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Effects of low-level laser therapy on acupuncture points on knee pain and function in knee osteoarthritis

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SUMMARY

OBJECTIVE: Knee osteoarthritis is a common and disabling disease. We aimed to examine the effect of low-level laser therapy in addition to routine physical therapy modalities (transcutaneous electrical stimulation, superficial heating modality of infrared, ultrasound, and exercise) on the functional status and pain in knee osteoarthritis.

METHODS: Patients with knee osteoarthritis (n=71) who underwent physical therapy (transcutaneous electrical stimulation, infrared, ultrasound, exercise therapy, and low-level laser therapy) were retrospectively screened. Patients who received low-level laser therapy on acupuncture points, transcutaneous electrical stimulation, infrared, ultrasound, and exercise were included in the low-level laser therapy (+) (n=35), and patients who received only transcutaneous electrical stimulation, ultrasound, infrared, and exercise were included in the low-level laser therapy (–) group (n=36). The Visual Analog Scale for activity pain, Lysholm Knee Scoring Scale, and walking and stair climbing tests were used before and after treatment obtained from patient files.

RESULTS: The post-treatment Visual Analog Scale activity score and walking and stair climbing test results were statistically significantly lower in the low-level laser therapy (+) group than in the low-level laser therapy (–) group. There was no significant difference in post-treatment Lysholm Knee Scoring Scale scores between the two groups. In both groups, the Visual Analog Scale activity, Lysholm Knee Scoring Scale, and walking and stair climbing test scores statistically significantly decreased after treatment.

CONCLUSION: Knee osteoarthritis increases with aging and creates significant functional limitations. low-level laser therapy with routine physiotherapy contributed to the improvement in the pain and functional status of the patients with knee osteoarthritis. Low-level laser therapy can be recommended in osteoarthritis treatment guidelines with the support of further studies, which is an easy-to-apply, effective, and reliable method.

KEYWORDS: Osteoarthritis. Knee. Physical therapy modalities. Laser therapy.

INTRODUCTION

Traditionally, osteoarthritis has been considered to be the progressive wear and tear of articular cartilage. Recent evidence has shown that osteoarthritis is an inflammatory disease involving not only the mechanical degeneration of articular cartilage but also the structural and functional alteration of the entire joint, including the synovium, meniscus (in the knee), periarticular ligament, and subchondral bone[1]. In the adult population, the incidence of structural and symptomatic knee osteoarthritis (KOA) is 6%, which increases with age, reaching rates of up to 40% in individuals aged 70–74 years[2]. KOA is one of the leading causes of pain and disability across the world and reduces quality of life[3]. Treatment options for KOA include patient education, exercise, lifestyle modifications such as weight control, orthoses, physical therapy applications, pharmacotherapy, intra-articular methods, and surgery[4]. Available traditional treatments with limited efficacy are pharmacotherapy and physiotherapy[5].

The goal of osteoarthritis treatment is to slow the progression of the disease by reducing symptoms. This can also reduce the negative effect of osteoarthritis on the patient's mobility and quality of life[6]. In the 2019 American College of Rheumatology (ACR) guidelines, transcutaneous electrical stimulation (TENS) is highly recommended in KOA[7]. According to the 2014 European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis, and Musculoskeletal Diseases, superficial heating is recommended in treatment at any time when osteoarthritis is symptomatic[6]. Therapeutic ultrasound (US) is a safe and effective treatment for relieving pain and functional improvement in KOA[8]. Acupuncture treatment for KOA has gained popularity in recent years. Acupuncture is an effective drug-free treatment with few side effects and low cost[9]. In the literature, there are also laser applications on acupuncture points[10]. Low-level laser therapy (LLLT) is known to induce the anti-inflammatory process[11]. It has a stimulating effect on the inflammatory process

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and tissue metabolism after injury. It increases cellular oxygenation and mediates the release of neurotransmitters associated with pain modulation and the release of anti-inflammatory endogenous mediators[12]. However, LLLT is not recommended in major osteoarthritis treatment guidelines. There are studies showing positive and negative results concerning the efficacy of LLLT in the treatment of KOA[11,12]. In this study, we aimed to investigate the effects of biostimulant, analgesic, and non-invasive LLLT applied to acupuncture points in addition to routine physical therapy modalities (superficial heating modality of infrared (IR), TENS, US, and exercise) on the pain, functionality, and quality of life of patients with KOA.

METHODS

Patients with KOA who underwent TENS, superficial heating modality of IR with heat lamps, US, and exercise therapy with and without the addition of LLLT on acupuncture points for 15 treatment sessions were retrospectively observed. Patients, aged 40–75 years, who were administered the Visual Analog Scale (VAS) for activity pain, Lysholm Knee Scoring Scale (LKSS), and walking and stair climbing tests before and after treatment were included in file screening.

Exclusion criteria:

1. Not completing 15 sessions of physical therapy
2. Pregnancy and breastfeeding
3. Having received any physical therapy within the last 6 months or having used analgesics or antimuscarinic agents in the past
4. Peripheral vascular disease
5. Type 2 diabetes mellitus
6. History of fracture or surgery in the knee area
7. Inflammatory rheumatological disease
8. Cancer history
9. Acute inflammation

The files of the patients were screened, and their age, gender, weight, height, comorbidities, pretreatment, and post-treatment VAS activity scores, walking and stair climbing test results, and LKSS scores were recorded by a physiatrist. The physiatrist was blind to the groups in which the patients were included.

The patients (n=71) were divided into two groups according to whether they received LLLT on acupuncture points in addition to TENS, IR, US, and exercise therapy. Patients who completed the physical therapy program for 15 sessions were randomly selected from the groups. There were 36 patients in the LLLT (–) group and 35 patients in the LLLT (+) group. The LLLT (–) group did not receive a placebo LLLT. In both groups, the patients received a total of 15 treatment sessions over 3 weeks. In both groups, 20-min IR, 6-min US 1.5 W/cm^2, and 20-min TENS were applied. In addition, all the patients were given a home exercise program, including quadriceps strengthening, isometric, and isotonic exercises, and instructed to perform 10 repetitions of each exercise every day. In the LLLT (+) group, in one session, a patient was given a total dose of 25 mW (gallium arsenide laser, 904 nm wavelength, 4J/point). Treatment was administered in skin contact to six acupuncture points on the knee (ST34, ST35, GB34, SP10, EX-LE4, and SP9) for 180 s.

Statistical analysis

Continuous variables were presented as mean±standard deviation and median (min–max) values, and categorical data were presented as numbers and percentages. In the inter-group analysis of continuous variables, the normality of data distribution was examined with the Kolmogorov-Smirnov goodness-of-fit test. Student's t-test was used to compare the data that fit the normal distribution, and the Mann-Whitney U test was used for non-normally distributed data. The comparisons of categorical data were made with the chi-square test. The Wilcoxon signed-rank test was used for the intra-group analysis. Statistical analyses for 71 patients' data were performed using IBM SPSS version 26.0 (IBM Corporation, Armonk, NY, USA). The statistical significance level was accepted as $p<0.05$.

Ethics

The study was approved by the Clinical Research Ethics Committee of our hospital with decision number 1828, dated 10.03.2022.

RESULTS

A total of 71 patients were examined in this study, of which 36 were in the LLLT (–) group and 35 were in the LLLT (+) group.

There was no statistically significant difference between the LLLT (+) and (–) groups in terms of age, mean body mass index, gender, and rate of comorbidities ($p>0.05$) (Table 1).

The pretreatment VAS activity and LKSS scores and walking and stair climbing test measurement values did not significantly differ between the treatment groups ($p>0.05$). However, the LLLT (+) group had statistically significantly lower post-treatment VAS scores and walking and stair climbing test measurement values compared with the LLLT (–) group ($p<0.001$ for all). The mean post-treatment LKSS score was also lower in the LLLT (+) group, but this was not statistically significant compared with the LLLT (–) group ($p=0.201$) (Table 2).

Table 1. Comparison of the demographic and clinical characteristics of the groups.

	LLLT (–) (n=36)	LLLT (+) (n=35)	p
Age (years) (mean±SD)	63.0±9.2	66.6±7.1	0.063*
BMI (kg/m²) (mean±SD)	27.8±2.7	26.6±2.6	0.087*
Gender (n, %)			
Female	22 (61.1)	20 (57.1)	0.734*
Male	14 (38.9)	15 (42.9)	
Comorbidity (n, %)			
Absent	18 (50.0)	17 (48.6)	0.904*
Present	18 (50.0)	18 (51.4)	

*Student's t-test. LLLT: low-level laser therapy; BMI: body mass index.

Table 2. Intra-group and inter-group comparison of the pretreatment and post-treatment evaluations of the groups.

	LLLT (–) (n=36) [median (min–max)]	LLLT (+) (n=35) [median (min–max)]	p
VAS activity (pretreat)	8 (7–10)	8 (7–10)	0.631*
VAS activity (posttreat)	4.5 (2–8)	3 (2–5)	**<0.001***
	p<0.001**	**p<0.001****	
LKSS (pretreat)	76.5 (45–90)	78 (55–90)	0.719*
LKSS (posttreat)	52.5 (20–85)	45 (30–65)	0.201*
	p<0.001**	**p<0.001****	
Walking test (pretreat)	80 (40–110)	75 (40–90)	0.187*
Walking test (posttreat)	57.5 (30–100)	45 (25–65)	<0.001*
	p<0.001**	**p<0.001****	
Stair climbing test (pretreat)	65 (35–90)	65 (40–85)	0.333*
Stair climbing test (posttreat)	50 (15–80)	40 (25–65)	<0.001*
	p<0.001**	**p<0.001****	

*Mann-Whitney U test. **Wilcoxon signed-rank test. LLLT: low-level laser therapy; VAS: Visual Analog Scale; pretreat: pretreatment; posttreat: post-treatment; LKSS: Lysholm Knee Scoring Scale.

In intra-group evaluations, it was determined that the VAS activity and LKSS scores and walking and stair climb values statistically significantly decreased in the post-treatment period compared with the pretreatment period in both groups (p<0.001) (Table 2).

DISCUSSION

Knee osteoarthritis is a disease that increases with age and causes pain, functional limitation, and decreased quality of life. Among the many methods that can be preferred in the treatment of KOA, LLLT is a non-invasive option, but its efficacy remains controversial. In a systematic review and meta-analysis evaluating the effect of LLLT on pain and disability in KOA, LLLT was reported to significantly reduce pain and disability compared with the placebo[11]. In a randomized controlled study including 215 patients with KOA, the combination of stretching exercises with laser therapy was found to improve pain at rest, activities of daily living, stiffness, muscle contracture, and range of motion[13]. Liao et al., investigated the efficacy of dual-frequency LLLT (combination of red light at 780 nm and near-IR light at 830 nm) in 30 patients with KOA. The authors applied LLLT and placebo laser therapy to three acupuncture points (SP9, SP10, and EX-LE2) on the knee joints and reported that the application of dual-frequency LLLT to these acupuncture points reduced pain and disability in KOA[5]. In a study in which active laser acupuncture and placebo were compared in KOA, 10 sessions of treatment were applied using a gallium aluminum arsenide laser device on the ST35, ST36, SP9, GB34, and EX-LE4 acupuncture points on the affected knee. In the laser acupuncture group, the VAS scores showed significant improvement compared with the placebo group[14]. A total of 40 patients with bilateral grade 2 KOA were evaluated in two groups. In the first group, 5.4 joule laser was applied to the acupuncture points (ST35, ST36, SP9, SP10, and GB34) in each session. Acupuncture points were applied for 1 min in each session, and a total of 12 sessions were treated. The patients of the second group are the control group and have received sham laser. In group 1, VAS decreased, serum beta-endorphin levels increased, and serum substance p levels decreased compared with the control group after treatment[15]. Groups were designated as no acupuncture (control group, n=71) and needle acupuncture (n=70), laser (n=71), and sham laser (n=70) acupuncture. Neither needle nor laser acupuncture has significantly improved pain and functionality compared with shame. They commented that the findings do not support acupuncture in patients with moderate to severe chronic knee pain[16]. In a study investigating the safety and efficacy of LLLT in KOA, Rayegani et al., found LLLT to be superior to the placebo in terms of rest, activity, and total pain scores, and the Western Ontario and McMaster Universities Osteoarthritis Arthritis Index (WOMAC) function, stiffness, and total scores. However, in that meta-analysis, the authors stated that they did not have data on how LLLT efficacy was affected by wavelength, energy density, treatment duration, number of sessions, treatment, osteoarthritis severity, and application site[17]. In another study, a total of eight sessions of LLLT (830 nm) were applied to 4 points (20.1 J/cm² per point) in 35 patients with KOA, and significant improvement was found in VAS scores at the end

of the treatment[18]. LLLT (904 nm, 10 mW/cm^2 power density) and placebo laser were compared in patients with grade 2 and 3 KOA. Pain on movement (pVAS), 50-foot walking time (50 foot w), knee circumference (KC) improved significantly in the LLLT group. In the placebo group, significant improvement was observed in pVAS, 50 foot w, and WOMAC. When the two groups were compared, the improvement in KC was more significant in the LLLT group at 2 weeks. As a result, LLLT was said to be effective only in reducing periarticular swelling[19]. In contrast, in a systematic review and meta-analysis evaluating nine randomized controlled trials, LLLT was not found to be effective for KOA. In this study, seven randomized controlled trials using sham laser versus LLLT were reviewed. There was no significant difference between LLLT and sham in VAS scores within 2 weeks of treatment. All five studies evaluated delayed (12 weeks) outcomes, and no difference was observed in VAS scores. WOMAC pain, stiffness, and function values were not different between the groups immediately after treatment in five studies and 12 weeks after treatment in three studies. It was stated that LLLT had no positive effect on pain and functionality either in the early or late period[12]. Stausholm et al., stated that there was a methodological error in the meta-analysis of Huang et al. Statistical analysis of repeat data showed that there was a significant improvement in VAS values in favor of the LLLT group compared with placebo[20]. Atalay et al., who applied a total of 12 sessions of hot pack application, US, TENS, and home exercise program to the physiotherapy group, reported significantly lower VAS and WOMAC function scores at the end of treatment and at 12 weeks after the end of treatment. The WOMAC total and pain scores did not significantly change at the end of treatment, but they were significantly lower at 12 weeks after the end of treatment[21]. In our study, statistically significant results were observed in the post-treatment VAS activity, LKSS, and walking and stair climbing test scores of both groups compared with the pretreatment values. When the post-treatment values of the groups were compared, no statistically significant difference was found in the LKSS score, but a statistically significant decrease was detected in the VAS activity score and walking and stair climbing test results in favor of the LLLT (+) group. TENS, IR, US, and exercise, which are used in the routine treatment of KOA, are known to be effective, but they do not prevent the recurrence of patient symptoms. In this study investigating the effect of LLLT added to routine treatment, we observed better results in the LLLT (+) group compared with the group that only received routine physiotherapy. LLLT can be added to physiotherapy in appropriate patients as an easy-to-apply method with a very low side-effect profile. Our study is retrospective, and there are no long-term results. LLLT and routine physical treatments of the patients were not applied by the same physiotherapist. These are our study's limitations.

ETHICS COMMITTEE

The study was approved by the Clinical Research Ethics Committee of our hospital with decision number 1828, dated 10.03.2022.

AUTHORS' CONTRIBUTIONS

AY: Conceptualization, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft. **GYÖ**: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing.

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