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Efficacy of High-Intensity and Low-Level Laser Therapy Combined With Exercise Therapy on Pain and Function in Knee Osteoarthritis: A Systematic Review and Network Meta-analysis

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Abstract

Introduction: High-intensity laser therapy (HILT) and low-level laser therapy (LLLT) combined with exercise therapy (ET) have emerged as effective treatment options for musculoskeletal pain. However, there have remained uncertainties regarding the magnitude of their effects in reducing pain and improving function in patients with knee osteoarthritis. Hence, we performed a systematic review and network meta-analysis of available evidence in the literature to answer this query.

Methods: A literature search was carried out in Embase, PubMed, and Scopus databases without any language restrictions from 1 January 1990 to 31 December 2023. We examined randomized controlled trial (RCT) studies that investigated the efficiency of HILT or LLLT plus knee osteoarthritis ET in pain and functional improvement of the knee. We performed a network meta-analysis and provided the standardized mean difference (SMD) with a 95% confidence interval (CI) by pooling the continuous data on the visual analogue scale (VAS) pain score and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) function score using a random-effects model.

Results: In total, 11 eligible RCTs were included. Our analysis revealed significant improvements in the VAS pain and WOMAC function scores on weeks 4 and 8 after interventions in groups treated with LLLT + ET and HILT + ET compared with placebo + ET. Moreover, HILT + ET showed a greater reduction in the VAS pain score (SMD = -1.41; 95% CI: -2.05 to -0.76) and improvement in the WOMAC function score (SMD = -2.20; 95% CI: -3.21 to -1.19) than LLLT + ET in week 8.

Conclusion: Based on our findings, both HILT + ET and LLLT + ET treatments effectively reduced pain and improved function, but HILT + ET showed a more significant improvement in both outcomes compared to LLLT + ET.

Keywords: Low-level laser therapy; High-intensity laser therapy; Exercise therapy; Pain; Function; Knee osteoarthritis.

Introduction

Knee osteoarthritis is a degenerative and progressive condition that chronically causes knee pain and limited movement, negatively impacting an individual's daily activities and quality of life.[1,2] Knee osteoarthritis management has progressed from pharmaceuticals to therapeutic exercise and physical modalities. High-intensity laser therapy (HILT) and low-level laser therapy (LLLT) have emerged as effective treatment options for musculoskeletal pain because of their biostimulatory, non-invasive, and anti-inflammatory properties.[3,4] However, the therapeutic success of HILT and LLLT in combination with exercise therapy (ET) for knee osteoarthritis is still being determined due to inconsistent findings in clinical settings.[5,6]

There are a few meta-analyses that aimed to assess the clinical efficiency of HILT or LLLT in conjunction with exercises for rehabilitating knee osteoarthritis versus the placebo control group[6-8]; however, they did not include subgroup analysis based on follow-up periods and did not compare the effectiveness of HILT and LLLT. Finally, to the best of our knowledge, there are no network meta-analyses about this topic. Therefore, the current up-to-date systematic review and network meta-analysis aimed to investigate and compare the relative effects of HILT and LLLT combined with ET in alleviating pain and improving

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function in patients suffering from knee osteoarthritis at different follow-ups. The findings of this study can help healthcare professionals make informed decisions regarding the management of knee osteoarthritis, leading to more personalized care and improved outcomes for the patients.

Methods

Information Sources and Search Strategy

We presented this study in accordance with the PRISMA Extension Statement for Reporting of Systematic Reviews Incorporating Network Meta-analyses (PRISMA-NMA) guideline.[9] A literature search was done across the databases of Embase, PubMed, and Scopus with no language restrictions from 1 January 1990 to 31 December 2023. The search was conducted by using specific keywords, including *photobiomodulation* OR *laser* AND *gonarthrosis* OR *osteoarthritis* AND *knee*, limited to the Title or Abstract. Additionally, we manually searched the reference lists of the qualified papers retrieved from the database to identify other relevant articles.

Inclusion and Exclusion Criteria

With regard to the primary objective of this systematic review, we focused on randomized controlled trial (RCT) studies that investigated the efficiency of HILT or LLLT alongside knee osteoarthritis ET in reducing pain and improving the function of the knee. We established specific selection criteria based on the PICO approach as follows:

- Population: Adult subjects (aged ≥ 18 years old) with knee osteoarthritis.
- Interventions: HILT or LLLT plus ET.
- Comparisons: Placebo HILT or LLLT plus ET.
- Outcomes: Pain reduction (based on the visual analogue scale [VAS]) and/or functional improvement (based on the Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC]). Higher scores of the VAS and WOMAC indicated a worsening of the outcomes.

We excluded review articles, case reports, editorials, and letters to the editors, as well as duplicate publications and studies with data that could not be extracted on the specified outcomes.

Study Selection and Data Extraction

We began our review process by transferring the electronic database search records to EndNote X8.1 (Thomson Reuters, Stamford, Connecticut, USA), reference management software. We removed duplicates and then rigorously screened the titles and abstracts of the rest of the papers independently by using a pre-designed eligibility form to determine suitability. After that, we examined the appropriate reports in full-text format, resolving any discrepancies through consensus. We then extracted pertinent information from the proper retrieved studies onto a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, Washington, USA), including the first author's name, publication year, irradiation parameters, exercise program, number of subjects, mean age, and study outcomes. We also recorded continuous data (mean and standard deviation) on pain and functional improvement for three groups (LLLT + ET, HILT + ET, and placbo + ET), where available. In cases where non-English reports were included, we utilized Google Translate as necessary.

Risk of Bias Assessment

In our assessment of the potential bias in the RCTs included, we utilized the updated Cochrane risk-of-bias tool for randomized trials (RoB 2) and then displayed the results using the robvis tool (https://mcguinlu.shinyapps.io/robvis/). The RoB 2 tool appraises the potential for bias through five essential domains, encompassing the randomization process, any deviations from the intended interventions, missing outcome data, methods for outcome measurement, and choosing the reported findings. Each domain is rated as 'low risk', 'some concerns', or 'high risk' regarding the risk of bias.

Statistical Analysis

We estimated the direct effect size of the interventions for the study outcomes using the pairwise meta-analysis with the R statistical package "meta" (https://cran.r-project.org/package=meta). We also performed network meta-analyses of the study outcomes using the frequentist model with the R statistical package "netmeta" (https://cran.r-project.org/package=netmeta). To determine the standardized mean difference (SMD) with a 95% confidence interval (CI), we pooled the continuous data extracted from individual studies on VAS and WOMAC using a random-effects model. Our analysis focused on data collected four and eight weeks after the interventions. We used the P-score (ranging from 0 to 1) to rank interventions against each other or a placebo. To assess global statistical heterogeneity, we used the τ^2 measure; an estimate of τ^2 around 0.04, 0.16, and 0.36 indicated low, moderate, and high levels of heterogeneity, respectively.[10] Finally, we generated network plots that illustrated the symmetry and geometry of the evidence.

Results

Search Results, Study Selection and Characteristics

At first, 958 records were obtained from the searched databases. Following the elimination of duplicate and irrelevant studies, 18 papers were left for detailed screening. Out of these, 7 were excluded during the full-text screening process. Finally, 11 studies were deemed eligible for this review following a rigorous scrutinizing process.[11-21] The PRISMA diagram in Figure 1 depicts the

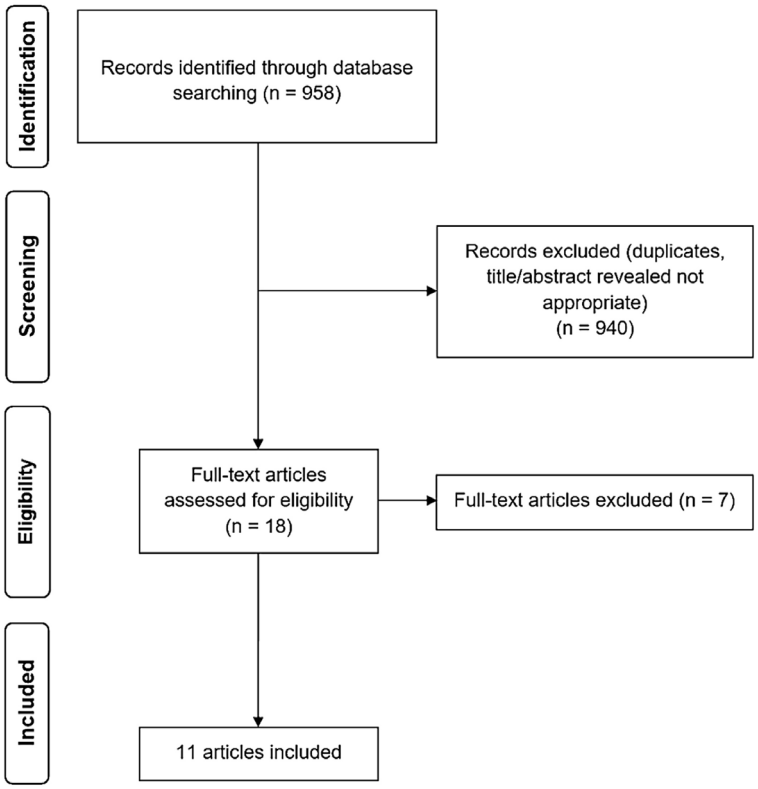

Figure 1. PRISMA Flow Diagram

process of the search strategy and result information. All 11 selected articles were authored in English and published between 2003 and 2023. HILT + ET was evaluated in two studies and LLLT + ET in eight, and one study involved both interventions. The sample sizes varied from 10 to 30 participants, and pain and function outcomes were evaluated in two studies each, while others evaluated both outcomes. Table 1 provides an overview of the articles included in this systematic review. The assessment of the risk of bias was represented for all the included RCTs in Figure 2.

Pain

Pairwise Meta-analysis

The results of the direct meta-analysis of VAS pain reduction according to the treatment have been summarized in Table 2. In week 4, a statistically significant reduction in the VAS pain score was observed in groups treated with HILT + ET (SMD = -0.95; 95% CI: -1.75 to -0.15) and LLLT + ET (SMD = -0.61; 95% CI: -1.11 to -0.11) compared with the control. In week 8, our analysis showed significant decreases in the VAS pain scores in patients receiving HILT + ET (SMD = -2.47; 95% CI: -3.06 to -1.88) and LLLT + ET (SMD = -0.75; 95% CI: -1.27 to -0.24) compared with the control. Moreover, HILT + ET demonstrated a greater improvement in the VAS pain versus LLLT + ET (SMD = -1.02; 95% CI: -1.74 to -0.31).

Network Meta-analysis

Figure 3 demonstrates the network plots for the studies included in the network meta-analysis of VAS pain reduction in weeks 4 and 8 after the intervention according to the treatment. Our analysis demonstrated a statistically significant reduction in the VAS pain score in week 4 in groups treated with HILT + ET (SMD = -1.01; 95% CI: -1.93 to -0.08; P-score = 0.87) and LLLT + ET (SMD = -0.64; 95% CI: -1.20 to -0.07; P-score = 0.62) compared with the control (Table 3 and Figure 4). There was moderate heterogeneity between the studies ($\tau^2 = 0.23$). On the other hand, no significant difference was observed in the VAS pain improvement between HILT + ET and LLLT + ET by week 4 (SMD = -0.37; 95% CI: -1.45 to 0.71; P-score = 0.77). In week 8, we found significant decreases in the VAS pain scores in patients who received HILT + ET (SMD = -2.24; 95% CI: -2.85 to -1.63; P-score = 1.00) and LLLT + ET (SMD = -0.84; 95% CI: -1.27 to -0.40; P-score = 0.50) compared with the control. Low heterogeneity was seen between the studies ($\tau^2 = 0.11$). Moreover, HILT + ET showed a statistically greater improvement in the VAS pain compared with LLLT + ET by week 8 (SMD = -1.41; 95% CI: -2.05 to -0.76; P-score = 0.81).

Function

Pairwise Meta-analysis

The results of the direct meta-analysis of WOMAC

Table 1. Baseline Characteristics of the Studies Included in the Systematic Review

Study	Intervention and Comparator (Number of Subjects; Mean Age [y])	Irradiation Parameters	Exercise Program	Outcome; Assessment (wk)
Alayat, 2017[11]	HILT + ET (n = 23; 55.0) PL + ET (n = 22; 52.9)	Pulsed Nd: YAG (ASA, Arcugnano, Vicenza, Italy)/1064 nm/ 3 kW/15 Jcm^2/3000 J	Range of motion exercise, hamstring and calf stretches, hamstring resistance	Pain (VAS) and Function (WOMAC); 8 wk
Alfredo, 2012[12]	LLLT + ET (n = 20; 61.2) PL + ET (n = 20; 62.3)	GA (Irradia Class 3B; Stockholm, Sweden)/ 904 nm/ 60 mW/ 6 Jcm^2/ 27 J	Warm-up, stretching, mobilizing, balance, coordination and strengthening	Pain (VAS) and Function (WOMAC); 4 wk
Alfredo, 2018[13]	LLLT + ET (n = 20; 61.2) PL + ET (n = 20; 61.2)	GA (Irradia Class 3B; Stockholm, Sweden)/ 904 nm/ 60 mW/ 6 Jcm^2/ 27 J	Warm-up, stretching, mobilizing, balance, coordination and strengthening	Pain (VAS) and Function (WOMAC); 8 wk
Alghadir, 2014[14]	LLLT + ET (n = 20; 55.2) PL + ET (n = 20; 57.0)	GA (Intellect Laser, Chattanooga, USA)/ 850 nm/ 100 mW/ 6 Jcm^2/ 48 J	Isometric knee extension, straight leg raising exercise	Pain (VAS) and Function (WOMAC); 4 wk
Kheshie, 2014[18]	HILT + ET (n = 17; 52.1) LLLT + ET (n = 17; 56.6) PL + ET (n = 17; 55.6)	HILT: Pulsed Nd:YAG (ASA, Arcugnano, Vicenza, Italy)/ 1064 nm/ 3 kW/ 610-810 $mJcm^2$/ 1250 J LLLT: GA diode (BTL-5000 laser)/ 830 nm/ 800 mW/ 50 Jcm^2/ 1250 J	Straight leg raise exercise, treadmill, hamstring and calf stretches	Pain (VAS) and Function (WOMAC); 8 wk
de Paula Gomes, 2018[15]	LLLT + ET (n = 20; 65.2) PL + ET (n = 20; 67.2)	905 nm/ 8.5 W/ 7.85 Jcm^2/ 23.55 J	Enhancing muscle strength (mainly the gluteus maximus, gluteus medius and quadriceps), proprioception	Function (WOMAC); 4 wk
Ekici and Ordahan, 2023[16]	HILT + ET (n = 30; 61.1) PL + ET (n = 30; 57.9)	Pulsed Nd: YAG (ASA, Arcugnano, Vicenza, Italy)/ 1064 nm/ 5 kW/ 12 Jcm^2/ 3000 J	Warm-ups, range-of-motion exercises, hamstring and calf stretches	Pain (VAS) and Function (WOMAC); 4 wk
Gur, 2003[17]	LLLT + ET (n = 30; 58.6) PL + ET (n = 30; 60.5)	GA (Frank Line IR 30)/ 904 nm/3 Jcm^2/ 3 J	Straight leg raise exercise	Pain (VAS) and Function (WOMAC); 4 wk and 8 wk
Rastgar Koutenaei, 2017[19]	LLLT + ET (n = 20; 52.3) PL + ET (n = 20; 53.0)	Metron laser model B-860 (Australia)/810 nm/ 100 mW/7 Jcm^2/56 J	Training for lower limbs with the straight knee in the supine position, isometric contraction of the quadriceps	Pain (VAS); 4 wk
Sardim, 2020[20]	LLLT + ET (n = 10; 65.1) PL + ET (n = 10; 65.7)	850 nm/540 mW/4 Jcm^2	Passive stretching of the lower extremity muscles, straight leg raise, proprioceptive training, exercises for gait control	Pain (VAS); 8 wk
Vassão, 2020[21]	LLLT + ET (n = 16; 61.2) PL + ET (n = 17; 61.7)	GA (Cluster; DMC® São Carlos, SP, Brazil)/ 808 nm/100 mW/4 Jcm^2/56 J	Warm-up, strength exercises, stretching of quadriceps and hamstrings	Function (WOMAC); 8 wk

Abbreviations: HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

Table 2. League Table for Pairwise Meta-analysis of VAS Pain Reduction and WOMAC Functional Improvement in Weeks 4 and 8 After the Intervention According to the Treatment

VAS			**4 wk**	
		HILT + ET	NA	-0.95 (-1.75 to -0.15)
	8 wk	-1.02 (-1.74 to -0.31)	**LLLT + ET**	-0.61 (-1.11 to -0.11)
		-2.47 (-3.06 to -1.88)	-0.75 (-1.27 to -0.24)	**PL + ET**
WOMAC			**4 wk**	
		HILT + ET	NA	-1.21 (-2.12 to -0.30)
	8 wk	-1.50 (-2.26 to -0.73)	**LLLT + ET**	-0.81 (-1.16 to -0.46)
		-3.34 (-4.03 to -2.64)	-0.43 (-1.24 to 0.39)	**PL + ET**

Abbreviations: HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; PL, placebo; NA, not applicable; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
The reported estimates are a standardized mean difference and a 95% confidence interval in parentheses. To compare the treatments, read from left to right and compare the columns with the rows. The boxes that are shaded blue indicate a statistically significant difference.

function improvement according to the treatment have been represented in Table 2. In week 4, we found a significant reduction in the WOMAC function score in subjects treated with HILT + ET (SMD = -1.21; 95% CI: -2.12 to -0.30) and LLLT + ET (SMD = -0.81; 95% CI: -1.16 to -0.46) compared with the control. By week 8, a significant reduction was seen in the WOMAC function scores for patients receiving HILT + ET (SMD = -3.34; 95% CI: -4.03 to -2.64) when compared to the control group. Additionally, HILT + ET improved the WOMAC function score more than LLLT + ET (SMD = -1.50; 95% CI: -2.26 to -0.73).

Network Meta-analysis

Figure 5 indicates the network plots for the studies included in the network meta-analysis of WOMAC

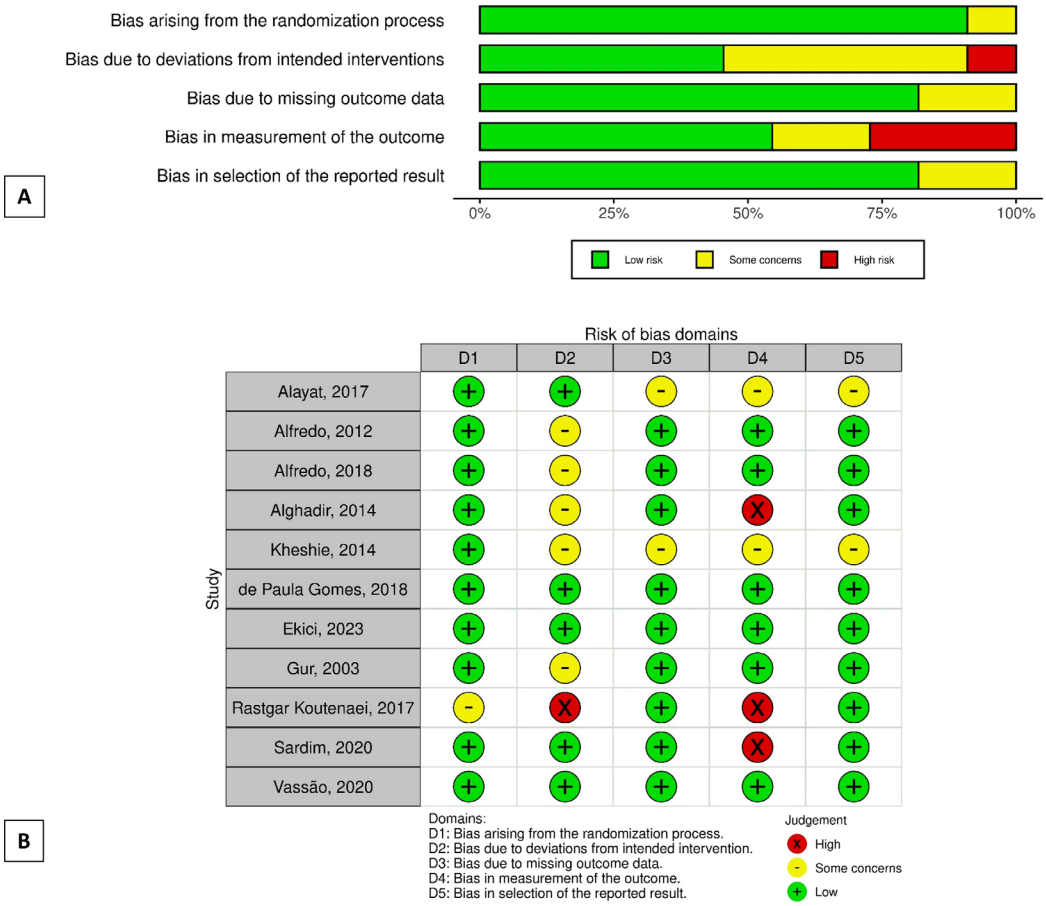

Figure 2. Risk of Bias Assessment for the Individual Domains (A) and Studies (B)

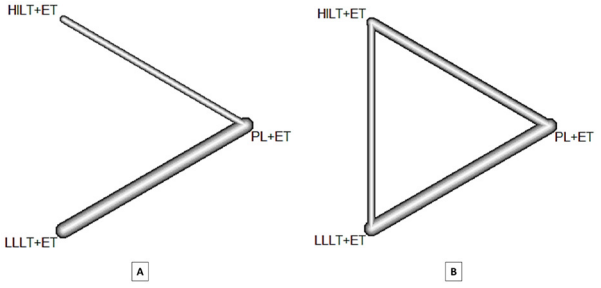

Figure 3. Network Plot for the Visual Analogue Scale for Knee Pain in Weeks 4 (A) and 8 (B) According to the Treatments. The line width (connection size) corresponds to the number of studies comparing the treatments. HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; PL, placebo

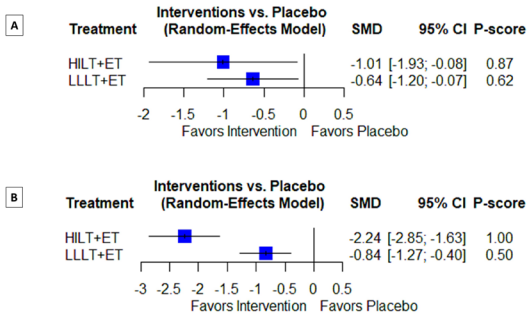

Figure 4. Forest Plot for Knee Pain Reduction in Weeks 4 (A) and 8 (B) After the Intervention According to the Treatments. HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; SMD, standardized mean difference; CI, confidence interval.

function improvement in weeks 4 and 8 after the intervention according to the treatment. Based on our analysis, a statistically significant reduction was seen in the WOMAC function score in week 4 in subjects treated with HILT + ET (SMD = -0.91; 95% CI: -1.55 to -0.27; P-score = 0.81) and LLLT + ET (SMD = -0.80; 95% CI: -1.16 to -0.44; P-score = 0.69) compared with the control (Table 3 and Figure 6). The heterogeneity between the studies was low ($\tau^2 = 0.04$). However, there was no significant difference in the WOMAC function improvement between HILT + ET and LLLT + ET groups by week 4 (SMD = -0.11; 95% CI: -0.85 to 0.62; P-score = 0.74). By week 8, we observed a significant reduction in the WOMAC function scores for patients who received HILT + ET (SMD = -2.92; 95% CI: -3.86 to -1.97; P-score = 1.00) and LLLT + ET (SMD = -0.72; 95% CI: -1.39 to -0.04; P-score = 0.49) when compared to the control group. The heterogeneity was high between the

Table 3. League Table for Network Meta-analysis of VAS Pain Reduction and WOMAC Functional Improvement in Weeks 4 and 8 After the Intervention According to the Treatment

VAS			**4 wk**	
	8 wk	**HILT + ET**	-0.37 (-1.45 to 0.71)	-1.01 (-1.93 to -0.08)
		-1.41 (-2.05 to -0.76)	**LLLT + ET**	-0.64 (-1.20 to -0.07)
		-2.24 (-2.85 to -1.63)	-0.84 (-1.27 to -0.40)	**PL + ET**
WOMAC			**4 wk**	
	8 wk	**HILT + ET**	-0.11 (-0.85 to 0.62)	-0.91 (-1.55 to -0.27)
		-2.20 (-3.21 to -1.19)	**LLLT + ET**	-0.80 (-1.16 to -0.44)
		-2.92 (-3.86 to -1.97)	-0.72 (-1.39 to -0.04)	**PL + ET**

Abbreviations: HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; PL, placebo; VAS, visual analogue scale; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
The reported estimates are a standardized mean difference and a 95% confidence interval in parentheses. To compare the treatments, read from left to right and compare the columns with the rows. The boxes that are shaded blue indicate a statistically significant difference.

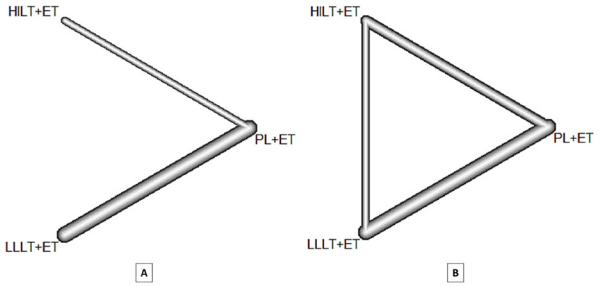

Figure 5. Network Plot for the Western Ontario and McMaster Universities Osteoarthritis Index for Knee Function in Weeks 4 (A) and 8 (B) According to the Treatments. The line width (connection size) corresponds to the number of studies comparing the treatments. HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; PL, placebo

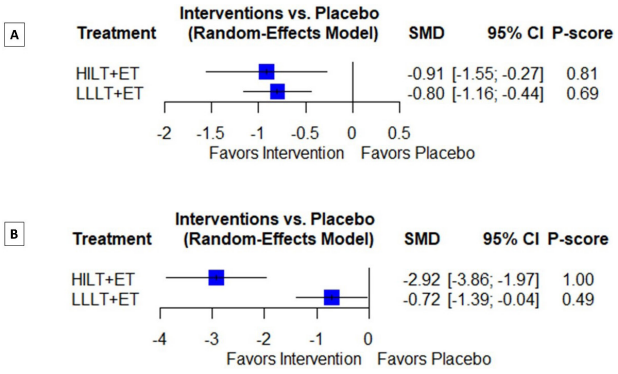

Figure 6. Forest Plot for Knee Function Improvement in Weeks 4 (A) and 8 (B) After the Intervention According to the Treatments. HILT, high-intensity laser therapy; LLLT, low-level laser therapy; ET, exercise therapy; SMD, standardized mean difference; CI, confidence interval

studies ($\tau^2 = 0.44$). Additionally, HILT + ET improved the WOMAC function score more than LLLT + ET by week 8 (SMD = -2.20; 95% CI: -3.21 to -1.19; P-score = 0.83).

Discussion

LLLT and HILT have been used as non-invasive treatments for knee osteoarthritis. ET has also been shown to be an effective treatment for knee osteoarthritis.[7,22] However, the optimal treatment approach that combines these therapies for knee osteoarthritis has remained unclear. To gain clarity on the matter, we thoroughly examined the existing data pertaining to this subject across various scientific databases. After carefully assessing numerous articles, we ultimately selected 11 relevant RCTs for our analysis.

Our network meta-analysis results showed a statistically significant reduction in the VAS pain score for both HILT + ET and LLLT + ET treatment groups versus the control group in week 4 and week 8. Similarly, both HILT + ET and LLLT + ET treatments were effective in improving WOMAC function scores compared to the control group in the same follow-ups. These improvements are clinically meaningful, enhancing daily activities and quality of life. Additionally, HILT + ET showed a greater improvement in VAS pain and WOAMC function scores compared to LLLT + ET in week 8. Overall, our systematic review and network meta-analysis revealed that both HILT + ET and LLLT + ET could effectively alleviate pain and enhance functionality in individuals suffering from knee osteoarthritis; however, HILT + ET demonstrated superior long-term benefits. This suggests that HILT + ET treatment may be the preferred treatment for achieving sustained relief and functional improvement.

In their meta-analysis, Ahmad et al[7] reported that HILT + ET efficiently reduced pain and improved function for knee osteoarthritis versus placebo + ET. Furthermore, Malik et al[8] stated that LLLT + ET could decrease the VAS pain score but it could not improve the WOMAC function scale compared with placebo + ET. A limitation of these meta-analyses was the absence of subgroup analysis based on the follow-up periods. To overcome this weakness, we tried to conduct analyses in weeks 4 and 8 after the interventions. Additionally, we performed a network meta-analysis, which could provide more precise estimates than traditional pairwise meta-analysis; with this analytic approach, we could show for the first time that HILT + ET was more efficient than LLLT + ET.

Laser therapy, specifically LLLT and HILT, has been

shown to be beneficial in treating symptoms of knee osteoarthritis. These positive outcomes are mainly attributed to the combined effects of laser and physical therapies. Because of its biostimulatory and anti-inflammatory effects on tissues and cells, laser therapy can lead to pain and inflammation suppression, tissue regeneration, and repair.[23-25] Due to higher power levels and optimized wavelengths, HILT has roughly five times deeper penetration than LLLT, and its photo-thermal effects allow for tissue relaxation and positive blood flow changes.[7] Compared with LLLT, HILT may also be employed to treat larger areas like the knee joint, resulting in more significant improvement in symptoms of knee osteoarthritis and shorter treatment durations.[6,25,26] Laser therapy may also improve exercise compliance by reducing pain-induced restrictions and pain medication consumption.

The clinical implications of this study are significant for healthcare professionals who treat patients with knee osteoarthritis, especially orthopedic surgeons, rheumatologists, and physical therapists. The results suggest that HILT and LLLT, combined with rehabilitation exercise, can effectively reduce pain and improve function in patients with knee osteoarthritis. The significant reductions in VAS pain scores observed after four weeks of treatment in both HILT + ET and LLLT + ET groups compared with the control group suggest that laser therapy can provide early-stage pain relief for knee osteoarthritis patients. Moreover, the significant decreases in VAS pain scores observed after eight weeks of treatment in both HILT + ET and LLLT + ET groups propose that laser therapy may provide long-term pain relief benefits. The similar analgesic effects of LLLT and HILT at week 4 and the stronger effect of HILT compared with LLLT at week 8 could be due to the deeper tissue penetration and higher energy density of HILT, leading to sustained and enhanced modulation of chronic pain mechanisms, neuroplastic changes, and tissue regeneration. Additionally, the distinct physiological responses of different types of tissues to HILT and LLLT may also play a role in the observed differences. The finding that HILT + ET had a greater improvement in VAS pain and WOMAC function than LLLT + ET after eight weeks of treatment indicates that HILT may be a more potent intervention for reducing pain and improving function in knee osteoarthritis patients than LLLT. Healthcare professionals should be aware of this finding when considering laser therapy as a treatment option for their patients. The statistically significant reduction in WOMAC function scores observed after four weeks of treatment in both HILT + ET and LLLT + ET groups compared with the control group shows that laser therapy can also improve function in knee osteoarthritis patients. These results are significant for patients who experience difficulty carrying out daily activities due to knee pain and stiffness. The significant decreases in WOMAC function scores observed after eight weeks of treatment in both HILT + ET and LLLT + ET groups imply that laser therapy may provide long-term functional benefits to knee osteoarthritis patients.

A limitation of the current systematic review and network meta-analysis was significant heterogeneity between the studies for some outcomes, which could be attributed to differences in sample size or irradiation parameters. However, to prevent the likelihood of higher heterogeneity, we focused on selecting only VAS pain and WOMAC function scores as our primary outcomes.

Conclusion

Our network analysis found that HILT + ET and LLLT + ET treatments effectively reduced pain and improved function. Knee pain significantly decreased in both groups in weeks 4 and 8 of treatment. HILT + ET showed a more significant improvement in pain and function than LLLT + ET in week 8. Moreover, both treatments showed an effective improvement in knee function. Additional future studies could investigate larger sample sizes over a longer follow-up duration and the cost-effectiveness of these treatments compared to other available options.

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Authors' Contribution

Conceptualization: Majid Khalilizad, Danial Hosseinzade.
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Project administration: Majid Khalilizad.
Resources: Majid Khalilizad, Danial Hosseinzade.
Supervision: Majid Khalilizad.
Writing–original draft: Danial Hosseinzade, Mobin Marzban Abbas Abadi.
Writing–review & editing: Majid Khalilizad.

Competing Interests

The authors declare that they have no conflict of interest.

Ethical Approval

Not applicable.

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