.4 ± 10.1	2.5 ± 8.8	NS
Flexion	9.3 ± 18.9**	7.5 ± 13.3**	NS
Lessening of joint tenderness+			
Thumb CMC	0.2 ± 0.8	0.2 ± 1.0	NS
Thumb MCP	0.3 ± 0.7***	0.2 ± 0.9	NS
Thumb IP	0.2 ± 0.6***	0.1 ± 0.6	NS
Other hand joints	0.2 ± 0.6	0.2 ± 0.9	NS

*Wilcoxon rank-sum tests; ** Wilcoxon rank-sum tests, $p<0.0001$ and 0.003 for the treated and control groups, respectively; ***Wilcoxon signed-rank test, $p<0.1$; +In terms of an arbitrary five-point scale ranging from 0 to 5

periment. It should be noted, however, that in the laser-treated group there was a slight increase in three-finger chuck pinch strength, as well as a small reduction in tenderness at the MCP and IP joints of the treated thumb (tables 2 and 3). However, there was a trend toward improvement of these measurements in the control group also; when the groups were compared, no significant differences in ROM or tenderness changes were found between them. In addition, no differences were found between the treated and control groups in pain, activity level, or medication.

This finding was a disappointment and it will be useful to examine the clinical and experimental background for low-energy laser treatment. Briefly, a wide,[14,18,19,21] but not universal,[2,9,17,23] body of literature finds that many neuronal, enzymatic, and metabolic functions are altered with low-energy laser treatment.[1] In particular, a number of investigators report that 60% to 80% of patients with a variety of conditions including osteoarthritis, radiculopathies, and neuropathies benefit from low-energy (0.5 to 50mw) laser treatment. Many of these studies are poorly controlled[3,4,12,13,20] but some, reportedly controlled,[6,22] also find improvement. Other studies, however, may find no benefit.[16]

A major problem in evaluating any new device is the determination of the optimal dosage and treatment schedule. For low-energy lasers, this remains an area of controversy. Parameters such as wavelength (ie, laser type), duration of treatment, energy density, number of treatments, and mode of delivery may be critical. Although there is some guidance from other experiments, the choices remain dismayingly wide. We chose the parameters used in this study because positive results are reported with HeNe lasers using similar treatment schedules.[15,18,23] It is possible that other choices, particularly higher intensities, may be more effective.

The mode of application is also important and may affect outcome. Typically, low-energy lasers are used either directly over the involved tissue or in an acupuncture-type mode. Both approaches are widely used, and we chose to irradiate directly over the joints. At the energies we used, the subjects could not perceive the irradiation, and tissue temperatures were elevated less than 0.1 to 0.2C.[7,9] Thus, neither a thermal nor a counterirritant mechanism can be used to explain any effects that may be reported.

Some investigators report that laser treatment also produces "systemic" (perhaps on a humoral basis) effects at locations distant from a treated area.[8,11,19] Although we saw suggestive, but limited, evidence of local effects at some treated joints, we saw no changes at the other hand joints that could be attributed to a systemic component.

CONCLUSION

We do not find that osteoarthritis of the thumbs benefits from treatment with 0.9mw HeNe laser irradiation. It seems reasonable to assume that the other superficial joints of the hands and feet, as well as those more deeply situated in the body will be similarly unresponsive. If low-energy laser treatment is to be effective, correct laser and parameter choice will be important. It may be that somewhat higher intensities, on the order of 5 to 50mw/cm^2, and energies in the 1 to 4 joule/cm^2 range, are needed.

Table 4: Patients' Reports of Benefits and Adverse Effects

	Last treatment			Follow-up at one month		
	Treated group (n=47)	Control group (n=34)	Significance*	Treated group (n=47)	Control group (n=34)	Significance*
Adverse effects	0	1 (3%)	NS	1 (2%)	0	NS
Beneficial effects	22 (47%)	15 (44%)	NS	22 (47%)	16 (47%)	NS

*chi-square tests

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Suppliers

a. Dynatronics, 271 West Crossroads Square, Salt Lake City, UT 84115
b. Glendale Optical Company, 130 Crossways Park Drive, Woodbury, NY 11797