

ORIGINAL RESEARCH

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Efficiency of high intensity laser therapy in patients with knee osteoarthritis**Ezgi Deniz Ciplak¹, Semra Akturk², Raikan Buyukavci², Yuksel Ersoy²**¹*Midyat State Hospital, Department of Physical Medicine and Rehabilitation, Mardin, Turkey*²*Inonu University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Malatya, Turkey*

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Abstract

It is aimed to compare the effects of high-intensity laser treatment (HILT) and the transcutaneous electrical nerve stimulation (TENS) and ultrasound (US) combined treatment on pain, functionality, and quality of life in the patients with knee osteoarthritis. The patients were randomized into 2 groups. Combination of hot pack, TENS and US treatment were applied to the first group and HILT was applied to the second group for 2 weeks. At every visit; resting, movement and night pain scores, function, and stiffness scores were assessed. The patients were invited for the control after the treatment and in the 6th week. A total of 48 patients (33 women and 15 men, aged between 25 and 65 years, average age of 54.25 years) participated in this study. In both groups, a statistical significant change was observed in all the parameters in post-treatment measurements. In the between-groups comparison, it was observed that HILT provided a significant recovery in pain scores both after the treatment and in the 6th week than TENS and US combined treatment. HILT in knee osteoarthritis is a statistically significant efficient method on pain and functional scales compared to TENS+US combined treatment.

Keywords: Knee osteoarthritis, hilttherapy, TENS, ultrasound**Introduction**

Osteoarthritis (OA) is a degenerative joint disease characterized by an increase in the thickness of joint capsule together with the loss of articular cartilage and also by synovitis at various grades that may accompany these pathologies [1]. It causes limitations in activities of daily living and impairment in the quality of life due to the accompanying pain and morning stiffness [2]. It increases by age and it generally affects the knee joint [3]. According to World Health Organization (WHO), it affects 9.6% of men and 18% of women over 60 years old [4]. In 2020, it is estimated that it will be the 4th biggest cause of disability in all the diseases. Generally, 43.4 million people in the world is affected by osteoarthritis-associated disability [5]. This disorder has become one of the most important problems decreasing productivity and increasing health costs today due to gradually increasing obesity and sedentary life in the community [6,7].

Knee osteoarthritis may develop as a result of overloading on a normal joint or the normal loads on a damaged cartilage and surrounding tissues. Generally, it is thought that it has developed depending on the mechanic and metabolic response secondary to the changes occurring in the cartilage tissue [8-10].

There are many different approaches used in the treatment of knee osteoarthritis. The recommended treatment in clinical practice is to use the combination of pharmacological and non-pharmacological treatments. Pharmacological treatments recommended in the final guidelines are acetaminophen, NSAID, topical anti-inflammatory drugs, capsaicin, chondroitin, intraarticular corticosteroid injection, glucosamine, duloxetine, hyaluronic acid, and oral/transdermal opioids. Non-pharmacological treatments are training, weight loss, nutritional recommendations, exercise, the use of appropriate shoes, walkers, balneotherapy and physical treatment modalities [11-13]. Physical treatment modalities used in the treatment are superficial heaters, transcutaneous electrical nerve stimulation (TENS), diadynamic current, magnetotherapy, ultrasound (US), and laser [14].

While argon, CO₂ and neodymium YAG lasers were used generally in surgical processes beforehand, they are started to be used in musculoskeletal system diseases today. In knee osteoarthritis treatment, low-level laser treatment (LLLT) producing a laser beam at 600-800 nm wavelength is widely used [15]. High intensity laser therapy (HILT) is a laser having a wavelength of 1064 nm and it is started to be used in the treatment of musculoskeletal system diseases recently. Its primary effect is analgesic effect and reactive vasodilatation that are formed by affecting the cutaneous nerve endings [16]. Another mechanism of action is based on tissue stimulation. This stimulation forms at cell, vascular tissue, interstitial tissue and immune system level.

*Corresponding Author: Semra Akturk, Inonu University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Malatya, Turkey
E-mail: semrakayakturk@hotmail.com

It increases regeneration and beta-endorphin release by inducing the protein synthesis in synovial fluid, thus it shows analgesic and anti-inflammatory effect [17].

Electrotherapy is frequently used for the treatment of knee osteoarthritis. The most common types of electrotherapy are TENS, a method of pain relief in which a special device transmits low voltage electrical impulses through electrodes on the skin to an area of the body suffering from pain and it is indicated to be superior to placebo in the control of pain. US is a modality of treatment that uses sound waves to generate heat within a body part and it is usually combined with TENS for treatment of knee osteoarthritis [18].

The aim of this study was to compare the efficiency of HILT, a new treatment method, for the treatment of the patients diagnosed with knee osteoarthritis, with the combination of TENS and ultrasound.

Material and Method

The patients, who applied to outpatient clinic of Inonu University Faculty of Medicine Physical Medicine and Rehabilitation outpatient clinic between February 2016 and June 2016 due to knee pain and were radiologically assessed as Kellgren-Lawrence grade 2-3 after being diagnosed with Primary Knee Osteoarthritis according to the ACR criteria, were included in the study. The study was carried out in accordance with the Helsinki Declaration and approved by the Inonu University Faculty of Medicine Clinical Research Ethics Committee. All participants were informed about the study and each gave written consent.

The study was designed as prospective, randomized, and single blind. It was calculated that a total of 48 individuals should be taken, with at least 24 subjects from each group when $\alpha=0.05$ and $1-\beta=0.80$ were taken in the power analysis performed. The patients, who underwent a previous knee surgery, had tendon or meniscus rupture, had central or peripheral neuropathy, had received physical treatment or intra-articular corticosteroid or hyaluronic acid injection within the last 6 months, had malignancy and were pregnant, were not included in the study. The patients were randomized into 2 groups. Randomization was made by drawing lots.

A total of 10 sessions of hotpack, TENS (20 minutes/session) and active continuous ultrasound treatment (5 minutes/session at a dose of 1.5 w/cm²) were applied to the first group for 2 weeks. A total of 10 sessions of HILT and hotpack were applied to the second group for 2 weeks via BTL 6000 High Intensity Laser device following the hotpack application. HILT was first applied in biostimulation mode for 4 minutes at the dose of 12j/cm² with power of 10 watt and frequency of 25 Hz and then in analgesia mode for 6 minutes at the dose of 150j/cm² with power of 7 watt in of the device in the knee region of patients.

Quadriceps strengthening, hamstring strengthening and isometric exercises were applied to both groups. The patients were invited for the control after the treatment and in the 6th week. At every visit; resting, movement and night pain scores, function, and stiffness scores were assessed.

Visual Analogue Scale (VAS): The knee pain intensities of the

patients during resting, movement and night were assessed by using VAS. Accordingly, on a 10- cm long line, point 0 was accepted as no pain and point 10 was accepted as worst pain. The patients were asked to mark the intensity of their knee pains on this line. Then the distance between the point marked and point 0 was measured by a ruler [19].

Western Ontario and McMaster Universities (WOMAC) Osteoarthritis Index: It consists of three sections as pain, stiffness and physical function and totally 24 questions. The increase of this value shows that pain and stiffness increase and physical function impairs. In previous studies, validity and safety assessments were performed in osteoarthritis assessment and its use in osteoarthritis was accepted [20].

Statistical Analysis

SPSS for Windows version 17.0 software was used to conduct the statistical analysis of the study data. Identification of data related to quantitative variables was performed by Arithmetic mean[Mean]±Standard deviation [Sd], and the identification of data related to qualitative variables via min-max was performed by using number [n] and percentage [%]. The data of quantitative variables were tested by using Shapiro Wilk normality test. Unpaired t test and Mann-Whitney U test were used to compare the groups. Paired t test and Wilcoxon test were used in the examination of within-group variances. The value of $p<0.05$ was accepted as statistically significant.

Results

A total of 48 patients (33 women and 15 men, aged between 25 and 65 years, average age of 54.25 years) participated in this study. Both groups included 24 patients. Average age of the groups was determined as 56.91±7.86 years for Group 1 (hotpack+TENS+US) and 51.62±10.3 years for group 2 (HILT+hotpack). There was no statistical significant difference between the groups in terms of age, gender, occupation, level of education, body mass index and period of complaint, accompanying systemic diseases and the radiological grades of knee osteoarthritis ($p>0.05$) (Table 1). Also, there was no significant difference between the groups in the baseline of VAS or WOMAC subscales (Table 2).

Table 1. Demographic data of the patients

	Group 1	Group 2	p
Age (years)	56.91±7.86	51.62±10.3	0.070
BMI (kg/cm²)	30.14±5.8	28.65±4.99	0.208
Kellgren-Lawrence radiological stage			
Grade 2	17	13	0.968
Grade 3	20	16	0.928

All treatment groups showed a significant reduction in VAS and WOMAC subscales in the post-treatment period (after 6 weeks) compared to baseline values (Table 2). When before/after treatment and before treatment/6th week within-group differences were compared, a more significant recovery was observed in favor of group 2 in terms of pain score in VAS resting, night pain and movement ($p<0.05$). When the within-group differences were compared in terms of WOMAC pain and total scores, a significant

recovery was observed in favor of group 2 ($p<0.05$) (Table 2). When the within-group differences were compared in terms of WOMAC function score, no significant difference was observed between both groups ($p>0.05$).

Table 2. Changes in VAS and WOMAC scores between treatment groups

		Group 1 Mean±SD	Group 2 Mean±SD	p [#]
VAS movement	Pre	6.95±1.82	7.33±1.46	0.43
	6 weeks	4.58±1.99	3.41±1.47	0.02
	<i>p</i>	0.000*	0.000*	
VAS night pain	Pre	3.54±2.70	4.58±2.01	0.13
	6 weeks	2.20±2.30	2.20±1.44	1.00
	<i>p</i>	0.001*	0.001*	
Womac pain	Pre	10.37±3.18	13.12±3.28	0.05
	6 weeks	6.87±2.89	7.08±3.43	0.82
	<i>p</i>	0.001*	0.001*	
Womac stiffness	Pre	3.37±2.68	4.29±2.54	0.23
	6 weeks	2.70±2.10	2.70±1.78	0.53
	<i>p</i>	0.001*	0.000*	
Womac function	Pre	40.66±11.06	42±10.70	0.67
	6 weeks	32.04±8.57	31.08±9.17	0.71
	<i>p</i>	0.000*	0.000*	

SD standard deviation, VAS visual analog scale (score: 0–10) measures the intensity of pain (a higher score indicates a higher pain intensity), WOMAC Western Ontario and McMaster Universities Arthritis Index (score: 0–96) measures pain (0–20), stiffness (0–8), and function (0–68) (a lower score indicates less dysfunction)

* Unpaired test ($p<0.05$)

[#] Mann–Whitney U test ($p<0.05$)

Discussion

In the present study, it was determined that HILT application on the patients with knee OA was more effective on pain and functional scales in a statistically significant manner compared to TENS and US combined treatment.

In the literature, US is considered as an effective treatment modality which is used in the treatment of knee osteoarthritis [21–25]. It was used alone or combined with TENS or exercises. Symptomatic and functional recovery of therapeutic ultrasound application in the treatment of knee OA were revealed in two different meta analyses published in 2010 [26,27]. In another study, ultrasound and TENS treatment combined with exercise was compared with only exercise treatment and it was concluded that combined treatment was more efficient in the restoration of balance function [28]. It was reported that TENS application together with exercise and hot compression treatment was more efficient on pain than the placebo TENS application with the same treatments and it provided a significant recovery on the quality of life questionnaires [29]. In the present study, significant recoveries were observed in the VAS and WOMAC parameters that were the pain and functionality indicators of the patients together with the combination of US, TENS and exercise.

Recently, pulsed Nd:YAG laser therapy, a form of HILT, has been used for a wide range of musculoskeletal diseases. HILT applications include radiculopathy [30], myofascial pain syndrome [31], frozen shoulder [32], lateral epicondylitis [33], and low back pain [34]. Mechanism of action is based on tissue stimulation. This stimulation forms at cell, vascular tissue, interstitial tissue and immune system level. Moreover, the laser has direct effect when applied locally on the tissues and has systemic effects when applied on the acupuncture points. It forms reactive vasodilatation by reducing spasm in muscle arterioles and the pain sense at the sensory nerve endings. It increases regeneration and beta-endorphin release by inducing the protein synthesis in synovial fluid, thus it shows analgesic and anti-inflammatory effect. Additionally, it induces hematopoiesis in the bone marrow and shows an anti-bacterial effect by stimulating the immune system [35]. These results showed that the potential physiological effects of laser were independent from heat. It was shown that Nd: YAG lasers contributed to the recovery process in tendons and ligaments and also prevented the formation of fibrosis [17].

In the study comparing the efficiency of high dose laser treatment with splint in the patients with lateral epicondylitis; the patients were divided in three groups as HILT, placebo HILT and splint groups and the results were assessed by VAS scores and SF-36. As a result, significant efficiency was observed in both groups and no significant difference was observed between the groups [33]. In another study conducted by Fiore et al. in the patients having low back pain; efficiencies of HILT and ultrasound treatment were compared and in the 3rd post-treatment week assessment, a significant decrease was observed in the VAS score in the HILT group compared to the ultrasound group [34]. In the study conducted by Danilov et al., to assess the efficiency of high dose laser treatment in the patients with knee osteoarthritis; a statistical significant difference was observed in all the WOMAC scores compared to the scores before treatment [36]. In two studies, efficiencies of placebo, LLLT and HILT were compared and significantly higher decrease was observed in HILT group compared to LLLT group in terms of post-treatment VAS and WOMAC scores. In placebo laser group; no recovery was determined observed after the treatment [37,38]. In the present study, a significant decrease was determined in pain in groups of TENS+US and HILT at the end of treatment and in the first month control compared to pre-treatment period in terms of resting, movement and night pain VAS score; but when within-group differences were compared, the decrease in HILT group was significantly evident compared to TENS+US group.

Conclusion

HILT application on the patients with knee OA is a significantly efficient method on pain and functional scales compared to TENS+US combined treatment and when it is combined with exercise, it might provide better outcomes for patients with OA.

Limitations

Different effects of laser on pain may be related to the wavelength, treatment period, power density applied and the no. of treatments and there was no specified optimal dose and treatment scheme yet. Also in the present study, because the efficiency of the current treatments is assessed in a short period of time as 6 weeks, more extensive studies assessing the long-term effects of high intensity

laser, which is an adjuvant treatment are required.

Competing interests

The authors declare that they have no competing interest

Financial Disclosure

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