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ORIGINAL ARTICLE

Is low-level laser therapy effective in acute or chronic low back pain?

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Abstract The purpose of this study was to compare the effectiveness of low-level laser therapy (LLLT) on pain and functional capacity in patients with acute and chronic low back pain caused by lumbar disk herniation (LDH). LLLT has been used to treat acute and chronic pain of musculoskeletal system disorders. This study is a randomized, double-blind, placebo-controlled study. Forty patients with acute (26 females/14 males) and 40 patients with chronic (20 females/20 males) low back pain caused by LDH were included in the study. Patients were randomly allocated into four groups. Group 1 (acute LDH, n=20) received hot-pack + laser therapy; group 2 (chronic LDH, n=20) received hot-pack + laser therapy; group 3 (acute LDH, n=20) received hot-pack + placebo laser therapy, and group 4 (chronic LDH, n=20) received hot-pack + placebo laser therapy, for 15 sessions during 3 weeks. Assessment parameters included pain, patients' global assessment, physician's global assessment, and functional capacity. Pain was evaluated by visual analog scale (VAS) and Likert scale. Patients' and physician's global assessment were also measured with VAS. Modified Schober test and flexion and lateral flexion measures were used in the evaluation of range of motion (ROM) of lumbar spine. Roland Disability Questionnaire (RDQ) and Modified Oswestry Disability Questionnaire (MODQ) were used in the functional evaluation. Measurements were done before and after 3 weeks of treatment. After the treatment, there were statistically significant improvements in pain severity, patients' and physician's global assessment, ROM, RDQ scores, and MODQ scores in all groups (p<0.05). However, no significant differences were detected between four treatment groups with respect to all outcome parameters (p>0.05). There were no differences between laser and placebo laser treatments on pain severity and functional capacity in patients with acute and chronic low back pain caused by LDH.

Keywords Laser therapy · Low back pain · Lumbar disk herniation

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Introduction

Low back pain (LBP) is one of the most common problem and is an important cause of morbidity in adults. LBP lasting less than 3 months is referred to be acute LBP, and pain over 3 months is defined as chronic LBP [1–3]. It affects nearly two thirds of the adults at some time during their lives [4]. Lumbar disk herniation (LDH) is one of the most common reason of LBP. It commonly causes impairments in quality of life of the patients with musculoskeletal system problems. The chronic LBP is also an important health problem for economic costs to the community [3–5].

The goals of the treatment are to reduce pain, allow patients to resume their normal activities, and to increase quality of life. Combinations of pharmacological and nonpharmacological methods are mostly preferred [1, 6]. Nonpharmacological treatment modalities recommended by the American College of Physicians and the American Pain Society for LBP treatment emphasize patient education

programs, exercise programs, back schools, spinal manipulation, massage, acupuncture, physical therapy, and lumbar supports [6, 7].

Low-level laser therapy (LLLT) is used by many parts of the world including Europe, USA, and the Far East. However, it has not yet received Food and Drug Administration approval for any indication [6, 8]. Laser is a noninvasive, nonionizing, monochromatic, and polarized electromagnetic highly concentrated light beam. LLLT has analgesic, myorelaxant, tissue healing, ligament repair, fibroblast proliferation, biostimulant effects and nonthermally and nondestructively alters cellular function and anti-inflammatory effects [4, 9–13]. Even though LLLT has been used to treat acute and chronic pain, the exact mechanism of pain relief is still unclear [4, 12]. Results in the studies related to its efficacy in the musculoskeletal system problems are conflicting due to indistinct rules for dosage per point, type, frequency, and duration. However, various studies supported its beneficial effects and this contraversion leads us to investigate the effectiveness of laser therapy on pain relief [3, 6].

The purpose of this study was to compare the effectiveness of LLLT on pain and functional capacity in patients with acute and chronic low back pain caused by LDH.

Materials and methods

This study included 40 patients with acute (26 females and 14 males, with a mean age of 46.95±25.44 years) and 40 patients with chronic (20 females and 20 males, with a mean age of 53.50±12.89) LBP caused by LDH. The diagnosis of LDH was based on clinical examination. After detailed clinical evaluation, all patients received lumbar magnetic resonance imaging (MRI). Also, full blood count, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and biochemical markers were evaluated.

Patients with neurological deficits, spondylosis, spinal stenosis, spondylolisthesis, and inflammatory, infectious, or malignant diseases of the vertebra and ones having previous spinal surgery and pregnancy were excluded.

Study design

This study was a prospective, randomized, placebo-controlled, double-blind trial. Before treatment, all participants were informed about the study and signed written informed consent. The study was approved by the University of Ufuk Human Research Ethics Committee.

Randomization

Patients were randomly assigned into four groups. Randomization were allocated by numbered envelopes method. Before the therapy, a physician evaluated the patients. Posttreatment outcomes were assessed by another physician. Both of the physicians and patients were blinded to the treatments. Only the physioterapist who applied the therapy was aware of the procedure.

Group 1 (acute LDH, n=20) received hot-pack + laser therapy
Group 2 (acute LDH, n=20) received hot-pack + placebo laser therapy
Group 3 (Chronic LDH, n=20) received hot-pack + laser therapy
Group 4 (Chronic LDH, n=20) received hot-pack + placebo laser therapy

Hot pack All groups received hot-pack therapy for 20 min.

LLLT The gallium–aluminum–arsenide (GaAlAs, infrared laser) diode laser device (Chattanooga group, USA) with a wavelength of 850 nm, power output of 100 mV, continuous wave, and 0.07-cm^2 spot area laser was used for the treatment. The laser was applied at two to four points over both sides of the paraspinal tissues of the disk spaces. Patients were treated for 4 min at each point, producing

Table 1 Demographic features of the patients

	Group 1[a]	Group 2[b]	Group3[c]	Group 4[d]
Age	48.35±15.22	45.55±15.66	52.25±10.77	54.75±15.02
Gender (female/male)	14/6	12/8	9/11	11/9
Disease duration (month)	2.45±1.43	2.20±1.28	50.35±68.71	48.40±49.06
BMI (kg/m^2)	75.32±13.49	78.70±10.70	74.65±11.51	73.70±8.81
Education (n, %)				
Primary school	7 (%35)	6 (%30)	6 (%30)	13 (%65)
Secondary school	1 (%5)	2 (%10)	1 (%5)	2 (%10)
High school	3 (%15)	10 (%50)	3 (%15)	2 (%10)
University	9 (%45)	2 (%10)	10 (%50)	3 (%15)

[a] Acute LDH laser therapy
[b] Acute LDH placebo laser therapy
[c] Chronic LDH laser therapy
[d] Chronic LDH placebo laser therapy
BMI body mass index

Table 2 The herniated disk levels on MRI in all groups

	Group 1 (*n*)	Group 2 (*n*)	Group3 (*n*)	Group 4 (*n*)
L3–4 protrusion	3	4	4	3
L4–5 protrusion	15	14	16	13
L5–S1 protrusion	8	12	8	8

energy of approximately 40 J/cm^2 using a 850 nm gallium–aluminum–arsenide laser. Laser device was used with a pulse frequency of 16 Hz for acute LDH and used with a pulse frequency of 155 Hz for chronic LDH. Placebo laser was applied on the same area for the same period without turning on the device. Both therapist and participant wore protective goggles for safety during the treatment period.

All treatments were applied over a period of 3 weeks, 5 days a week, once a day for a total of 15 sessions. Patients were not allowed to take analgesic or nonsteroidal anti-inflammatory drugs during the follow-up period.

Outcome measures

Outcome measures included pain, patients' global assessment, physician's global assessment, lumbar range of motion, and disability.

Pain Pain was evaluated by using visual analog scale (VAS, 0–10 cm; 0 means no pain, 10 means severe pain). Patient's and physician's global assessments were also measured with VAS.

Range of motion Modified Schober test and flexion and lateral flexion measures were used in the evaluation of range of motion (ROM) of lumbar spine.

Disability Roland Disability Questionnaire (RDQ) and Modified Oswestry Disability Questionnaire (MODQ) were used in the functional evaluation. RDQ is validated and comprises 24 item in which greater levels of disability are reflected by higher numbers on a 24-point scale. The MODQ is a ten-item self-assessment questionnaire based on the low back pain. Each item is scaled from 0 to 5, with higher values representing greater disability. The validity and the reliability of its Turkish version had been shown before [14, 15].

Statistical analysis

The results of statistical analysis were expressed as mean ± SD (standard deviations). All data for normality were tested by using the Kolmogorov–Smirnov test. For determining the difference before and after treatment for all groups, Wilcoxon test was used. To compare the differences between all the groups, Kruskal–Wallis test was used. A level of significance of $p<0.05$ was accepted for this study. All analysis were performed by using the SPSS 16.0 for Windows.

Results

All patients completed the study, and no one had adverse effects. Demographic features and pretreatment values of the groups were detailed in Table 1. No statistically significant differences were observed in pain, patients' and physician's global assessments, and lumbar ROM of initial values of all groups ($p>0.05$).

The results of full blood count, ESR, CRP, and biochemical markers were in normal ranges for all groups. The herniated disk levels on MRI were detailed in Table 2 for all groups.

Table 3 The pretreatment and posttreatment results of VAS and patients' and physician's global assessment scores

	Group 1	Group 2	Group3	Group 4	*p*
VAS					
Pretreatment	6.70±2.15	6.15±2.39	6.0±2.29	6.60±2.25	
Posttreatment	2.70±1.49	2.0±1.37	2.65±1.42	2.65±1.46	0.405
p	0.000*	0.000*	0.000*	0.000*	
Patients' global assessment					
Pretreatment	6.45±2.25	5.70±2.27	5.65±2.13	6.05±2.62	
Posttreatment	2.55±1.50	1.±1.31	2.35±1.18	2.15±1.26	0.409
p	0.000*	0.000*	0.000*	0.000*	
Physician's global assessment					
Pretreatment	6.60±2.28	6.15±2.32	5.80±1.98	6.30±2.51	
Posttreatment	2.50±1.67	1.95±1.31	2.65±1.22	2.25±1.20	0.616
p	0.000*	0.000*	0.000*	0.000*	

VAS visual analog scale

* $p<0.001$

Table 4 The baseline and post-treatment results of lumbar mobility measured by ROM and modified Schober test in all groups

	Group 1	Group 2	Group 3	Group 4	*p*
Right lateral flexion (cm)					
Pretreatment	49.65±6.15	48.30±7.48	53.75±5.04	47.95±7.78	
Posttreatment	46.20±5.36	44.90±6.70	48.50±5.23	45.55±7.58	0.065
p	0.000*	0.000*	0.000*	0.004**	
Left lateral flexion (cm)					
Pretreatment	48.65±6.66	48.80±7.03	50.55±13.39	48.20±6.63	
Posttreatment	46.50±6.16	44.90±6.70	49.55±4.38	46.00±6.77	0.069
p	0.003**	0.000*	0.007**	0.003**	
Modified Schober (cm)					
Pretreatment	18.15±1.72	18.30±1.45	17.65±1.30	17.75±1.68	
Posttreatment	19.95±1.39	19.60±0.88	19.15±1.49	19.65±1.13	0.181
p	0.000*	0.000*	0.001*	0.000*	

*$p<0.001$; ** $p<0.01$

After treatment, there were statistically significant improvements in pain severity, patients' and physician's global assessments, ROM, RDQ scores, and MODQ scores in all groups ($p<0.05$). However, no significant differences were detected between the four treatment groups with respect to all outcome parameters ($p>0.05$; Tables 3, 4, and 5).

Discussion

LDH is a very common condition which can be seen in every age. If it is not effectively treated in acute phase, consequently, chronicity will occur with high effort loss [1, 3]. LLLT is used as an alternative noninvasive treatment for acute and chronic pain of musculoskeletal system. Its analgesic effect is not clear and still controversial [6, 8, 16]. LLLT has analgesic effect by altering peripheral nociceptive afferent input to the central nervous system which decreases the localized pain perception [17]. Walker has shown that the efficacy of LLLT on chronic pain treatment is associated with an increased urinary elimination of 5-hydroxyindoleacetic acid which is a product of serotonin metabolism[18]. Adenosine triphosphate production and endorphin increases are emphasized. Also, the cell metabolism is found to be increased by the biostimulation effect of laser [19]. Studies suggested that it has positive effects on chondrocyte and fibroblast proliferation, matrix synthesis, and increased cellular oxygenation. LLLT may also have anti-inflammatory, anti-edematous, and spasmolytic effects [2, 9, 20].

The previous studies had evaluated only acute or only chronic pain. The important difference of our study is that we evaluated the efficacy of laser in both acute and chronic lumbar pain in the same study.

The results of some clinical studies suggest that LLLT may be successful in the treatment of reducing the pain in musculoskeletal conditions [3, 5, 20–23]. However, some investigators have described no superiority of laser therapy over placebo in the treatment of musculoskeletal conditions [4, 8, 24, 25].

Unlu et al. investigated the effectiveness of three physical therapy modalities for acute pain in LDH. They applied either LLLT, ultrasound, or traction for 3 weeks. They found an improvement in pain and disability scores in all treatment groups, but no differences between three groups [5]. Gur et al. compared the effectiveness of LLLT plus exercise group, LLLT group, and exercise-only programs on patients with chronic LBP. They found an improvement in both pain and functional capacity, but no difference was observed among any of the therapy groups [20]. In a randomized clinical trial, LLLT was found to be

Table 5 Comparison of the disability scores in all groups

	Group 1	Group 2	Group3	Group 4	*p* value
RDQ					
Pretreatment	13.20±6.45	12.60±5.79	15.10±5.41	15.60±5.38	
Posttreatment	7.20±5.57	6.95±4.22	8.40±4.24	10.95±5.63	0.075
p	0.000*	0.000*	0.000*	0.000*	
MODQ					
Pretreatment	19.80±8.25	20.80±9.44	23.90±7.51	24.65±10.04	
Posttreatment	11.60±8.29	12.10±7.93	14.30±7.40	18.45±9.52	0.074
p	0.000*	0.000*	0.00*0	0.001*	

RDQ Roland Disability Questionnaire, *MODQ* Modified Oswestry Disability Questionnaire

* $p<0.001$

superior over placebo group on pain relief in chronic LBP patients [21]. Similarly, compared to placebo laser groups, LLLT was found to have moderate effect on pain reduction in cervical and lumbar pain syndromes [23].

A recent review reported that LLLT has a minor positive effect on pain and disability in patients with acute and chronic LBP [3]. In patients with chronic LBP, Djavid et al. indicated no significant difference on pain reduction between the laser group and the placebo laser group [4]. In another placebo-controlled randomized clinical study, low-intensity Nd:YAG laser irradiation on musculoskeletal back pain was found to have moderate effect on pain reduction and improvement in functional capacity compared to placebo laser group. However, they concluded that this effect was limited and decreased with time [8]. In chronic LBP patients, LLLT with exercise program did not provide additional advantage over exercise alone [24]. Also, the results of a meta-analysis indicated that LLLT was not found to be effective on pain originating from musculoskeletal system [25].

In our study, we found no statistical significant differences between the laser and placebo laser groups in all outcome measures in both acute and chronic LBP patients. However, there were improvements in pain, ROM, and functional capacity in all groups which may be positively influenced by application of additional hot-pack therapy which increases local blood stream and tissue metabolism, relaxation of muscles, and flexibility in fibrous tissues [6, 26]. Various factors play an important role on the effectiveness of LLLT such as laser wavelength, dosage, intensity, energy density, and frequency. There is no standard therapy program. Different lasers may have different effectiveness in different diagnosis and heterogeneous laser parameters.

This study has several limitations. First, sample sizes were too small to detect differences between groups. Second, follow-up duration was short. The third limitation of the study was that there was no placebo group alone. We had to use a therapeutic application like a hot pack because of the ethical constraints in our country.

In our study, although all groups showed improvements on assessment parameters, we failed to show the superiority of laser therapy over placebo laser on pain severity and functional capacity in patients with acute and chronic LBP. LLLT is a noninvasive physical therapy modality, and there is no accepted standard therapy consensus about optimum dosage, wavelength, and application technique. Further longer follow-up studies with larger patient population are needed to explain the mechanism.

Disclosures None

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