effect of LES rather than an effect on the muscle atrophy, because of the way of evaluation of the muscle atrophy by measuring the volume of the injured hand.

The differences between our study and most of the other studies in man and the good results of LES in small animals may be caused by species differences between the muscle fibres (17). In most of the animal studies the denervated muscles were stimulated with faradic current, causing tetanic contractions. Also in the case of the galvanic stimulated muscles, with stimuli of long duration a galvanotropic may have been performed. The differences may be explained by the more intensive stimulation in the case of small mammals. It may also be more easy to reach all the muscle fibres with the electrostimulation current in the small muscles of animals than in men.

In conclusion a beneficial effect of LES on muscle atrophy could not be demonstrated. It has not been conclusively demonstrated in other studies in man up to the present time. Therefore in our opinion there is no indication to use this therapy in patients with peripheral nerve lesions.

ACKNOWLEDGEMENTS

The authors wish to thank T. L. v. Weele for his statistical help, L. te Strake and W. J. Overbeek for their assistance with ultrasonography and computer tomography, F. H. Robinson, plastic surgeon, and the Departments of Neurosurgery of the Netherlands Institute for Plastic and Reconstructive Surgery of the University Hospital Groningen and hospitals of Leiden for their participation in the study. This study was supported by a grant from the Prinses Beatrix Fonds.

REFERENCES


Address for offprints: A. M. Boonstra
Department of Rehabilitation
University Hospital (Lentkamp) 5900 EV Groningen
The Netherlands

60-62 patients (76%) attributed symptoms to sport, 18 (22%) to housework and 2 (2%) followed traumas to the elbow.

Clinical trial

Out of the 82 patients, 57 were allocated to the clinical trial. The patients (31 men and 26 women) ranged in age from 18 to 42 years (mean 34 years). The patients were randomly placed in three groups. Group A (n=19) received placebo laser treatment. Group B (n=19) received infrared Gallium–Arsenide (Ga–As) laser radiation. Group C (n=19) received Helium–Neon (He–Ne) radiation.

Procedure

The two laser machines used were standardised initially and then every month. Output was also checked before each treatment session on a simple radiation balance constructed for this purpose. An output key introduced into the transducer circuit allowed stock radiation to be given to a placebo group without affecting the normal output when the key was turned on.

The laser wand was held 1 cm from the patient’s skin. The distance between the skin and the laser wand was maintained by a piece of plastic 5x3 mm fixed to the wand. The He–Ne laser was a continuous-wire laser with a wavelength of 625 nm and a maximum output of 1.5 mW. The Ga–As laser was a pulse laser, with a wavelength of 646 nm: the measured power output was 0.07 mW at a frequency of 71 Hz.

During treatment the following acupuncture points were stimulated: LI10, LI11, LI12, ST5, ST6, SI4, SI6, LU13, LU14, P3. The wound of the laser was held stationary at a right angle to the surface of the skin for 60 sec/acupuncture point.

Ten treatments were given (two per week) over to six weeks. A therapist not involved in the treatments arranged a schedule allocating patients at random to either placebo or clinical treatment. She was responsible for selecting the apparatus at session to that the grouping remained unknown to patients, therapists and the medical assessor alike.

Patients were reviewed fortnightly during treatment. Follow-up continued for at least another three months before patients were discharged or, if symptomatic, offered alternative treatment.

At each visit clinical assessment included: (A) determining a pain score using a 10 cm horizontal analogue scale; (B) noting pain (0-3), and diminished power, assessed manually and compared against the normal wrist.
induced by resisted wrist dorsiflexion (0 = no pain, 1 = mild pain but not moderate pain and reduced power, 2 = moderate pain and absent power). A weight of ability to lift weights of 5.2, and 1 kg with elbow extended and forearm pronated (D) is a test of arm strength using a 300 N load spring coil gauge attached to a rubber band prest to 30 mmHg, made with the elbow extended and using an average of 3 estimations. After completion of treatment, follow-up patients were asked to assess the results of their treatment. The medical assessor also judged the outcome.

The functional result with only minor ache or slight tenderness was considered a satisfactory outcome. At the end of the study the patients either withdrew, were discharged or had alternative treatment.

Experimental trial
Out of the 82 patients 25 were allocated to the experiment trial. The patients (14 men and 11 women) ranged in age from 23 to 48 years (mean 39 years).

The patients were randomly placed in three groups. Group 1 (n=10) served as a control and did not receive any laser radiation but was measured for sensory nerve conduction characteristics similar to the other groups. Group 2 (n=10) received infrared (Ga-As) laser radiation for 60 sec to each of five 1-cm² segments of the skin overlaying the superficial radial nerve. Group 3 (n=10) received He-Ne radiation for 60 sec to each of five 1-cm² segments of the skin overlaying the superficial radial nerve.

Procedure
All patients lay comfortably on a treatment table. The ambient temperature was maintained at 25°C. The stimulating and recording electrodes were placed along the right superficial radial nerve (4). All electrode sites were cleansed with alcohol, and the conducting medium applied. The ground electrode was secured to the palm of the hand. The negative recording electrode was placed over the branch of the radial nerve where it crosses the tendons of the extensor pollicis longus muscle. The positive recording electrode was placed over the proximal portion of the first dorsal interosseous. The recording electrodes had silver-silver chloride discs, 4 mm in diameter. The stimulating electrodes were also two 4 mm silver-silver chloride discs on a 2 cm plastic bar. The negative stimulating electrode was placed over the nerve along the crest of the radius at a point 12 cm proximal to the negative recording electrode, and the bar was moved medially or laterally until a maximum amplitude action potential was obtained. Positioning of the recording and stimulating electrodes as described permitted antidromic conduction which produces more consistent and fewer abnormal responses than orthodromic conduction. The stimulus was a monophasic pulse of 0.1 msec duration, delivered once a second. The frequency response of the amplifier was 16 to 1.5 kHz.

The area of skin chosen for application of the Ga-As or He-Ne laser radiation corresponded to the course of the superficial radial nerve determined by the nerve-conduction technique. The skin, 2 cm distal to the hair-stimulating negative electrode, was marked with ink for five 1-cm² segments. A sterile, hypodermic probe was inserted percutaneously through the skin to the level of the radial nerve. The tip of the needle probe was placed in the area where the laser radiation would be applied to record accurately any temperature changes by the treatment. The needle probe was connected in series with a scanning thermocouple and was accurate to ±0.05°C.

After all recording equipment was secured on the subject, initial nerve conduction latency and subcutaneous temperature were recorded. Nerve conduction latencies and amplitudes were reproduced on a fiberoptic printout. The latency of the evoked sensory response was measured from the start of the stimulus artifact to the peak of the negative portion of the nerve action potential. The amplitude of the evoked sensory response was measured from peak to peak of the nerve action potential. A summation stimulus intensity was used to produce each evoked sensory response.

The treatment of laser radiation was applied in the following manner. The laser was held 1 mm from the subject’s skin along the course overlying the superficial radial nerve beginning 2 cm distal to the hair-stimulating negative electrode. The separation distance between the skin and the laser was maintained by a plastic wedge, 5 x 3 mm fixed to the wand. The wand was held stationary at right angles to the surface of the skin for the time determined for each segment (60 sec/segment). The five skin segments were treated in turn without pause.

At the completion of the laser radiation to the last segment, the superficial radial nerve was stimulated and the latency and amplitude of the evoked sensory response were recorded following the same procedure as the pre-treatment measurements. Subcutaneous temperatures were again recorded for each subject. The superficial radial nerve stimulation and subsequent conduction and temperature recordings were repeated at intervals of 5, 10, and 15 min post-treatment.

Results
The latency test with Yates’s correction and the Wilcoxon rank sum test were used to analyze the objective outcome and the rate of recovery.

An analysis of variance (ANOVA) with repeated measures over time was calculated for latency and temperature with a computer program. The Newman-Keuls post hoc analysis was used to evaluate significant differences between means.

Results
Table I. Mean improvement and standard deviation of latency as well as improvement on resisted wrist dorsiflexion (PD), pain on weight test, and the improvement in grip strength in extension (GS) in the three treatment groups

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PD (ms)</th>
<th>W (°)</th>
<th>WT (°)</th>
<th>TS (º)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>2.2±0.2</td>
<td>0.8±0.5</td>
<td>0.3±0.0</td>
<td>37±2.5</td>
</tr>
<tr>
<td>He-Ne</td>
<td>2.4±0.2</td>
<td>0.9±0.6</td>
<td>0.2±0.5</td>
<td>39±3.2</td>
</tr>
<tr>
<td>Ga-As</td>
<td>2.0±0.2</td>
<td>0.8±0.5</td>
<td>0.4±0.3</td>
<td>41±2.5</td>
</tr>
</tbody>
</table>

DISCUSSION

Modality of treatment such as ultrasound, laser irradiation and short-wave diathermy, by increasing the temperature of tissues surrounding the nerve, increase peripheral nerve conduction velocity in man (3). Further, in vitro and in vivo studies have confirmed the direct effect of temperature changes on nerve conduction.

Laser radiation at clinical intensities, and of 60 sec duration, does not cause thermal changes in human tissues (7).

Results of the present study show that the two different modes of laser over the skin do not significantly affect sensory nerve conduction latency or the amplitude of an evoked action potential. Nei.

Table II. Means of latency, amplitude and temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Latency (ms)</th>
<th>Amplitude (V)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placebo</td>
<td>2.7±0.3</td>
<td>3.3±0.2</td>
<td>35±2.1</td>
</tr>
<tr>
<td>He-Ne</td>
<td>2.6±0.3</td>
<td>3.2±0.2</td>
<td>35±2.1</td>
</tr>
<tr>
<td>Ga-As</td>
<td>2.7±0.3</td>
<td>3.0±0.3</td>
<td>35±2.0</td>
</tr>
</tbody>
</table>

Conclusions

The results showed that there was a difference in temperature measurement against time. Generally, five minutes after laser radiation application the temperature decreased. Post hoc analysis revealed a significant difference (p<0.05) between means at the immediate, and at 15 min post-treatment temperature.

We also found a significant difference for mean latency of the evoked sensory response with time lapse. The latency of the evoked response subsequently increased 15 min after the laser application. A significant difference to the amplitude of the evoked sensory response.

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induced by restricted wrist dorsiflexion (0 = no pain, 1 = mild pain not moderate pain and reduced power, 3 = severe pain and absent power); (C) a weight-bearing ability of 10-20% of 5.2, and 1 kg with elbow extended and forearm pronated; (D) a test of grip strength using a 300 mmHg spring coil gauge attached to a rubber band prestretched to 25 mmHg, made with the elbow extended and using an average of 3 estimations. After completing their treatments, follow-up patients were asked to assess the results of their treatment. The medical assessor also judged the outcome.

The functional outcome with only minor ache or slight tenderness was considered a satisfactory outcome. At the end of the study the patients either withdrew, were discharged or had alternative treatments.

Experimental trial
Out of the 82 patients 25 were allocated to the experiment.

The patients were randomly placed in three groups. Group 1 (n = 10) served as a control and did not receive any laser radiation but was measured for sensory nerve conduction characteristics similar to the other groups. Group 2 (n = 10) received infrared (Ga-As) laser radiation for 60 sec to each of five 1-cm2 segments of the skin overlying the superficial radial nerve. Group 3 (n = 10) received He-Ne radiation for 60 sec to each of five 1-cm2 segments of the skin overlying the superficial radial nerve.

Procedure
All patients lay comfortably on a treatment table. The ambient temperature was maintained at 23°C. The stimulating and recording electrodes were placed along the right superficial radial nerve (4). All electrode sites were cleansed with alcohol, and the conducting medium applied. The ground electrode was secured to the palm of the hand. The negative recording electrode was placed over the branch of the radial nerve where it crosses the tendon of the extensor pollicis longus muscle. The positive recording electrode was placed over the proximal portion of the first dorsal interosseous. The recording electrodes had silver-silver chloride discs, 4 mm in diameter. The stimulating electrodes were also two 4 mm silver-silver chloride discs on a 2 cm plastic bar. The negative stimulating electrode was placed over the nerve along the crest of the radius at a point 12 cm proximal to the negative recording electrode, and the bar was moved medially or laterally until a maximum amplitude action potential was obtained. Positioning of the recording and stimulating electrodes as described permitted antidromic conduction which produces more consistent and accurate amplitudes than orthodromic conduction. The stimulus was a monophasic pulse of 0.1 ms duration, delivered once a second. The frequency response of the amplifier was 16 to 1.5 kHz.

The area of skin chosen for application of the Ga-As or He-Ne laser radiation corresponded to the course of the superficial radial nerve determined by the nerve-conduction technique. The skin, 2 cm distal to the bar stimulating negative electrode, was marked with ink for five 1-cm2 segments. A sterile, hypodermic probe was inserted perpendicular to the skin, and the tip of the needle probe was placed in the area where the laser radiation could be applied to record accurately any temperature changes by the treatment.

The needle probe was connected in series with a scanning temperature probe and was accurate to ±0.07°C.

After recording equipment was secured on the subject, initial nerve conduction latency and subsequent conduction and temperature recordings were repeated at intervals of 5, 10 and 15 min post-treatment.

Statistics
The F test with Yata's correction and the Wilcoxon rank sum test were used to analyse the outcome, and the effect of the recovery from 0 to each follow-up visit (Wilcoxon's rank sum tests), showed no significant advantage for either laser mode over the placebo group. Table I shows the reduction in the pain score, pain on resistance dorsiflexion, pain on weight test, and the improvement in grip strength in extension in the three groups. The duration of symptoms, dominance of the affected arm, and of treatment given before referral did not influence the outcome, but patients who responded to mock radiation had less severe symptoms on presentation than those responding to laser.

All the patients were re-examined or completed a postal questionnaire at six months. No difference in incidence of recurrence of severe pain was noted in the patients. Minor or intermittent pain in the elbow was still present in 60% of the patients.

RESULTS
Thirteen patients treated with laser (6 He-Ne, 7 Ga-As) and six who had received placebo showed a satisfactory outcome on objective testing both at the end of treatment and during follow-up.

Contingency table analysis showed that the difference between the groups was not significant.

Four patients (2 given laser treatment and 2 given placebo) reported the outcome immediately after completing treatment to be satisfactory despite persistent disability on objective assessment. Review three months later confirmed an unsatisfactory result in all these patients.

The three treatment groups showed no significant difference in the mean severity of any of the clinical variables on presentation. Comparisons of the rate of recovery from time 0 to each follow-up visit (Wilcoxon’s rank sum tests), showed no significant advantage for either laser mode over the placebo group. Table I shows the reduction in the pain score, pain on resistance dorsiflexion, pain on weight test, and the improvement in grip strength in extension in the three groups. The duration of symptoms, dominance of the affected arm, and of treatment given before referral did not influence the outcome, but patients who responded to mock radiation had less severe symptoms on presentation than those responding to laser.

All the patients were re-examined or completed a postal questionnaire at six months. No difference in incidence of recurrence of severe pain was noted in the patients. Minor or intermittent pain in the elbow was still present in 60% of the patients.

Table II presents the means and standard deviations for the latency and amplitude of the evoked sensory response and temperature of the subcutaneous tissue for each group. No significant difference between groups was found for latency and amplitude of the evoked sensory responses. Furthermore, the difference in temperature of the subcutaneous tissue of the treated areas was not significant between groups.

The results show that there was a difference in temperature measurement against time. Generally five minutes after laser radiation application the temperature decreased. Post hoc analysis revealed a significant difference (p < 0.05) between means at the immediate, and at 15 min post-treatment temperature.

We also found a significant difference for mean latency of the evoked sensory response with time lapses. The latency of the evoked response subsequently increased 15 min after the laser application. Post hoc analysis revealed a difference between mean latency at the 15 min post-treatment interval and those of other time periods. This indicates a significant difference to the amplitude of the evoked sensory response.

DISCUSSION
Modality of treatment such as ultrasound, laser irradiation and short-wave diathermy, by increasing the temperature of tissues surrounding the nerve, increase peripheral nerve conduction velocity in man (3). Further, in vitro and in vivo studies have confirmed the direct effect of temperature changes on nerve conduction.

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EYE MOTILITY DYSFUNCTION IN CHRONIC PRIMARY FIBROMYALGIA WITH DYSTESIA

Ulf Rosenhall, Göran Johansson and Gustav Örnhall

From the Department of Audiology and Otolaryngology, the Department of Rehabilitation Medicine, Sahlgrens's Hospital and the Department of Medicine, Östra Hospital, Göteborg, Sweden

ABSTRACT. Thirty-six patients with chronic primary fibromyalgia combined with dysesthesia were studied using ocular motor tests. The test results were compared with those of a control group consisting of 71 healthy persons. The saccades were found to be abnormal in 42% of the patients studied. The maximum velocity of the saccades was often reduced, while the accuracy was normal. The smooth pursuit eye movements were deranged in 89% of the patients. The velocity gain was reduced and the number of corrective saccades was increased. The results indicate that brain dysfunction, often at the brainstem level, is commonly seen in patients with chronic primary fibromyalgia syndrome combined with dysesthesia.

Key words: chronic pain, chronic primary fibromyalgia (CPF), dysesthesia, ocular motor tests, saccades, smooth pursuit eye movements.

Patients with pain in muscles and muscle insertions that cannot be properly explained, seem currently to constitute an increasing group in clinical practice. In addition to the pain, these patients also complain of stiffness in musculature and joints, tender areas in the musculature and limitation of movement. They also often have manifestations of autonomic dysfunction (18). The etiology is unknown and only symptomatic treatment can be given (12). The course of the disease is often chronic and disabling (4). The syndrome is often referred to as chronic primary fibromyalgia (22).

In earlier studies the main symptoms of patients with chronic primary fibromyalgia (CPF) were pain, muscular weakness and mental asthenia (Johansson & Nystrom, to be published). The pain was located in the cervical and lumbar regions, in most cases also involving the extremities. It was usually described as more severe on one side of the body. The muscular weakness was also most pronounced on the same side where in many cases there were also varying degrees of dysesthesia. All patients complained of headache and in most cases also of dizziness and vertigo. Mental asthenia in combination with memory disturbances, lack of concentration and sensitivity to noise was observed in all cases. Symptoms of autonomic dysfunction usually described in terms of psychosomatic symptoms were reported by most patients. Hemicrania of different types was reported by 55% of the patients and an exaggerated startle reaction by 30% (Johansson & Nystrom, to be published).

The mental symptoms and the neurological signs indicate a presence of a psychosomatic syndrome in certain patients with CPF. Therefore we studied a series of consecutive patients with CPF by ocular motor test techniques.

Lesions at different locations in the brain might disturb eye motility. Lesions in various parts of the central nervous system have been studied by ocular motor test techniques. Supratentorial lesions in the frontal-pontine area have been reported to cause dysfunction of the smooth pursuit eye movements (2, 15) as well as of the saccadic system (5, 10, 15). Normal saccadic velocity was, however, also reported in such lesions (2). Lesions in the occipital lobe can also affect the smooth pursuit system (9).

Infratentorial lesions very often cause disturbance of the oculomotor system. Lesions affecting structures in the brainstem, e.g. the eye motor nuclei, the medial longitudinal fasciculus, the paramedian pontine reticular formation, the inferior olive, the vestibular nuclei and the nucleus prepositus hypoglossi might cause eye motor dysfunction. The maximum saccadic velocity is reduced, the saccadic accuracy might be disturbed and the smooth pursuit velocity and velocity gain decreased in such disorders (2, 6, 10, 17, 20). Cerebellar disorders might cause saccadic dysmetria (the saccadic velocity is normal) and reduced smooth pursuit velocity gain (6, 8, 17, 21). There is often a combination of brainstem and cerebellar symptoms in posterior fossa lesions causing complex eye motility dysfunction (2, 21).