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Effect of Helium-Neon Laser Irradiation on Peripheral Sensory Nerve Latency

LYNN SNYDER-MACKLER
and CHRISTOPHER E. BORK

The purpose of this randomized, double-blind study was to determine the effect of a helium-neon (He-Ne) laser on latency of peripheral sensory nerve. Forty healthy subjects with no history of right upper extremity pathological conditions were assigned to either a Laser or a Placebo Group. Six 1-cm² blocks along a 12-cm segment of the subjects' right superficial radial nerve received 20-second applications of either the He-Ne laser or a placebo. We assessed differences between pretest and posttest latencies with t tests for correlated and independent samples. The Laser Group showed a statistically significant increase in latency that corresponded to a decrease in sensory nerve conduction velocity. Short-duration He-Ne laser application significantly increased the distal latency of the superficial radial nerve. This finding provides information about the mechanism of the reported pain-relieving effect of the He-Ne laser.

Key Words: Phototherapy, laser; Physical therapy.

The helium-neon (He-Ne) laser emits a visible, red, cold laser beam at a 632.8-nm wavelength. The reported depths of penetration of the beam in human tissue range from 0.8 to 15 mm.¹ The maximum output of the He-Ne laser, unlike more powerful hot lasers, is about 14 to 29 mJ at 15- to 20-second therapeutic dosages. The brief, low-level output of the He-Ne laser does not produce tissue heating.²⁻⁴ Therapeutic effects of cold laser therapy (CLT) have been documented by case studies.¹⁻⁵ Until the early 1980s, the literature concerning CLT largely consisted of uncontrolled, unsubstantiated, and equivocal eastern European findings cited elsewhere.¹⁻⁵ The He-Ne laser's manufacturer has made similar claims.⁶

The nonthermal, metabolic consequences of low power laser irradiation have been of interest to researchers. Fork found that a 10- to 30-second exposure to 488 nm of an argon laser beam activated identified and unidentified interneurons in the cells of isolated abdominal ganglia in Aplysia californica (a marine mollusk).⁴ Vizi et al noted an increase in the amount of acetylcholine released from Auerbach's plexus in the intestine of the guinea pig after a nonthermal dose of ruby laser radiation.⁷ Walker suggested that He-Ne laser irradiation may affect serotonin metabolism.⁸ She noted a large increase in urinary excretion of 5-hydroxyindoleacetic acid in patients who received He-Ne laser treatment in a double-blind study of pain relief. All of these studies describe the nonthermal effects of laser irradiation; heating did not produce similar results.

At least two studies showed that the He-Ne laser, classified as a cold or soft laser because of its lack of heat producing capabilities,⁶ and the slightly more powerful and deeper-penetrating neodymium laser decrease pain.⁸⁻⁹ The lasers' pain-reduction mechanism, however, has not been investigated. A study of the effect of another type of CLT (infrared or gallium-arsenide) reported that laser irradiation did not affect sensory nerve conduction velocity or subcutaneous tissue temperature.² The purpose of this randomized, double-blind study was to determine the immediate effect of He-Ne laser irradiation on the distal latency of peripheral sensory nerve in healthy human subjects. We hypothesized that the He-Ne laser would cause no difference in latency.

METHOD

Subjects

The 40 healthy subjects (20 men, 20 women) ranged in age from 18 to 42 years (X = 29.3 years). Each subject was screened to rule out right upper extremity pathological conditions using accepted physical therapy evaluative procedures including manual muscle testing and sensory and deep-tendon reflex testing.¹¹ Subjects read and signed an informed consent form and were assigned randomly to either a Placebo Group (n = 16) or Laser (treatment) Group (n = 24). Assignment was made using the first 40 of 100 sealed, numbered envelopes into which 50 cards labeled “A” (treatment) and 50 cards labeled “B” (placebo) had been placed randomly.

Instrumentation

The He-Ne laser used in this study was the Dynatron 1120.* We also used a placebo apparatus that did not emit a laser

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* Dynatronics Research Corp, 270 W Crossroads Square, Salt Lake City, UT 84115.
beam but otherwise was identical to the Dynatron 1120. We recorded the distal latencies on a Cadwell 7400† using standard sensory settings (gain = 20 μV/division, filters = 2,000 Hz and 10 Hz, sweep speed = 1 msec/division, pulse duration = 100 μV). 10(pp84-87)

Procedure

The subjects sat with their right arm supported on a tabletop. Room temperature was maintained at 23°C. 10(pp97-98) We placed stimulating and recording electrodes along the subjects' right superficial radial nerve according to the procedure outlined by Downie and Scott. 12 The recording cathode (disk electrode) was placed over the largest palpable branch of the superficial radial nerve where it crosses the extensor pollicis longus tendon. If the nerve could not be palpated, the electrode was placed 1 cm distal to the extensor muscle's retinaculum, a site sufficiently consistent to allow placement. We placed the recording anode (disk electrode) over the belly of the first dorsal interosseous muscle. A bar stimulating electrode (including both anode and cathode) was placed with the cathode 12 cm proximal to the active recording electrode along the radius. We moved the bar electrode medially or laterally at this 12-cm distance to produce the largest antidromically evoked compound sensory action potential (SAP) and then secured the electrode with tape. We limited skin preparation to the stimulating and recording electrode area so as not to interfere with the laser beam transmission (Fig. 1). 12 We degreased the subjects' skin by gently rubbing prepared acetone swabs on each treatment area for 10 seconds. Small amounts of electrode paste were placed on each of the disk electrodes and on the bar electrode.

All of the subjects received either He-Ne laser treatment or a placebo. Treatment periods consisted of 20 seconds of irradiation per square centimeter of tissue irradiated. 1,2,8 An opaque shield that touched the skin surface maintained a 0.5-mm distance from the optical fiber tip to the skin (Fig. 2). The laser was set to deliver continuous energy at 19 mJ (maximal intensity) per square centimeter of tissue.

We marked six 1-cm² segments with a skin pencil on the skin overlaying the superficial radial nerve between the stimulating and recording electrode cathodes. A pretest distal sensory latency was recorded at this time and stored in the Cadwell 7400. Each marked skin segment either was irradiated for 20 seconds with the He-Ne laser or received placebo application. The opaque shield obscured the subjects' view of the laser application, thus preserving the study’s double-blind format (Fig. 2). A second latency reading was recorded and stored immediately after the treatment.

Data Analysis

The pretest and posttest latencies were compared using the Auto-NCV function of the Cadwell 7400. We used t tests for correlated measures to analyze the intragroup changes and a t test for independent samples to assess the intergroup differences.

RESULTS

A two-tailed t test used to determine whether a pretreatment latency difference existed between the Placebo and Laser Groups showed no significant difference between the two groups. A two-tailed t test for independent samples to compare pretest and posttest latency for the Laser and Placebo Groups demonstrated a significant difference in latency (p < .001). The Laser Group had a significant change in latency compared with the Placebo Group.

The t tests for correlated measures showed a significant increase in latency in the Laser Group (p < .001) and no significant change in latency in the Placebo Group. The Laser Group’s mean increase in latency (14.2%) corresponded to a decrease in the sensory nerve conduction velocity in the nerve segment studied. Table 1 summarizes the study’s descriptive statistics, and Table 2 summarizes the statistical analyses.

DISCUSSION

The results of this study support the contention that the application of the He-Ne laser increases the distal latency of sensory nerves. Although no clear explanation of this mechanism exists, some conclusions about the analgesic effects of He-Ne laser irradiation may be drawn from these results.

Nerve fibers that have been shown to carry painful stimuli (A-delta and C fibers) are components of the peripheral sensory nerve. 13 Other researchers have shown that analgesic methods such as the therapeutic application of cold decrease

† Cadwell Laboratories, Inc, 1021 N Kellogg, Kennewick, WA 99336.
sensory nerve conduction velocity. The results of this study suggest that interference in sensory nerve transmission is a possible mechanism for the purported analgesic effects of He-Ne laser irradiation. Sensory nerve conduction does continue after laser irradiation but it is significantly slower (similar to the effect of prolonged cooling). Significant selective latency prolongation or even transmission block could continue in these small fibers without appreciable change in the compound SAP. We noted a significant change in the compound SAP after laser irradiation in this study. If we had proceeded to evaluate the amplitude or integration of the compound SAP, information about the percentage of fibers affected by the laser irradiation might have been ascertained.

**TABLE 1**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest Latency (msec)</th>
<th>Posttest Latency (msec)</th>
<th>Difference Posttest-Pretest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$</td>
<td>$s$</td>
<td>$\bar{x}$</td>
</tr>
<tr>
<td>Placebo (n = 16)</td>
<td>2.70</td>
<td>.26</td>
<td>2.69</td>
</tr>
<tr>
<td>Laser (n = 24)</td>
<td>2.61</td>
<td>.18</td>
<td>2.98</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>t-Test Results for Sensory Latencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td>Pretest Placebo and laser</td>
</tr>
<tr>
<td>Posttest Placebo</td>
</tr>
<tr>
<td>Laser</td>
</tr>
<tr>
<td>Difference (posttest-pretest) Laser</td>
</tr>
</tbody>
</table>

Future research of subject response to the He-Ne laser should include amplitude measurement to further quantify any change.

Pain perception mechanisms are intricate. Some researchers hypothesize that every synapse at the spinal cord level is under some form of spinal and supraspinal control. The idea that the brain does not merely receive information passively but also somehow determines what it “wants” is integral to our interpretation of the importance of these results. In these intricate relays, timing is crucial. Any change in sensory transmission patterns, however transient, may affect the precise circuitry of spinal cord-level relays.

Although a single, short-duration exposure of only 20 seconds demonstrated significant immediate increases in distal latency, further study is needed to determine any long-term effects. We suggest that the effects of He-Ne laser irradiation on nerve membranes should be studied under more rigorous electrophysiological conditions using techniques such as intracellular recording, voltage clamping, and patch clamping.

This study documents a physical finding that supports the contention that the He-Ne laser may be a useful noninvasive analgesic modality. The protocol design of this study eliminated any possible placebo effects. Further investigation is needed to determine whether the same physical finding results in He-Ne laser treatment of patients with pain and to study the correlation between our finding and patients’ subjective reports of pain reduction.

**CONCLUSION**

Helium-neon laser irradiation of skin overlying the superficial radial nerve resulted in a significant increase in distal sensory latency in this study. This increase in latency corresponded to a decrease in sensory nerve conduction velocity and could help explain the alleged pain-relieving effects of He-Ne laser irradiation.

**REFERENCES**

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