Effectiveness of Low-Level Laser Therapy in Chronic Plantar Fasciitis Conservative Treatment

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ABSTRACT

Introduction: This study aimed to evaluate the effectiveness of low-level laser treatment (LLLT) for treating chronic plantar fasciitis (PF).

Methods: The records of 60 patients with PF were retrospectively examined in this research. Thirty patients who have been applied LLLT and given exercise program constituted a treatment group. On the other side, 30 patients who have been given exercises but not applied LLLT was selected as a control group. Along with exercise, the treatment group underwent a 10-day continuous, 12-minute, 1.6 W, 808 nm wavelength diode laser treatment using gallium-aluminium-arsenide. The American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale and the Foot Function Index (FFI) were used to assess the patients’ foot discomfort and functional condition while they were at rest, taking their first steps, and during activities. These assessments were all documented before, after, and after two months of treatment.

Results: In the treatment group, all VAS, FFI, and AOFAS scores except alignment score has been significantly improved both in the first and the second months compared to the initial state (p<0.05). The improvement in these scores was higher in the treatment group than in the control group in the first and the second months both (p<0.05).

Conclusion: These findings confirm that LLLT is an effective and reliable therapy choice in the conservative management of PF.

Keywords: Exercise, low-level laser therapy, pain, plantar fasciitis

Introduction

Adults who experience heel pain most frequently have plantar fasciitis (PF) (1). The degenerative condition known as PF is brought on by repeated stress to the area where the plantar fascia connects to the calcaneus (2). The etiology of PF is multifactorial; advanced age, pes planus, increased pronation, obesity, improper preference of shoe model, and decreased ankle dorsiflexion are the most common causes and result in biomechanical overload (3).

Clinical diagnosis is made substantially by anamnesis and physical examination. The typical clinical symptom is deep pain at the heel that begins after inactivity, notably with the initial steps in the morning, eases with activity, gradually worsens in response with weight-bearing toward the end of the day. The painful point with palpation is usually next to the anteromedial protrusion of the calcaneal tuberosity (4).

PF is usually a self-limiting clinical condition. Most of the patients recover conservative treatments.

Rest, adjusting activity levels, stretching exercises, resting splints, insoles, oral and topical medications, local injections, and physical therapy modalities are some of the conservative treatment choices (4-7).

Nowadays, a treatment procedure called low-level laser therapy (LLLT) is employed extensively, and new evidence has begun to emerge with the standardization of dosage recommendations according to diseases. Nowadays, LLLT is used for reducing pain and inflammation, wound healing, and increasing the speed of healing in musculoskeletal injury (8-15).

There are very few researches in the literature that examine how well LLLT works to cure PF (16). Evidence for LLLT’s effectiveness in improving functional capacities in PF is still controversial. The fact that the studies were conducted with different laser devices and different treatment protocols affect these results. In this context, we need new studies that investigate different treatment protocols and dosages for finding the optimum LLLT method for PF therapy (16,17).

This study aimed to assess the effectiveness of LLLT in the management of chronic PF. Our LLLT treatment protocol in this study was distinct from previous suggested protocols that were applied in the literature. Cause no study had proved the best method for PF. For this reason, we gained to observe different kinds of treatment protocols’s effects. Moreover, in our study, we use different scales that evaluate functional abilities and gait functions.
Methods

In this retrospective investigation, the records of 60 individuals who were clinically diagnosed with PF and have been treated between May 2016 and October 2016 were included in the study. The files were retrospectively reviewed. 30 patients who have been applied LLLT and given exercise program constituted a treatment group. On the other side, 30 patients who have been given just exercises without any other therapy were selected as a control group.

The presence of chronic plantar heel pain symptoms that had persisted for at least three months and were resistant to first-step conservative treatment was the requirement for inclusion. By detecting discomfort to palpation and local pressure at the plantar fascia’s origin on the medial tubercle of the calcaneus during the physical examination, the diagnosis was clinically verified. The participants who ranged in age from 18 to 75, were admitted if they had not use any anti-inflammatory medications throughout their treatment. The exclusion criteria included a history of trauma, surgery, skin lesions, malignancy, steroid injections within the preceding three months, radiculopathy, arthropathy, and pregnancy.

The University of Health Sciences Turkey, İstanbul Training and Research Hospital Ethics Committee gave its approval to the study (approval number: 2016/902). Each participant gave written consent. The research was based on a PhD thesis.

Interventions

Age, weight, height, body mass index (BMI), and daily standing time were among the demographic details of the patients that were recorded. The treatment group had 10 days continuous, once daily 12-minute LED gallium-aluminium-arsenide (Ga-Al-As) 1.6 W, 808 nm wavelength diode laser treatment in addition to exercise treatment whereas control group had only exercise treatment. The plantar fascia’s sensitive spots received LLLT treatment (four points), for a total dose of 4 J/cm² for 30 s each point periodically, with a total duration of 12 min. Figure 1 shows the locations of the LLLT applications.

The exercise regimen comprised achille tendon, gastrocnemius, plantar fascia stretching exercises, roll ball or roller exercise, toe-tap, and intrinsic muscle strengthening exercises (18,19). Achilles tendon stretching exercise is performed in a long sitting position by bringing the foot dorsiflexed and waiting for 10 seconds in this situation (20-22). Stretching the gastrocnemius muscle is done by leaning forward against the wall, keeping the legs straight, lowering the heels, and standing on the foot tip on the step (23,24). The affected side is positioned on the opposing leg in a sitting position while performing the plantar fascia stretching exercise. The foot is brought to dorsiflexion and toes to extension and held in this position for 10 seconds (25). For the rolling exercise, a cylindrical object is moved back and forth under the foot for 10 min (20). Towel curls, towel pickup, and toe-tap exercises were instructed to both groups to strengthen the intrinsic muscles of the foot.

In the toe-tap exercise, all fingers are in the air while the heel is kept on the ground, and the big toe is repeatedly tapped on the ground and then the other four fingers are struck on the ground while the thumb is in the air (20,23,26). The participants were told that the exercises should be done ten times each, three times per day, for two weeks.

Outcome Measures

The patients’ rest, the first step and activity pain levels were evaluated using a visual analogue scale (VAS), foot pain and functioning state was evaluated by the Foot Function Index (FFI) and American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale. These assessments were all documented before, after, and after two months of treatment.

The level of subjective pain perception was assessed using VAS. Morning VAS, resting, and activity VAS were recorded separately. The patient selects a number describing his or her suffering levels between 0-10 (0: no pain, 10: the most severe pain). This number represents the intensity of the pain.

Functional ability was measured by AOFAS and FFI. AOFAS is a standardized evaluation of the clinical status of the ankle-hindfoot. It incorporates both subjective and objective information. Patients report their pain, and physicians assess alignment. AOFAS includes 9 items, distributed over 3 categories: pain (40 points), functional aspects (50 points), and alignment (10 points), for a total of 100 points with healthy ankles receiving 100 points (27). The FFI is a standard questionnaire used to assess foot diseases. Pain, disability, and activity restriction are among the three subscales of the FFI. The FFI consisted of 23 items. Patients take into account their foot issues from the previous week when filling out the FFI, scoring each item with a VAS. To obtain the subscales and the overall score, the scores for each item are added up (28-31).

Statistical Analysis

Descriptive information was shown using the following formats: number, percent, median, mean, ratio, frequency, and standard deviation. The Kolmogorov-Smirnov test was used to determine if the data were conformable to a normal distribution. The Independent Sample t-test and Mann-Whitney U test were used to assess quantitative independent data. Wilcoxon test results were used to assess the dependent data. The Pearson chi-square test was used to compare categorical variables. The cut-off for statistical significance was p=0.05. The Statistical Package for the Social Sciences program for Windows, version 22.00, was used for statistical analysis (SPSS Inc., Chicago, IL, USA).

Results

The trial involved 60 individuals in total. The baseline features and demographic data of the participants are listed in Table 1. The median age of the individuals was 45.4±12.3 years. The majority of participants were female (85%). Most individuals were overweight or obese. BMI values vary in range 19-40; the mean BMI of the participants was 28±5.7. The two groups did not substantially vary in terms of age, BMI, or daily standing time (p>0.05). Rest, activity, and first-step VAS scores in the treatment and control groups all significantly improved both in the first and second months compared to baseline. The improvement in these scores was better in the treatment group than in the control group in the first and second month both (p<0.05) (Table 2).

In the treatment group, significant reduction has been observed in all FFI scores in the first and second months both (p<0.05). There has been no significant change in FFI pain subscale score in the control group.
Except this score, all other measurements has been improved both in the first and second months in the control group (p < 0.05). The improvement in these scores was higher in the treatment group than in the control group in the first and the second months both. Just there has been no significant difference in the reduction ratio in the FFI activity limitation subscale score in the first month between the groups (Table 3).

In the treatment group, all measurements of AOFAS scores except alignment score has been significantly improved both in the first and the second months compared with to the initial state (p < 0.05). The improvement in these scores was higher in the treatment group than in the control group in the first and the second months both. There has been no significant change in AOFAS pain and alignment scores compared to the initial state in the control group (p > 0.05). Only the function score on the AOFAS scale in the control group showed a significant improvement (Table 4).

**Discussion**

For adults, PF is the most typical source of heel discomfort. Although this condition can be self-limiting, there are many conservative treatment options (32). However, their effectiveness is still uncertain, and the optimal treatment has not been defined (33).

Literature contains a insignificant number of publications examining LLLT’s efficacy in the management of PF. It has been reported that there are a number of disputed cases about the LLLT treatment for PF, which may be caused by variations in the treatment protocols and kinds of LLLT. Numerous factors, including frequency, dose, and locations, are taken into account in LLLT’s therapeutic use. Consequently, future research should concentrate on identifying the best treatment parameters to enhance the clinical effectiveness of the treatment (34).

The purpose of this research was to asses the efficacy of LLLT in the management of persistent PF. Our LLLT treatment protocol in this study was distinct from the other protocols described in the literature. We observed different kinds of therapy protocol's effects. Moreover, in our study, we used different scales that evaluate functional abilities and gait function.

We retrospectively examined 60 patient files diagnosed with PF. Because of our study, VAS, FFI, and AOFAS values significantly improved in both the treatment and control groups, according to our findings, which were significantly better in the treatment group compared with the control group. These results demonstrate that LLLT can be a viable therapy option for PF.

LLLT in the treatment of PF was first investigated in 1998 by Basford et al. (35). They applied LLLT at a wavelength of 830 nm at a dose of 1.75 mJ/mm² for each spot for a total of 24 spots.
1 J to the to the plantar fascia’s starting point and a dose of 2 J along the medial fascial edge for 12 sessions and found no significant clinical difference with the placebo group in the first month after treatment. However, the reason for this result is likely to be due to the low dose of treatment administered. In our study, unlike this study, a higher dose of LLLT was applied to the patients. In contrast to this study, our treatment group showed a significant improvement in comparison to the control group on the VAS, FFI, and AOFAS scales for all criteria of pain, function, and activity limitation.

In their 2009 investigation, Kiritsi et al. (8) used a Ga-As laser with an infrared wavelength of 904 nm to perform LLLT. The active treatment dose was 8.4 J over the tendon insertion point, followed by 8.4 J along the medial fascial boundary. They evaluated the clinic of the patients with VAS pain scores and the plantar fascia thickness ultrasonographically.

<table>
<thead>
<tr>
<th>Table 3. Foot function index</th>
<th>LLLT group (n=30)</th>
<th>Control group (n=30)</th>
<th>p</th>
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<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
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<tr>
<td>Pain subscale</td>
<td></td>
<td></td>
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<tr>
<td>Baseline</td>
<td>7.7±1.2</td>
<td>7.6±1.9</td>
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<tr>
<td>The first month after treatment</td>
<td>7.6±1.3</td>
<td>4.8±2.7</td>
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<tr>
<td>Second month after treatment</td>
<td>7.4±1.3</td>
<td>3.5±3.0</td>
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<tr>
<td>Disability subscale</td>
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<tr>
<td>Baseline</td>
<td>7.0±1.6</td>
<td>6.2±2.2</td>
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<tr>
<td>The first month after treatment</td>
<td>6.8±1.6</td>
<td>4.7±3.2</td>
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<td>Second month after treatment</td>
<td>6.6±1.7</td>
<td>3.1±3.1</td>
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<tr>
<td>Activity limitation subscale</td>
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<tr>
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<td>Total FFI score</td>
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<td>Baseline</td>
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<tr>
<td>Second month after treatment</td>
<td>6.3±1.0</td>
<td>3.3±3.0</td>
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</table>

*Mann-Whitney U test/Wilcoxon test, LLLT: Low-level laser treatment, SD: Standard deviation, FFI: Foot function index

<table>
<thead>
<tr>
<th>Table 4. American orthopaedic foot and ankle society</th>
<th>LLLT group (n=30)</th>
<th>Control group (n=30)</th>
<th>p</th>
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</thead>
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<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
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<tr>
<td>Pain subscale</td>
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<tr>
<td>Baseline</td>
<td>21.7±25.2</td>
<td>23.3±25.4</td>
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<td>The first month after treatment</td>
<td>21.7±25.2</td>
<td>61.7±28.4</td>
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<tr>
<td>Second month after treatment</td>
<td>21.7±25.2</td>
<td>67.5±30.2</td>
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<tr>
<td>Function subscale</td>
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<td></td>
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<tr>
<td>Baseline</td>
<td>43.5±17.4</td>
<td>58.7±20.3</td>
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<tr>
<td>The first month after treatment</td>
<td>46.1±17.4</td>
<td>68.5±24.2</td>
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<td>Second month after treatment</td>
<td>48.2±17.8</td>
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<td>Alignment subscale</td>
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<td>Baseline</td>
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<td>78.3±31.3</td>
<td>0.632</td>
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<tr>
<td>The first month after treatment</td>
<td>75.0±31.5</td>
<td>78.3±31.3</td>
<td>0.632</td>
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<tr>
<td>Second month after treatment</td>
<td>75.0±31.5</td>
<td>78.3±31.3</td>
<td>0.632</td>
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<tr>
<td>Total AOFAS</td>
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<tr>
<td>Baseline</td>
<td>37.9±14.7</td>
<td>46.5±19.8</td>
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<tr>
<td>The first month after treatment</td>
<td>39.2±15.1</td>
<td>66.8±24.9</td>
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<tr>
<td>Second month after treatment</td>
<td>40.3±14.7</td>
<td>73.6±26.5</td>
<td>0.001</td>
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</tbody>
</table>

*Mann-Whitney U test/Wilcoxon test, LLLT: Low-level laser treatment, SD: Standard deviation, AOFAS: American Orthopaedic Foot and Ankle Society
After treatment, the LLLT group showed a substantial reduction in pain levels, although both groups also showed an increase in plantar fascia thickness. Fascia thicknesses, on the other hand, were unchanged in comparison to the placebo group.

Jastifer et al. (34) performed a total of 6 sessions of 635 nm, 17-mW dose, 10 min, 2 times a week, 3 weeks. They evaluated their patients with FFI and VAS scales before treatment, at 2 weeks, 6 months, and 12 months after treatment. They found that there was a significant difference in all evaluations compared to premassage values. However, in our study, we were unable to evaluate the long-term effects of treatment. Similar to this study, we also used the FFI scale and a significant change was found in the FFI scale scores in terms of both the amount of pain reduction and the improvement in functions at the 1st and 2nd months after the treatment.

Randomized placebo-controlled study in 2015, Macias et al. (36) applied LLLT at a dose of 17 mw with a wavelength of 635 nm for 10 min, twice a week, for 3 weeks. They showed that the LLLT group was significantly superior to the placebo group in both decreasing VAS pain scores and decreasing fascia thickness. They also achieved significant improvement in all FFI scores in both the LLLT and the placebo groups, but they did not detect a difference between the groups. The limitation of our study, according to the study by Macias et al. (36) and Kiritsi et al. (8) is that the plantar fascia thickness was not evaluated by ultrasound (US) and the placebo group was excluded in our study.

In their investigation in 2017, Ulusoy et al. (16) used the AOFAS test to assess the efficacy of LLLT in PF. They applied a Ga-Al-As laser device at 830 nm, 50 mW output power, 8 j/cm² dose for a total of 3 weeks 5 times a week. They compared the efficacy of LLLT with extracorporeal shock wave therapy (ESWT) and therapeutic US therapy. AOFAS ratings in the LLLT group improved more than in the ESWT and US groups, according to the study.

In a randomized prospective study by Cinar et al. (37) both treatment and control groups were given insoles and a home exercise program, and LLLT was also applied to the treatment group. They used the AOFAS function scale for functional evaluation and the VAS scale for pain after the 12-minute walk test. They performed LLLT in the 5 most painful points at a dose of 5.6 j/cm² for 80 seconds. While both groups showed a substantial improvement in their AOFAS function scores in the third week following treatment, only the group that received LLLT in the third month showed a meaningful improvement. Although there was a significant improvement in the measurement of activity-related pain in both groups at the 3rd month, the amount of improvement was greater in the treatment group. In our study, in parallel with this study, a significant increase was observed in all groups of AOFAS scores compared with the pre-treatment scores, except the alignment score in the treatment group. This is a result consistent with previous studies. This supports that LLLT is an effective treatment. The different aspects of our study according to the study by Cinar et al. (37) is that the LLLT was applied at a lower dose and with a different application method.

The positive sides of our study; in accordance with previous studies, no adverse effects were seen in the patients throughout the study. This finding supports that LLLT is a safe treatment. The fact that the treatment responses of the patients included in our study was evaluated using the FFI and AOFAS scales also enabled us to investigate the correlation of these two scales. And the results obtained from the two scales were correlated with each other.

Study Limitations
The limitations of our study are that the evaluation process was short, retrospective, and there was no placebo group.

Conclusion
According to this study, LLLT is useful in PF conventional treatment with regard to pain, functional activities, and quality of life. It has been concluded that LLLT is a reliable and effective application in the physical treatment of PF. To investigate the effects of LLLT on PF treatment, placebo-controlled studies with longer follow-ups are needed for more patients.

Ethics Committee Approval: The University of Health Sciences Turkey, Istanbul Training and Research Hospital Ethics Committee gave its approval to the study (approval number: 2016/902).

Informed Consent: Each participant gave written consent.

Peer-review: Externally and internally peer-reviewed.


Conflict of Interest: No conflict of interest was declared by the authors.

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17. Maskill JD, Bohay DR, Anderson JG. Gastrocnemius recession to treat isolated foot pain. Foot Ankle Int 2010; 31: 19-23.


