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Original Article

Comparison of The Effectiveness of High Intensity Laser Therapy (HILT) and Low-Level Laser Therapy (LLLT) on Improving Balance in Knee Osteoarthritis

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Abstract

Background : Osteoarthritis (OA) of the knee is a joint disease with a high prevalence among the elderly. OA can cause balance disorders, which are one of the main causes of falls in the elderly. Balance can be measured using several scoring systems, one of which is the Berg Balance Scale (BBS). One of the treatment modalities for OA is laser therapy which is non-invasive and easy to apply. Low level laser therapy (LLLT) has been widely used in patients with knee OA, but recently high intensity laser therapy (HILT) has begun to be used in physical therapy with advantages over a wider range and depth. The aims of this study was to compare the effect of LLLT and HILT therapy on improving functional balance in the elderly with knee OA.
Methods : This research is a randomized controlled trial pre-test and post-test-controlled group design. The sampling method used in this study is the simple random sampling method. The sample size was 27 subjects and divided into two groups, the LLLT group (n=14) and the HILT group (n=13). Each subject received laser therapy sessions 2 times a week for 4 weeks. Balance was assessed using the BBS before and after the intervention.
Results : There was an increase in BBS scores before and after treatment in the HILT group ($p<0.001$) and in the LLLT group ($p<0.001$), with the increase in the HILT group (7.79 ± 2.16) significantly greater than in the LLLT group (3.08 ± 0.76) ($p<0.001$).
Conclusion : HILT improves balance score better than LLLT.

Keywords : Balance Knee, Laser Therapy, Osteoarthritis

INTRODUCTION

Osteoarthritis (OA) of the knee is a musculoskeletal joint disease that often occurs in the elderly. OA of the knee alone accounts for 50% of all rheumatological disorders.[1] Studies estimated that 70–85% of people aged over 60 years old experience OA with symptoms such as pain, joint stiffness, instability, and muscle weakness, which causes functional limitations and decreased quality of life. The prevalence of symptomatic knee OA is estimated at 3.8% globally, which is higher in women (4.8%) compared to men (2.8%).[2] Based on data from Riskesdas in 2018, the prevalence rate of knee OA in Indonesia is 15.5% for men and 12.7% for women.[3]

The leading cause of functional impairment and impairment in knee OA is pain, whereas osteophyte formation, cartilage damage, periarticular muscle spasms, and contractures cause a limited range of joint motion.[4] In addition, muscle weakness and impaired proprioceptive function in knee OA reduce neuromuscular protective mechanisms and increase joint instability, contributing to balance disorders. Impaired postural stability is one of the leading causes of falls in the elderly and is a significant public health problem.[5] The Berg Balance Scale (BBS) is the most widely known and widely used balance assessment among other balance measurement instruments. Using BBS as a balance measurement instrument is relatively easy, fast, and has a high degree of reliability.[6]

The management of knee OA includes pharmacological and non-pharmacological therapy. Laser is a non-invasive, painless, and easily administered modality to patients with OA. Low-Level Laser Therapy (LLLT) has been widely used as a non-pharmacological treatment in patients with knee OA for pain relief. LLLT exerts analgesia by altering nerve transmission or inhibiting sensory nerve activity to increase pain threshold. LLLT could also increase joint cartilage regeneration through the mechanism of chondrocyte synthesis proliferation and extracellular matrix secretion.[7]

Recently, High-Intensity Laser Therapy (HILT) was introduced to the field of physical therapy, which can reach and stimulate larger and deeper joints than LLLT. A distinguishing characteristic of HILT is the ability to produce photomechanical effects in tissues due to the very short duration and high intensity of the impulses. This phenomenon can have important therapeutic effects, as the stimulation can trigger biological signals to promote tissue repair and regeneration and activate the vascular and lymphatic systems.[8] Angelova *et al*. who studied the administration of 7 sessions of HILT therapy in patients with grade 2–3 knee OA showed significant improvement in the degree of pain and balance (static and dynamic) as measured using pedo barometric assessment.[1] Research on the effect of laser therapy on the balance of patients with knee OA is still limited, so this study aims to determine and compare the effect of HILT and LLLT administration on the balance of patients with knee OA.

METHODS

This research is a randomized controlled trial pre-test and post-test-controlled group design. The sampling method used in this study is the simple random sampling method. The research was conducted in Physical Medicine and Rehabilitation Clinic at RSUD KRMT Wongsonegoro, Semarang from August to September 2022. Patients aged 50–65 years old with bilateral grade 2–3 knee OA based on Kellgren-Lawrence classification, body mass index > 18 dan < 24 Kg/m^2, mild pain (VAS 0–3), not contraindicated for laser therapy, and were agreed to participate were included in this study. Patients with an acute inflammatory condition of the knee joint, neurological disorders affecting balance, cognitive impairment (MoCA-INA score <26), visual and vestibular disorders, lower extremity MMT strength <4, other musculoskeletal disorders, history of total knee replacement surgery or other knee surgery, deep lower extremity fractures in the last 6 months, intra-articular injections into the knee joint in the last 6 months, received viscosupplementation therapy in the last 7 days, or currently taking drugs that can affect balance were excluded from the study.

The participants were randomly allocated into 2 groups, HILT and LLLT. HILT was given using High Intensity Laser Device BTL-600 in 2 phases; phase 1 (analgesic effect) consist of continuous circular movements for 2 minutes, 10 watts power, application of pulses with a frequency of 25 Hz with 80% duty cycle, a dose of 12 J/cm^2, wavelength 1064 nm, and treatment area of 25 cm^2, continued with phase 2 (biostimulation effect), which consist of continuous linear motion for 4 minutes, 5 watts power, a dose of 120 J/cm^2, wavelength 1064 nm, treatment area of 25 cm^2. LLLT was given using Low Level Laser EME Polyeter Evo with a wavelength of 905 nm, 78mW power, a dose of 1.5 J/spot for 120 seconds in 6 spots. Each subject in both groups received 2 laser therapy sessions a week for 4 weeks. Balance was assessed using the BBS before and after the intervention.

The collected data were analyzed using SPSS software. The normality of the data was analyzed using the Shapiro Wilk test. For normally distributed data, the parametric statistics analysis was performed. Otherwise, the Kruskal Wallis test followed by the Mann Whitney test was used to determine differences between groups. A paired t-test was used to analyzed the difference before and after treatment in each group. The p value <0.05 with a 95% confidence interval were considered as statistically significant.

This research has received ethical clearance from

the Health Research Ethics Commission, Faculty of Medicine, Diponegoro University Semarang with number 268/EC/KEPK/FK-UNDIP/VII/2022 and ethical clearance from the Research Ethics Committee of RSUD K.R.M.T. Wongsonegoro, Semarang City with number B/7065/070/IX/2022. All research subjects had asked for their consent by signing a written informed consent

RESULTS

Thirty-four patients were enrolled in this study, and there were 4 participants (3 with BMI >24 kg/m^2 and 1 with VAS pain > 3) who did not meet the inclusion criteria, so they were excluded from this study. Of the 30 participants who had the initial measurement, there were 1 participant from the LLLT group and 2 participants in the HILT group who did not come for therapy and could not be contacted by the researchers. Hence, a total of 14 participants in the HILT group and 13 participants in the LLLT group underwent the final measurement.

Demographic analysis showed that the mean age of the HILT group was older than the LLLT group (62.00 ± 3.47 vs 59.54 ± 3.67 years), with no significant difference found between the groups. No significant difference was found in the patient's gender, education level, BMI, length of time suffering from OA, MoCA-INA score, and level of physical activity between the groups (Table 1). So it can be concluded that the characteristics of age, gender, education level, BMI, length of time suffering

TABLE 1
Patients' Characteristic

Variables		Laser Therapy		p
		HILT	LLLT	
Age (year)		62.00 ± 3.47	59.54 ± 3.67	0.053‡
Gender	Male	4 (66.7%)	2 (33.3%)	0.362¥
	Female	10 (47.6%)	11 (52.4%)	
Education Level	Middle School	8 (61.5%)	5 (38.5%)	0.520‡
	High School	4 (36.4%)	7 (63.6%)	
	Bachelor	2 (66.7%)	1 (33.3%)	
Body Mass Index (BMI)		23.28 ± 1.39	23.47 ± 1.48	0.528‡
Duration of OA (year)		4.90 ± 3.06	4.96 ± 4.17	0.675‡
MoCA-INA Score		25.71 ± 1.33	26.77 ± 1.48	0.062§
Physical Activity	Low	9 (52.9%)	8 (47.1%)	1.000‡
	Moderate	4 (44.4%)	5 (55.6%)	
	Active	1 (100%)	0 (0%)	

Description: * Significant (p <0.05); ‡Mann Whitney; ¥Fisher's exact; §Independent t

TABLE 2
BSS Score Analysis

BBS	Laser Therapy		p
	HILT	LLLT	
Pre treatment	32.00 ± 10.42	29.15 ± 7.66	0.429§
Post treatmet	39.79 ± 11.31	32.23 ± 7.53	0.054§
p	<0.001¶*	<0.001¶*	
Difference	7.79 ± 2.16	3.08 ± 0.76	<0.001‡*

Description : *Significant (p <0.05); §Independent t; ‡Mann Whitney; ¶Paired t

from OA, MoCA-INA scores, and levels of physical activity were similar in the two groups and were not confounding variables in the study.

Paired analysis in both the HILT and LLLT groups showed no significant difference in the BBS values before treatment, and there was no significant difference in the BBS values after treatment between the HILT and LLLT groups. There was a significant difference in BBS scores before and after treatment in the HILT group, which showed improved functional balance in patients treated with HILT. Likewise with the LLLT group, where the BBS values before and after treatment showed significant differences, indicating improved patient balance. The Mann-Whitney test of the difference in BBS values before and after therapy showed a significant difference, where the difference in BSS values was found to be greater in the HILT group compared to the LLLT group (Table 2).

DISCUSSION

The characteristics of the research subjects, which included age, gender, education, BMI, duration of suffering from OA, and physical activity, showed that there were no significant differences in the characteristics of the study subjects in the two groups, indicating a similar population.

Laser therapy is one of the therapeutic modalities for patients with osteoarthritis, which is influenced by the amount of energy or power generated, the wavelength, and the time of therapy administration. LLLT has been widely used to treat musculoskeletal pain, with several studies showing that LLLT can suppress pain and inflammation, stimulate healing, and improve blood circulation. The healing and repair caused by laser therapy are one of its biostimulation properties, where laser therapy can increase the production of ATP and nucleic acids and increase the synthesis of collagen, which will trigger tissue regeneration. The development of HILT offers a modality capable of delivering high-energy lasers in a shorter time and significantly deeper tissue penetration.[9]

This study used BSS to quantify the balance function of patients with OA, and Kim *et al*. have shown that BBS values in patients with moderate-to-severe OA are significantly lower than those with mild OA.[10] Balance involves the interaction between sensory input from the proprioceptive, visual, and vestibular systems, motor systems, and cognitive components, to maintain the body's center of mass on a pedestal. OA can affect a person's balance, and it has been reported that patients with OA have reduced proprioceptive sensation and muscle strength around the joints.[11] Our study found that the BBS score before and after therapy according to the intervention group of each subject had a significant difference, indicating that both modalities of laser therapy can improve knee balance function. The difference in BBS scores between before and after therapy was significantly greater in subjects who received HILT therapy, indicating that HILT was more effective in improving patients' balance function.

Patients with OA are often associated with joint edema resulting in proprioceptive disturbances, and some studies suggest that this condition results from loss or distortion of afferent feedback from the mechanoreceptors innervating the affected joints.[12] Research by Cho *et al*. found that fluid within the joint contributes to proprioceptive deficits in knee OA. The presence of distention of the hypertrophied joint capsule in OA conditions is the cause of proprioceptive disturbances.[13] Laser therapy is known to have the ability to cause biostimulation in damaged tissue. The laser can trigger the repair of the mechanoreceptors in the joint, where it is known that type I mechanoreceptors (Ruffini receptors) and type 2 (Pacini receptors) are the main types of mechanoreceptors located in the joint capsule.[14]

OA is known to involve a chronic and low-grade inflammatory process in its pathogenesis.[15] Laser therapy was found to modulate inflammatory activity and accelerate wound healing, by a study by Stergioulas *et al*. reported the ability of LLLT to reduce swelling in sprained ankle joints. It was explained that laser therapy could promote vasodilation, increase blood flow and lymph drainage, and activate fibroblasts and neutrophils, which will cause changes in pain threshold and reduce edema.[16]

Laser therapy is also widely used to improve muscle strength and repair. The study by Alghadir *et al*. found that administering LLLT to patients with knee OA improved functional performance, reflecting improvements in muscle strength. The more significant improvement of knee balance in OA patients with HILT administration could be due to its ability to produce a photomechanical effect on the treated tissue due to its short duration and high light intensity.[17] Stimulation of HILT can trigger biological signals that promote tissue repair and regeneration, along with activation of the vascular and lymphatic systems, which improve muscle function.[8]

This research has several limitations. First, this study only measured the final result of the total BBS score and did not analyze the differences in each component of the BBS score assessment. Second, this study only analyzed the balance function in terms of sensory components; because the research subjects did not receive an exercise program, there was no assessment and analysis of the motor components of balance, such as muscle strength.

CONCLUSION

High-intensity laser therapy (HILT) and low-level laser therapy (LLLT) resulted in improvements to the Berg

Balance Scale balance score in patients with knee OA, with an increase in the post-treatment Berg Balance Scale balance score in the HILT group, which was higher than in the LLLT group.

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