Long term effects of high intensity laser therapy in lateral epicondylitis patients

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Abstract The objective of this study is to investigate short- and long-term effects of high-intensity laser therapy (HILT) in lateral epicondylitis (LE) patients. Thirty patients with LE diagnosis (23 unilateral and 7 bilateral in total 37 elbows) were treated using HILT. LE patients were evaluated before, right after, and 6 months following HILT intervention post-treatment using visual analogue scale for pain (VAS) during activity and resting. Disabilities of the Arm, Shoulder, and Hand (DASH) Score and hand grip strength test (HGST) were used. The participants of the present study were also evaluated using Short-Form 36 (SF-36) before and 6 months after the treatment. Out of the 30 patients, 8 were male and 22 female with a mean age of 47.2±9.7. The activity and resting VAS, DASH, and HGST scores revealed statistically significant improvement (p=0.001) following treatment. Whereas VAS activity, DASH, and HGST scores increased after treatment until post-treatment 6 months significantly (p=0.001), VAS resting scores remained stable (p=0.476). A statistically significant improvement was also evident in the physical and mental components of SF-36 scores following treatment until post-treatment 6 months compared to pre-treatment scores (p=0.001). In conclusion, the results of the present study suggest that HILT is a reliable, safe, and effective treatment option in LE patients in the short and long term considering pain, functional status, and quality of life.

Keywords High-intensity laser treatment · Lateral epicondylitis · VAS score · Pain · Elbow

Introduction

Lateral epicondylitis (LE), also known as tennis elbow, is tendinosis of the extensor group muscles in the lateral elbow. This anomaly is the result of the extensive use of stiffened muscles, and is frequently seen in the working population. It decreases the quality and level of work as a result of decreased hand grip strength [1]. Since physical strain may play a part in the development of LE, the arm that is used more often is more significantly affected than the other. The symptoms seem to resolve in between 6 and 24 months in most patients [2].

The treatment of LE is administered to relieve pain, accelerate the healing process, hinder extensive arm use, and help the patients to normalize their daily life activities. The treatment modalities are medical, non-electrotherapeutic (exercise, manipulation, acupuncture, orthotics, and taping), electrotherapeutic (laser, extracorporeal shock wave therapy [ESWT], electromagnetic field, ionization, ultrasound, and phonophoresis), and surgical operations [3]. Laser treatment is a noninvasive and painless method that can be easily administered in therapy units for a wide range of conditions. Throughout the last decade, high-intensity laser therapy (HILT) has been widely used in sports injuries (contusions, tendon injuries, muscle spasms, etc.) and in musculoskeletal disorders [4]. However, there have been few satisfactory and long-term studies about the efficacy of HILT in LE therapy [5]; therefore, the effectiveness of HILT in LE has not yet been clarified.
The aim of the present study was to investigate short- and long-term, 6 months, effects of HILT in lateral epicondylitis with regard to pain, function, and grip strength.

Materials and methods

Subjects

The study participants consisted of 30 patients who came to the physical medicine and rehabilitation outpatient clinic with elbow pain. These patients were diagnosed with lateral epicondylitis (23 unilateral and 7 bilateral in a total 37 elbows) after physical examination, laboratory testing, and imaging.

The exclusionary criteria consisted of those patients with upper extremity entrapment neuropathy, major psychiatric disease, those with a history of upper extremity surgical treatment, rheumatic disease, cervical radiculopathy and cervical myelopathy, and those who were injected with local corticosteroids and/or received physical therapy.

Pain and functional capacity measurements

The patients’ pain and functional levels were evaluated using an activity–rest 0–10 cm visual analogue scale (VAS), and an arm-shoulder-hand disability questionnaire (DASH). The DASH questionnaire is an example of an outcome measure focused on function, which can be used across conditions affecting the entire upper limb [6].

Hand grip strength assessment

The Jamar hand dynamometer grip strength measurements are known to yield reliable results [7], and these measurements were taken in the standing position and with the full extension of the elbow and wrist. The measurements were repeated three times, the average scores were calculated, and the outcomes were recorded in kilograms. All of the patients’ measurements were taken between 10:00 a.m. and 2:00 p.m. in order to reduce the muscle fatigue effects, 1-min intervals separated each measurement.

Life quality measurement

The quality of life of the participants was assessed by the Short-Form 36 health survey (SF-36), which is a reliable and valid questionnaire that can be used to evaluate patients with musculoskeletal disorders. The SF-36 includes 36 questions that are aggregated to score 8 domains: physical function, role limitations due to physical function, bodily pain, general health perceptions, vitality, social function, role limitations due to emotional problems, and general mental health. The eight domains are scored from 0 to 100 (worst to best possible health, respectively). There are two summary scales, namely the physical component (Physical Component Scale, PCS) and mental component (Mental Component Scale, MCS) [8].

High-intensity laser therapy

HILT was applied during the first four sessions for 75 s at a 4 W 6 J/cm² dose (analgesic effect) to the most painful areas, in a circular motion from the center toward the outside. In the subsequent six sessions, it was applied for 12 min and 30 s at a 6 W 100–150 J/cm² dose (bio-stimulation effect) at the pain inflicting region, in a linear motion. Then, the area was warmed up without causing discomfort to the patient for ten sessions (5 days per week for a total of 2 weeks).

Procedure

Thirty-seven elbows diagnosed with lateral epicondylitis were treated with HILT for 5 sessions per week for 2 weeks, 10 sessions in total. The active and resting VAS, DASH, and hand grip strength (HGS) test scores of the patients were evaluated before and after treatment, and after 6 months. The SF-36 was used in order to determine the quality of life before the treatment and during the sixth month of the post-treatment period. Throughout the treatment, the patients were discouraged from using analgesics; however, they were advised to use paracetamol (acetaminophen) in case of necessity. The patients were asked not to use analgesics during 24 h before the evaluation.

Statistical analysis

In the presentation of data, (1) the pre-treatment DASH, VAS rest, VAS activity, and HGS parametric values were compared to the post-treatment values; (2) the pre-treatment DASH, VAS rest, VAS activity, and HGS parametric values were compared to the post-treatment values in the sixth month; and (3) the post-treatment DASH, VAS rest, VAS activity, and HGS parametric values were compared to the post-treatment values in the sixth month using the Student’s t test. The pre-treatment SF-36 physical component and SF-36 mental component parametric values were compared to the post-treatment values in the sixth month using the Student’s t test; p values <0.05 were accepted as statistically significant.

Results

Twenty-three patients with unilateral complaints and 7 patients with bilateral symptoms (for a total of 37 elbows) were included in this study. The mean age of the patients was 47.2 ± 9.7, while 8 of the 30 patients were male and 22 were female. The patients’ demographic data are presented in Table 1.
Pain and functional capacity measurements

When the scores before treatment were compared to the ones after treatment, there were statistically significant decreases in the active and resting VAS evaluations after the treatment and in the sixth month. In the comparison of the scores after the treatment and in the sixth month, the VAS levels revealed a statistically significant decrease, while the improvement in the VAS resting scores remained the same (Table 2).

The DASH scores after the treatment and in the sixth post-treatment month compared to the scores before treatment also revealed a statistically significant improvement. When the sixth month was compared with the immediate post-treatment scores, a continuing statistically significant change was revealed (Table 2).

Hand grip strength assessment

The grip strength measurements after the treatment and in the sixth post-treatment month compared to the scores before treatment also revealed a statistically significant improvement. When the sixth month was compared with the immediate post-treatment scores, a continuing statistically significant change was revealed (Table 2).

Quality of life measurements

There was a statistically significant improvement in the SF-36 evaluation scores in the sixth post-treatment month, when compared to the scores before treatment in both the SF-36 physical and mental components (Table 4).

Discussion

Lateral epicondylitis is among the common pathologies of the musculoskeletal system, with different treatment options available. Among these, the most commonly used treatments are the non-surgical modalities, including patient education, the application of commonly available treatments, physiotherapy, manual therapy, laser therapy, a tennis elbow brace, exercise, massage and local injection therapy, as well as oral or topical nonsteroidal anti-inflammatory drugs (NSAIDs) [3].

Laser treatment is a method that has become popular over the last decade [9]; however, the studies on laser treatment in lateral epicondylitis have focused mainly on the efficacy of low-intensity laser therapy (LILT), and there are few studies on the efficacy of HILT. In the present study on the short- and long-term effects of HILT on lateral epicondylitis, we determined that HILT is an efficient and safe treatment modality with regard to pain, functional status, and the quality of life. The positive outcomes obtained immediately following HILT treatment in the pain, quality of life, HGS, and DASH scores continued to increase through the post-treatment sixth month.

LILT is a treatment modality that has been available throughout (approximately) the last three decades. There are controversial outcomes regarding the efficacy of LILT in general musculoskeletal problems and lateral epicondylitis, while some studies suggest that LILT efficacy outcomes are better than in placebos [9, 10]. However, one meta-analysis of LILT for lateral epicondylitis found that it was ineffective in the treatment of LE [11].

Laser treatment is a noninvasive and painless method that can be easily administered in therapy units for a wide range of conditions [4]. HILT has been reported to reduce inflammation and the symptoms of pain. HILT uses a particular waveform with regular peaks of elevated amplitudes and durations of time between them to decrease thermal accumulation phenomena, and it is able to rapidly induce photochemical and photothermic effects in the deep tissue. These photochemical and photothermic effects of HILT may stimulate collagen production within the tendons and increase the blood flow, vascular permeability, and cell metabolism; thus, they help to repair damaged tendons and remove painful stimuli. Furthermore, HILT with high-intensity laser beams leading to small and slow light absorption via chromophores has become more widely used. This absorption enabled not through

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Table 1: Patients’ demographic data

| Age       | 47.2 ± 9.7 |
| BMI       | 29.35 ± 3.63 |
| Gender    | 8 male (26.6 %) |
|           | 22 female (73.3 %) |
| Presence of complaints for months | 3.37 ± 3.97 |
| Working status | Housewife 15 (50 %) |
|           | Retired 5 (16.6 %) |
|           | Working 10 (33.3 %) |

Table 2: Pain and functional situation

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>Sixth month</th>
<th>pα</th>
<th>pβ</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAS activity</td>
<td>8.51 ± 1.93</td>
<td>5.83 ± 2.48</td>
<td>3.89 ± 2.51</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>VAS resting</td>
<td>6.02 ± 3.40</td>
<td>2.48 ± 2.39</td>
<td>2.21 ± 2.12</td>
<td>.000</td>
<td>.000</td>
<td>.476</td>
</tr>
<tr>
<td>DASH</td>
<td>53.64 ± 22.53</td>
<td>38.33 ± 17.10</td>
<td>30.49 ± 17.52</td>
<td>.000</td>
<td>.000</td>
<td>.006</td>
</tr>
</tbody>
</table>

the intensity of light but through diffusion in all directions, increases mitochondrial oxidative reactions, adenosine triphosphate, RNA or DNA production [12, 13]. The analgesic effects of HILT are based on multiple mechanisms of action, including its ability to slow the transmission of the pain stimulus and to increase the production of morphine-mimetic substances in the body [14]. It reportedly has an analgesic effect on nerve endings, but there has been no evidence of decreased inflammation [15].

There are a variety of applications related to HILT dosage. For example, Santamoto et al. applied HILT for ten sessions, each of which lasted for approximately 10 min, in three phases at 510, 610, and 710 mJ/cm² respectively, with a total energy use of about 2050 J [13]. Fiore et al., in their HILT study of 10-min sessions, applied a three-phase treatment using 2600 J of energy in total [16]. The present study was conducted using a BTL 6000 high-intensity laser at 12 W, and each patient underwent analgesic and bio-stimulation phases. The first four sessions were analgesic phases, applying a 25-Hz Intermittent Mode at 8 W, with a 6 J/cm² dose to an area of approximately 25 cm² for 75 s, for a total of 150 J of energy. The subsequent six sessions were at a bio-stimulation phase at a continuous flow mode, with 4 W of power at a 120 J/cm² dose to an approximately 25 cm² area, for 12 min and 30 s, in total, using about 3000 J.

HILT has been used for a wide range of disorders, for example, to relieve the symptoms of low back pain [16, 17], knee osteoarthritis [18], facial paralysis [19], and subacromial impingement syndrome [13]. HILT has also been used in the treatment of chronic diabetic foot ulcers [20]. Fiore et al. treated 15 of 30 sub-acute and chronic back pain cases with HILT sessions, and the other 15 with ultrasound, in a study in which they compared ultrasound with HILT in the treatment of lower back pain. They reported that HILT was a new, more effective treatment option for pain and disability [16]. In a study in which they compared ultrasound with HILT in the treatment of lower back pain, Santamoto et al. randomized 70 patients with subacromial impingement syndrome and divided them into 2 groups, applying 10 HILT sessions to 35 of them, and 10 sessions of ultrasound therapy to the remaining 35. In their results, they reported that HILT was more effective than ultrasound in pain management and improving the shoulder joint range of motion [13].

Alayat et al. used both HILT and LILT in the treatment in facial paralysis, and found that HILT was a more effective treatment option than LILT [19]. Alayat et al. divided their patients into three groups (HILT and back exercises, back exercises only, placebo laser and back exercises) during a 12-week follow-up study. They found that the HILT and back exercise group had better outcomes; however, they could not determine any statistically significant differences between the other two groups [17]. Keshie et al. used HILT and LILT combined with exercise in knee osteoarthritis, and found that these three combined treatments were effective modalities for decreasing pain and improving the knee function scores after 6 weeks of treatment. HILT combined with exercise was more effective than LILT combined with exercise, and both treatment modalities were better than exercise alone in the treatment of patients with knee osteoarthritis [18].

Dundar et al., in a study in which they compared the efficacy of a brace with HILT in LE treatment, found that HILT was safe, effective, and easily applicable, but it was not superior to a brace [5]. Similarly, we found HILT to have positive effects on the pain, quality of life, HGS, and functional capacity in LE treatment. In most of the studies on HILT, it was found to be a safe, effective, and easily applicable treatment modality. Although the study was conducted for 12 weeks, we determined that the positive effects of HILT in relieving pain, enhancing the quality of life, HGS, and functional capacity were still present in the sixth month after treatment. The main limitations of this study are that we had a relatively small study population, there were no control groups, and we did not compare our study with other treatment modalities.

### Table 3 Hand grip strength

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
<th>pα</th>
<th>Sixth month</th>
<th>pβ</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand grip strength</td>
<td>15.26 ± 9.56</td>
<td>21.81 ± 13.60</td>
<td>.000</td>
<td>27.24 ± 11.45</td>
<td>.000</td>
<td>.000</td>
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</table>

pα pre-treatment-post-treatment p values, pβ pre-treatment-sixth month p value, p* post-treatment-sixth month p values

### Table 4 Quality of life measurements

<table>
<thead>
<tr>
<th></th>
<th>Pre-treatment</th>
<th>Sixth month</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-36 (physical component)</td>
<td>35.31 ± 18.17</td>
<td>66.50 ± 15.90</td>
<td>.000</td>
</tr>
<tr>
<td>SF-36 (mental component)</td>
<td>48.44 ± 17.49</td>
<td>62.14 ± 17.85</td>
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</tr>
</tbody>
</table>

SF-36 short-form 36

**Conclusion**

HILT is currently an effective treatment option for effective pain management, as well as improving elbow function and the quality of life in lateral epicondylitis over both the short and long terms. However, longer-term, randomized controlled trial studies are required to verify the findings of this study.
Acknowledgments The authors would like to thank Dr. Harun Simsek for editing the present manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interest.

Ethical statement The current study has not been sent to any journal for consideration except Lasers in Medical Science. All of the authors agreed to submit this study (Long-Term Effects of High-Intensity Laser Therapy in Lateral Epicondylitis Patients) to Lasers in Medical Science to be published. The authors whose names appear on this submission have contributed sufficiently to the scientific work and, therefore, share collective responsibility and accountability for the results.

References