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Original Article

Comparison of the Effectiveness of High Intensity Laser therapy (HILT) and Low-Level Laser Therapy (LLLT) on Functional Improvement in Knee Osteoarthritis Patients

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Abstract

Background : Knee osteoarthritis causes sore, joint stilted, progressive deformity and functional encroachment. The current therapeutic focus on rectifying function and assuaging symptoms, especially pain. There are two types of laser therapy, namely Low-Level Laser Therapy (LLLT) and High Intensity Laser Therapy (HILT). High Intensity Laser Therapy (HILT) is a high-intensity laser radiation with photochemical, photothermal, and photomechanical action possess many therapeutic steads including analgesic, anti-edematous, and biostimulating effects. In this study, we compare the effectiveness of HILT with LLLT on functional enhancement in knee osteoarthritis assessed by the Knee Injury and Osteoarthritis Outcome Score (KOOS). The aims of this study was to compare the effectiveness of HILT with LLLT on functional enhancement in patients with knee osteoarthritis.
Methods : This research is a quasi-experimental pre-test and post-test with controlled group design. There were 27 subjects of knee osteoarthritis patients who were divided into 2 treatment groups, the first treatment group admit HILT therapy (14 patients) and the second treatment group admit LLLT therapy (13 patients). Knee Injury and Osteoarthritis Outcome Score (KOOS) was measured before and after 4 weeks of treatment.
Results : There was a significant difference in the mean value of functional improvement as measured by KOOS before and after treatment in each group ($p < 0.001$) and there was a significant difference in the mean value of KOOS in the two groups ($p < 0.001$).
Conclusion : The administration of HILT has shown significant escalation of functional improvement compared to the administration of LLLT in patients with knee osteoarthritis.

Keywords : Knee Osteoarthritis, Functional improvement, HILT, LLLT

INTRODUCTION

Chronic disease of the musculoskeletal system is one of the most common health jeopardy in the world's population, with osteoarthritis (OA) of the knee becoming a profound age-related public health problem. This condition is a progressive multifactorial joint disease peculiar by progressive bereavement of articular cartilage and results in pain, functional nuisance, functional disability, and degression patient quality of life.[1] Ten percent of the population over 60 years complains about this condition. In the United States, 37% of the population over 60 is diagnosed with knee osteoarthritis.[2]

The prevalence of knee OA has terrace significantly over the last decade. It is expected to continue to increase, partly because of the escalated prevalence of obesity, other risk factors and other independent causes. It is estimated that the prevalence of knee OA in adults aged 60 years and over is 10% in men and 13% in women. The results of the 2018 Basic Health Research (Riskesdas) by the Indonesian Ministry of Health, the prevalence of osteoarthritis terrace with age was 15.55% in those over 55 years of age, 18.63% in those over 65 years and 18.95% in those under over 75 years, as much as 6.1% in men and 8.5% in women.[2,3]

Treatment of knee OA is directed to rectify joint soreness and stilted, maintain and escalate joint mobility, alleviate physical disability, escalate health-related quality of life, restrain the progression of joint damage, and educate patients about the nature of disorder and its management.[4] A comprehensive plan for managing OA in patients can appertain educational, behavioral, psychosocial, and physical interventions, topical, oral, and intra-articular medications, physical modalities, and exercise therapy. The current therapeutic strategy focuses on escalating function and obliterating symptoms, especially soreness, as the main symptom and cause of disability.[5] Thus, an alternative is needed to not only alleviate pain but also target some of the biological alteration that are highly desirable in osteoarthritis, namely in cartilage, as well as those that occur around bones, muscles, synovia, and ligaments.[6]

Among the approaches that can potentially positively intervene in reversing or correcting some of these associated pathologies are low-level laser therapy (LLLT) and, more advanced, high-intensity laser therapy (HILT). LLLT was found to significantly alleviate acute and chronic pain conditions such as rheumatoid arthritis, chronic arthritis, carpal tunnel syndrome, and knee injuries. However, HILT recently has become more eminent in physical therapy, which can span and stimulate larger and/or deeper joints that are arduous to reach with LLLT. HILT is a new, painless, and powerful modality that significantly alleviate pain. With its photochemical, photothermal, and photomechanical actions, HILT has many therapeutic steads, including analgesic, anti-edema, and biostimulation effects. HILT is acceptable in treating pain, but its analgesic effect in osteoarthritis has been poorly studied.[7] Currently, research on the effects of HILT in patients with knee OA is still finite, so this study aims to compare the effectiveness of High-Intensity Laser Therapy (HILT) and Low-Level Laser Therapy (LLLT) in functional enhancement in patients with knee OA.

METHODS

This research was a quasi-experimental pretest and posttest with controlled group design. 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 diagnosed with bilateral grade 2–3 knee OA based on Kellgren-Lawrence classification, with a body mass index >18 dan <24 Kg/m2, mild pain (VAS 0–3), no contraindication for laser therapy, and agreed to participate in this study. Patients with an acute inflammatory condition of the knee joint, cardiovascular disease profile, uncontrolled hypertension, (systolic blood pressure >130 mmHg and/of diastolic blood pressure >90 mmHg), neurological disorders affecting balance, cognitive nuisance (MoCA-INA score <26), visual and vestibular 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, or currently taking drugs that can affect balance were excluded from the study. Any patients in which during the study period did not complete the program, had a serious dermatologic reaction after receiving laser therapy, or decided not to continue the program were dropped out of the study. Consecutive sampling was used as the method of sampling, with a minimum of 15 subjects in each group, calculated with 95% confidence level and 90% power of test with expected drop-out of 20%.

The participants' baseline data included age, gender, education level, BMI, duration suffering from OA, MoCA-INA score, and level of physical activity were obtained in the time of enrollment. The participants were then randomly allocated into 2 groups, HILT and LLLT. HILT was given using High Intensity Laser Device BTL-600 in 2 phases; phase 1, aimed to induced 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, aimed to elicit biostimulation, 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 admit 2 laser therapy sessions a week for 4 weeks. Knee functional status was assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS) before and after treatment was conducted. KOOS is a clinical outcome assessment for young, middle-aged, and elderly adults with knee injuries and/or knee OA, which commonly used to observe the clinical course and outcome of the disease after intervention. The patients were instructed to fill out the KOOS questionnaire that contain five subscales of questions; pain, other symptoms, daily life activities, sports and recreation functions, and quality of life related to the knee.[8]

This research has obtained an ethical clearance from the Health Research Ethics Commission, Faculty of Medicine, Diponegoro University Semarang and from the Research Ethics Committee of RSUD K.R.M.T. Wongsonegoro, Semarang City. All research subjects had asked for their consent by signing a written informed consent. 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 stipulate differences between groups. A paired t-test was used to analyzed the disparity before and after treatment in each group. The p value <0.05 with a 95% confidence interval were considered as statistically significant.

RESULTS

Thirty-four patients were initially enrolled in this study, and 4 participants (3 with BMI >24 kg/m^2 and 1 with VAS pain >3) were excluded from this study. Of the 30 participants who had the initial measurement, 1 participant from the HILT group and 2 participants in the LLLT group were dropped out due to lost in follow-up. A total of 14 participants in the HILT group and 13 participants in the LLLT group were analyzed. Demographic analysis showed no significant diversity in patient's mean age, gender, education level, BMI, length of time suffering from OA, MoCA-INA score, and level of physical activity between groups, which indicates similar characteristic in the two groups.

Analysis was conducted on each subscale of KOOS score (Table 2). Paired analysis of pain, other symptoms, and daily life activities subscales showed a significant difference in HILT and LLLT groups, while unpaired analysis of each of those subscales showed a significant

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
Knee Functional Improvement Analysis

Variables	Intervention	Laser Therapy		*p*
		HILT	LLLT	
Pain	Pre treatment	57.9 ± 4.78	59.0 ± 5.02	0.575§
	Post treatment	68.5 ± 3.03	63.5 ± 4.99	0.006§*
	p	<0.001¶*	<0.001¶*	
	Difference	10.6 ± 2.62	4.5 ± 0.52	<0.001‡*
Other Symptoms	Pre treatment	60.6 ± 5.13	61.5 ± 5.09	0.655§
	Post treatment	73.2 ± 3.24	64.9 ± 4.96	<0.001§*
	p	<0.001¶*	<0.001¶*	
	Difference	12.6 ± 2.47	3.4 ± 0.51	<0.001‡*
Daily life activities	Pre treatment	54.6 ± 3.86	54.0 ± 5.02	0.571§
	Post treatment	64.9 ± 3.18	58.1 ± 5.02	<0.001§*
	p	<0.001¶*	<0.001¶*	
	Difference	10.3 ± 1.33	4.1 ± 0.86	<0.001‡*
Sports and recreation	Pre treatment	28.0 ± 2.22	27.2 ± 1.63	0.272§
	Post treatment	34.6 ± 3.57	29.9 ± 1.85	<0.001§*
	p	<0.001¶*	<0.001¶*	
	Difference	6.6 ± 3.48	2.8 ± 0.44	0.001‡*
Quality of Life	Pre treatment	54.6 ± 3.11	57.0 ± 2.83	0,044§*
	Post treatment	64.4 ± 3.34	62.4 ± 2.79	0.110§
	p	<0.001¶*	<0.001¶*	
	Difference	9.8 ± 0.43	5.4 ± 0.51	<0.001‡*
KOOS Score	Pre treatment	51.1 ± 3.56	51.7 ± 3.84	0.680§
	Post treatment	61.1 ± 3.18	55.8 ± 3.81	0.001§*
	p	<0.001¶*	<0.001¶*	
	Difference	9.9 ± 1.02	4.0 ± 0.18	<0.001‡*

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

disparity in post-treatment and delta score between each group. The results indicates that the patients who admit HILT treatment experienced significantly greater enhancement than those who admit the LLLT intervention. Paired analysis on quality of life subscale showed a significant divergence in both groups, and the unpaired analysis showed a significant divergence in pre-treatment and delta score between each group. Post-treatment KOOS score were significantly different between the two groups, which is higher in HILT group. The delta KOOS score from pre- and post-treatment were significantly divergence, with HILT group gained a larger amendment in the KOOS score.

DISCUSSION

The result of this study indicated an enhancement in clinical symptoms that was greater in the HILT group. The result was in line with a meta-analysis by Ahmad *et al* that showed a greater effect of HILT on reducing pain, based on the VAS score, compared to the control group.[9] Improved clinical outcomes can be attributed to the effect of laser therapy, which is associated with biostimulation and anti-inflammatory properties at the tissue and cellular level.[10] Photon energy from the emitted laser is absorbed by the photoreceptors of the mitochondrial respiratory chain complex (cytochrome-c oxidase,

porphyrin, and flavoprotein), which yields high-energy molecules for optimal tissue and cellular function. Throughout this process, reactive oxygen species are also induced at low levels, stimulating various transcription products of genes responsible for anti-inflammatory activities. The high-intensity laser can also endow a large amount of energy output in a relatively short time and has deeper penetration than LLLT. Deep tissue penetration with scattered laser radiation allows HILT to exhibit a photo-thermal effect that triggers local tissue relaxation and positive blood flow changes, diminish edema. Thus, the application of HILT can yield in more favorable alleviation of knee OA symptoms and deduct treatment time compared to LLLT.[11,12]

On the daily activity subscale, there was a more significant enhancement in the KOOS score in the HILT group compared to the LLLT group. The results of this study are in accordance with the study of Khesie *et al*., which showed that the WOMAC score in patients who admit HILT was significantly better than the LLLT group.[13] The use of KOOS has been deemed more appropriate to assess a patient's quality of life and it can be used to evaluate the functional improvements that were not detected by WOMAC.[14] These findings were reinforced by the study of Kim *et al*., who showed that the functional score of patients with genu OA was better in the group administered HILT therapy than the group administered conventional therapy.[15] Tantamount results were also found on the daily activities subscale, where HILT produced better enhancement than LLLT. Assessment of daily activities in OA patients is critical because the OA condition is characterized by joint degeneration involving articular cartilage and much of the surrounding tissue. A disturbed balance between damage and repair of joint tissue leads to loss of articular cartilage, subchondral bone remodeling, osteophyte formation, ligament laxity, periarticular muscle infirmity, and occasionally synovitis. Joint degeneration in OA results in pain, stilted, and limited movement, thus contributing to inactivity.[16,17]

This study demonstrated a significant enhancement in the sports and recreation activity subscale in the group receiving HILT therapy. This result is in line with the study of Ordahan *et al*., who also discovered a significant increase in the HILT intervention group compared to the LLLT intervention group. Enhancement of function in the sport and leisure activity subscales, such as squatting, kneeling, jumping, twisting/twisting, and running, is a related consideration for sugery in OA patients. Exercise is also a factor which may worsen OA, where any mechanical stress that exceeds the tolerance of articular cartilage can lead progression of joint degeneration.[18]

The post-treatment quality of life subscale score of the HILT group was found to be higher than that of the LLLT group. These results align with the study of Ordahan *et al*., which signify a more significant enhancement in the quality of life subscale score in the HILT group than in the LLLT group.[19] Patients with knee OA tend to experience physical finite, pain, and functional restrictions. As such, these individuals suffer progressively increasing impacts on their daily living activities, leading to losses in work relationships, leisure, social life, and quality of sleep, which also significantly derives their quality of life. Thus, quality of life is one of the factors used to evaluate the impact of the disease.[20]

This research has a limitation. The evaluation of functional enhancement is only done once, after the 8th treatment, so it cannot assess how long the effectiveness of HILT and LLLT can last in increasing patient functional improvement.

CONCLUSION

The administration of HILT could significantly escalate the functional improvement more than LLLT in patients with knee osteoarthritis, which could be crucial in treating patients with a higher activity level and also provides a shorter period of treatment.

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