Efficacy of Pulsed High Intensity Laser Therapy in Treatment of Psoriatic Hand Arthritis

Mahmoud Shawky Helmy Abdelhamid[*1], Wafaa Hussein Borhan[1], Mohamed Maher Elkeblawy[2], Ahmed Mohamed Omar[3], Marwa Mahdy Abd Elhameed[1]

[1]Department of Surgery, Faculty of Physical Therapy, Cairo University, Giza, Egypt.
[2]Department of Medical Divisions, National Research Center, Giza, Egypt.
[3]Department of Dermatology and Andrology, National Research Center, Giza, Egypt.

***Corresponding Author:** Mahmoud Shawky Helmy Abdelhamid
Email: drmahmoudcanal@yahoo.com

Abstract:
Introduction: Psoriatic arthritis (PsA) is a long-lasting inflammatory condition affecting the joints in 10-20% of individuals with psoriasis (Pso). It causes pain, stiffness, swelling, and joint damage. Pulsed high-intensity laser therapy (PHILT) has shown the potential to reduce inflammation, relieve pain, improve mobility, and enhance function. This study looked at the impact of integrating PHILT into the standard treatment for psoriatic hand arthritis (PsHA).
Material and methods: Seventy-six patients of both genders, aged 30-50, with asymmetric PsHA, were randomly assigned into two equal groups. The study group (Group A, n=38) received PHILT alongside a conventional physical therapy program that included heat therapy, stretching, and strengthening exercises. The control group (Group B, n=38) underwent a sham PHILT along with the same physical therapy regimen. Treatment continued three sessions a week for eight consecutive weeks. Variables were measured pre and post-intervention, including handgrip strength (HGS), joint swelling, tenderness counts, and the visual analog scale (VAS).
Results: After the eight-week treatment period, group (A) exhibited significant improvements in outcome measures compared to group (B). Progression in group (A) was 33.17% for HGS, 53.72% for joint swelling count, 61.14% for joint tenderness count, and 57.43% for VAS, while in group (B) was, 17.02%, 25.87%, 24.93%, and 32.38% respectively when resembled to their levels before therapy ($p < 0.01$).
Conclusions: Counting PHILT into routine physical therapy may yield better results for patients with PsHA than traditional treatment alone.
Keywords: High-intensity laser therapy, psoriatic arthritis, handgrip strength, joint swelling and tenderness, visual analog scale

INTRODUCTION

Psoriasis (Pso) is a long-term inflammatory skin disease that can significantly impact an individual's quality of life and overall well-being (1). Between 10% and 20% of those with Pso develop psoriatic arthritis (PsA), majorly between the ages of 30 and 50, although it can also occur in children (2). Both genders are equally affected by this condition (3).
The National Psoriasis Foundation notes that PsA is a type of inflammatory arthritis (2). PsA is a chronic, inflammatory condition that is seronegative and immunologically triggered, although its exact cause is unknown. It intensely affects the quality of life of those suffering (4).

Key characteristics of PsA include asymmetric joint distribution, involvement of the distal interphalangeal (DIP) joints, enthesitis (inflammation of the sites where tendons and ligaments attach to bone), dactylitis (swelling of a finger or toe), spine, and sacroiliac joints. These features are often associated with various human leukocyte antigen (HLA) alleles (5).

The primary process involved in PsA is inflammation, which leads to tenderness, pain, and swelling in the joints and connective tissues, often accompanied by stiffness. PsA commonly influences the tips of the fingers and toes (6). Therefore, the objective of treatment is to reduce and control inflammation.

Several studies suggest that high-intensity laser therapy (HILT) may effectively alleviate pain, inflammation, joint tenderness, and swelling because of its photomechanical and thermodynamic effects (7). HILT may be beneficial for treating psoriatic hand arthritis (PsHA) due to its inflammatory, anti-edematous, analgesic, and healing properties (8).

Pulsed laser therapy is a specific high-intensity laser treatment used for various medical conditions. Its effectiveness depends on multiple parameters, such as wavelength, mode, pulse duration, energy, and power (9). The deep tissue penetration of HILT wavelengths enhances cellular metabolism without causing any disruptive changes (10).

This study provides guidelines on the usefulness of pulsed high-intensity laser therapy (PHILT) in rehabilitating PsHA by assisting in planning an ideal treatment approach for diminishing PsHA complications.

MATERIAL AND METHODS

Study design and ethics

The study was a single-blinded, controlled, and randomized clinical trial conducted from August 2023 to July 2024 after approval of the Faculty of Physical Therapy Ethical Committee (P.T.REC/012/004436). It adhered to the CONSORT statement and the Declaration principles of Helsinki concerning the ethical behavior of human research. Participants received comprehensive information about the study's objectives, advantages, and procedures. Also, they could withdraw at any time without justification. Before participating in the practice, each patient signed a written consent form. In the Clinical Trials Registry, the study was registered (Registration ID: NCT 06665282)

Settings

The outpatient physical therapy clinic of Suez Canal Authority Hospital in Ismailia served as the recruitment and treatment zone.

Participants

The investigation involved 76 patients of both genders, randomly diverged into two equal groups of thirty-eight individuals each. The study group (Group A) underwent PHILT with an ordinary physical therapy regimen that included hot therapy, stretching, and strengthening exercises. The control group (Group B) got sham PHILT and the same definitive physical therapy program.

Eligibility criteria

Individuals diagnosed with asymmetric psoriatic hand arthritis (PsHA) and experiencing tenderness, stiffness, swelling, and pain for less than one year were eligible to participate. The analysis incorporated patients aged between 30 and 50 years, regardless of sex.

Exclusion criteria

Patients who had any of the following conditions: circulatory disorders, positive rheumatoid factor, diabetes, pregnancy, or skin diseases such as urticaria or refused to sign the consent forms- couldn't partake in the procedure.

Randomization

Participants were randomly assigned to Group A (n=38) and Group B (n=38) by an unbiased method. Numbers were drawn blindly from sealed envelopes created by a random number generator. It employed permuted blocks to ensure equal group sizes. The envelopes contained allocation sequences to select patients to the respective groups.

Outcome measures

At the beginning and after 8 weeks of intervention, we recorded outcomes that enclosed the visual analog scale (VAS) scores, joint tenderness counts, joint swelling counts, and handgrip strength (HGS).

Evaluation procedures

Assessments were measured twice: once pre-the initial session and again post-the final eight-week one.

Handgrip strength (HGS) was estimated using the JAMAR handheld dynamometer device (model 12-0600, manufactured in the USA), which registers strength from zero to two hundred pounds and zero to ninety kilograms. The HGS examination was with the elbow flexed at approximately 90 degrees, following the recommendations of the American Society of Hand Therapists (11). Three consecutive measures were taken, with a two-minute interval between each. The mean of these three measurements was calculated and used as the conclusive HGS value (12).

The joint tenderness count represented the total number of tender joints, while the joint swelling count mirrored the sum of swollen joints before and after treatment in the dominant hand (13, 14).

A Visual Analog Scale (VAS) was employed to measure pain intensity. This scale consists of a horizontal line that is 100 mm long, starting with "no pain" on the left side and ending with "worst pain" on the right side. Patients marked a point on the line that best represented their pain intensity. The researcher then gauged the distance in millimeters between the "no pain" mark on the left end and the patient's mark, supplying a score that ranges from 0 to 100 mm (15).

Intervention

The study implicated two equal groups of participants: Group A underwent PHILT plus a routine physical therapy program, which comprised hot therapy, stretching, and strengthening exercises. Group B acquired sham PHILT alongside the same regular physical therapy regimen. Treatment lasted for eight weeks, three sessions per week consecutively.

Treatment Administration

All patients in both groups experienced a standard physical therapy program lasting thirty minutes a session and consisting of the following components (16, 17):

- Heat therapy: 10 minutes of warm baths for the affected dominant hand, applied pre-exercises.

- Stretching exercises: Ten minutes focused on hand flexor muscles and fingers to improve the range of motion and ease joint pain.

- Strengthening exercises: 10 minutes of isometric activities targeting the flexor muscles of the hand and fingers to enhance joint flexibility and muscle potency.

Protective procedures (14) were to prevent any potential adverse effects during the application of PHILT in group (A). Both the patients and the treating experimenter wore specialized eye safety goggles to protect the retina from conceivable damage. Some patients might have experienced a temporary worsening of their symptoms immediately post-treatment due to a flare-up of inflammation- so the examiner was keen on moving the laser prob continuously to avoid its thermic influence. We reassured participants that this response might be a part of the therapeutic effect. During therapy, individuals assumed a seated position, resting their hands on a table.

In the study group, patients received PHILT for ten minutes a session using a high-intensity laser device (12 W, wavelength: 1064 nm, and power beam > 500 mW; BTL Industries Ltd., UK). Equipping the device was with a handpiece featuring a fixed spacer with a length of 10 mm and a spot diameter of 12 mm.

Each session delivered a totality energy dose of 2100 J, applied in 3 stages (14):

- First stage: Quick scanning (60 cm^2 / 30 seconds) conducted longitudinally and transversely around the dominant wrist joint, hand, and fingers, with three fluencies put respectively at 510, 610, and 710 mJ/cm^2, resulting in a total quantity of 300 J.

- Second stage: The handpiece was held vertically at a ninety angle on a full of ten set points around the interphalangeal and metacarpophalangeal joints, with every point had radiation for 15 seconds, utilizing a fluency of 710 mJ/cm^2. This phase delivered 150 J per point for a total amount of 1500 J.

- Third stage: This is similar to the first one but applied at a significantly slower rate (60 cm^2 per 60 s) for a whole energy of 300 Jole.

Patients in group (B) obtained sham PHILT for the same treatment duration (10 minutes for all phases per session) as group (A), with the device parameters set but the machine turned off. HILT apparatus radiated only a visual light beam without energy delivery.

Sample size calculation

The sample size calculation was performed before the analysis using G*POWER statistical software (version 3.1.9.4; Franz Faul, Universitat Kiel, Germany), which anticipated a significant difference between the groups and indicated that the required sample size for this study was N=76. The count conduction was with an alpha level of 0.05, power set to 85%, and effect size of 0.7 (14, 18), with an allocation ratio of N2/N1= 1. The total estimated sample size was increased by 6.6%, resulting in a final target of 81 patients to account for potential dropouts from the time of randomization to the end of the treatment protocol.

Statistical analysis

The statistical analyses were collected utilizing the SPSS software version 25 for Windows (SPSS, Inc., Chicago, IL). All results demonstrated a normal distribution employing the Shapiro-Wilk test. Quantitative data served as means and standard deviation for PsHA patients' general demographic data (age and elapsed time) and outcome measures (HGS, joint swelling count, joint tenderness count, and VAS scores)- while Qualitative data were as

frequencies (percentages) for the gender and dominance variables. An independent t-test was employed to compare the demographic data between the two groups, while the chi-square test investigated the gender and dominance items within and between groups. Employing a mixed design 2 x 2 Multivariate analysis of variance (MANOVA) test, where the first independent variable (between subject-factors) consisted of 2 levels (study group vs. control group) and the second independent variable (within subject-factor) included two levels (pre-treatment vs. post-treatment). The primary dependent variables were the main outcome measurements. When the MANOVA test yielded a marked F value, we used the Bonferroni correction test for pairwise comparisons within and between groups for the tested variables. All statistical investigations were considered significant at a probability level of $P \leq 0.05$.

Results

An initial screening was performed of eighty-one patients to determine their eligibility for this study. Following that scanning, 76 were accepted into the research and randomly allotted into two equivalent groups (38/group). No participants withdrew after randomization nor reported any adverse effects during or after applying PHILT (Figure 1).

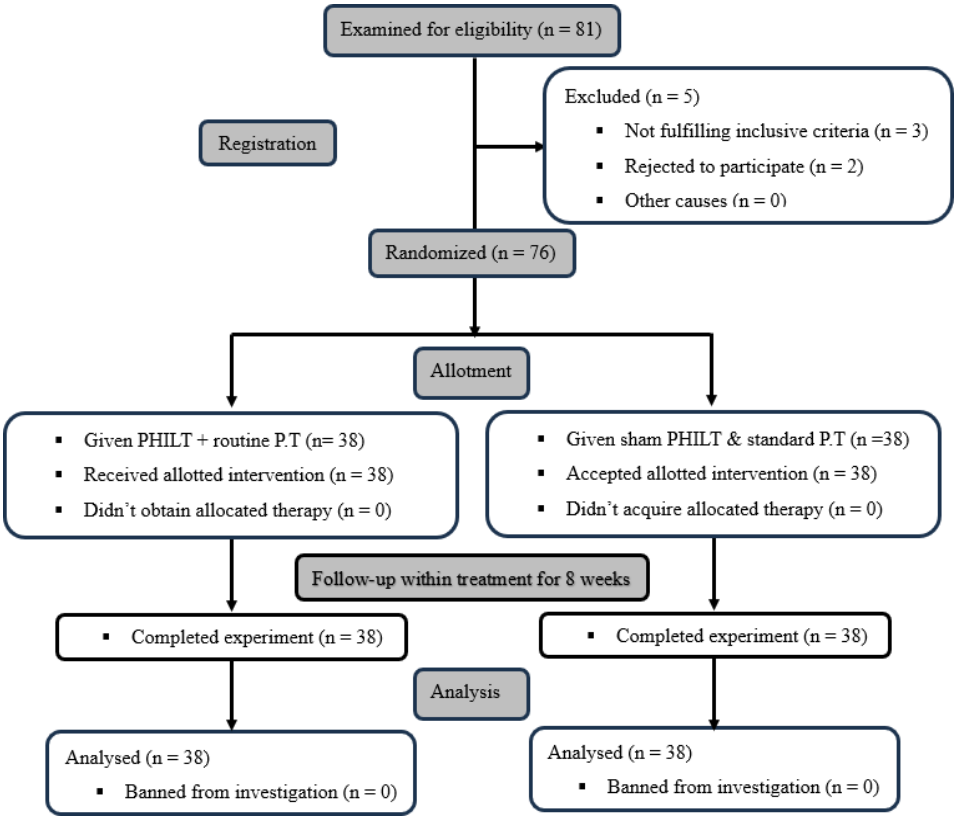

Fig. 1. Flow diagram of the trial

Subject characteristics

Seventy-six individuals of both sexes aged 30 to 50 with asymmetrical PsHA participated in this examination. Table (1) presents the features of subjects in each group. There were no significant differences between the groups regarding age, elapsed time, gender, and dominance ($p > 0.05$).

Tab. 1. Clinical demographic data for PsHA patients in both groups.

Items	Groups (Mean ±SD)		*P*-value
	Study group (n=38)	Control group (n=38)	
Age (year)	42.43 ±3.50	41.07 ±3.50	0.097
Elapsed time (months)	6.21 ±1.46	7.10 ±1.65	0.127
Gender (males: females)	11 (28.90%): 27 (71.10%)	13 (43.20%): 25 (65.80%)	0.622
Dominance (right: left)	32 (84.20%): 6 (15.80%)	36 (94.70%): 2 (5.30%)	0.135

Quantitative data variables (age and elapsed time) are expressed as mean ±standard deviation (SD) and were statistically compared using an independent t-test. Qualitative variable data (gender and dominance) is represented as frequency (percentage) and was statistically compared by a Chi-square test. P-value: probability value P-value >0.05: non-significant.

Statistical multiple pairwise comparison tests showed a significant increase in HGS in both groups after therapy compared to their pre-treatment measurements ($P < 0.01$). Additionally, there was a substantial decrease in counts of joint swelling, tenderness, and VAS ratings in both sets following intervention ($P < 0.001$). Prior investigation outcome measures revealed no statistically substantial dissimilarities between the two groups ($P > 0.05$). However, post-treatment results indicated that group (A) experienced a notable increase in HGS compared to group (B) ($P = 0.0001$). Furthermore, group (A) demonstrated marked reductions in totals of joint swelling, tenderness, plus VAS scores relative to group (B) ($P < 0.001$), as presented in Table (2).

A two-way mixed-design multivariate analysis assessed the contrasts between patients in groups (A) and (B) concerning changes in their scores across the four outcome variables. The results displayed significant multivariate influences, indicating that the treatment had a greater impact on the study group than the control one. That supports the inclusion of PHILT in a routine physical therapy regimen for treating PsHA rather than relying solely on a standard physiotherapy program.

Tab. 2. Within and between-group comparisons for symptoms of PsHA.

Variables	Items	Groups (Mean ±SD)		Change	Effect size (η^2)	*P*-value[2]
		Study group (n=38)	Control group (n=38)			
Hand grip strength (kg)	Pre-treatment	10.16 ±2.28	9.87 ±1.97	0.29	0.002	0.568
	Post-treatment	13.53 ±2.58	11.55 ±1.91	1.98	0.09	0.0001
	MD (Change)	3.37	1.68			
	95% CI	2.36 – 4.36	0.68 – 2.68			
	Improvement %	33.17%	17.02%			
	Effect size (η^2)	0.23	0.07			
	P-value[1]	0.0001*	0.001*			
Joint swelling count	Pre-treatment	9.55 ±1.67	10.05 ±1.51	0.52	0.01	0.132
	Post-treatment	4.42 ±1.58	7.45 ±1.24	3.02	0.33	0.0001
	MD (Change)	5.13	2.60			
	95% CI	4.44 – 5.81	1.94 – 3.31			
	Improvement %	53.72%	25.87%			
	Effect size (η^2)	0.59	0.28			
	P-value[1]	0.0001*	0.0001*			
Joint tenderness count	Pre-treatment	10.37 ±1.23	11.11 ±1.31	0.74	0.04	0.135
	Post-treatment	4.03 ±1.26	8.34 ±1.04	4.31	0.61	0.000
	MD (Change)	6.34	2.77			
	95% CI	5.78 – 6.89	2.21 – 3.31			
	Improvement %	61.14%	24.93%			
	Effect size (η^2)	0.77	0.39			
	P-value[1]	0.0001*	0.0001*			
VAS (mm)	Pre-treatment	86.11 ±4.24	89.24 ±4.08	3.13	0.04	0.104

For pain	Post-treatment	36.66 ±6.46	60.34 ±5.02	23.68	0.73	0.0001
	MD (Change)	49.45	28.90			
	95% CI	47.16 – 51.73	26.60 – 31.18			
	Improvement %	57.43%	32.38%			
	Effect size (η^2)	0.92	0.80			
	P-value[1]	0.0001*	0.0001*			

Data are expressed as mean ±standard deviation and were statistically compared using a MANOVA Test. MD: Mean difference; CI: confidence interval; P-value: probability value; *Significant (P<0.05) P-value[1]: Probability value within each group; P-value[2]: Probability value within among groups.

DISCUSSION

The present study aspired to assess the efficacy of adding PHILT to traditional treatment for PsHA patients. The findings informed a significant advancement in various outcomes, possessed an increase in HGS while a decline in joint swelling, tenderness counts, and pain measured by VAS of the study group (33.17%, 53.72%, 61.14%, and 57.43%, respectively) compared to the control groups' (17.02%, 25.87%, 24.93%, and 32.38%). These results indicate that PHILT is an effective intervention for enhancing output variables in PsHA people.

Through its photomechanical plus thermodynamic impacts, high-intensity laser therapy (HILT) may help reduce inflammation, pain, joint swelling, and tenderness totals (7). This therapy creates mechanical stress on cells, which improves cellular bio-stimulation, enhances venous and lymphatic microcirculation, increases the cells' mitotic index, facilitates extracellular ion transportation, and promotes healing procedures (10). Additionally, HILT may support the control of inflammation by lowering levels of C-reactive proteins, interleukin-1, neopterin, and prostaglandins (7). HILT could also boost blood flow, raise vascular permeability, and uplift cellular metabolism (19).

The sedative effect of PHILT, a type of HILT, is established on several mechanisms of action. Firstly, it modulates pain by promoting the discharge of endogenous opioids, such as serotonin and beta-endorphins, in the area where peripheral nerves are near nociceptors (20). When the levels of these endogenous opioids rise, they attach to nociceptors and occupy their binding sites, preventing external noxious stimulants from causing pain. Secondly, laser application lessens the production of ATP and calcium influx to the neurons in the dorsal root ganglion, increases the ranks of reactive O_2 species inside cells, disrupts pain signal propagation, and leads to pain relief (21). In addition to these mechanisms, the theory of gate control and regeneration of nerve fibers play substantial roles in the HILT's analgesic effects (22).

Despite the advantages of exercise in augmenting health outputs, many patients with chronic discomfort tend to loosen their mobility or avoid physical activity altogether to prevent further pain. These results in muscle weakness, diminished range of motion, physical performance, and extended joint stiffness (22). In the existing investigation, we integrated PHILT (a specific treatment or technique) into the exercise regimen to motivate patients to engage in more physical training. This combination greatly enhanced HGS and reduced joint pain. PHILT aids in slowing the transmission of pain signals and stimulates the morphine-like substance production within the body (20).

Our analysis is consistent with previous studies. For instance, Nazari et al. (22) discovered that PHILT is superior to traditional therapy in improving joint function and relieving pain. Similarly, Gworys et al. (23) demonstrated that laser treatment has an anti-edema influence. Additionally, Karabegović et al. (24) reported a drop in swelling, pain, and

disability by laser therapy while supplementing independence. Keramiotou et al. (17) discovered significant progress in HGS, dexterity, pinch strength, quality of life, and a notable decrease in pain among the exercise group. Furthermore, Abdel-Aal et al. (14) registered that incorporating HILT into a standard physiotherapy program was more effective than usual physical therapy treatment alone in improving HGS and diminishing joint tenderness, swelling numbers, and the VAS rating on hand arthropathy in someone with systemic lupus erythematosus. In contrast, Brorsson et al. (25) did not document a pain reduction after exercise, likely because they used different varieties of activity.

Based on the results of our study, physiotherapists plus other health specialists should assume the effect of weaving PHILT into a well-tolerated and safe exercise program for individuals' rehabilitation with PsHA.

Strengths and limitations

This study has several limitations. The HILT's high cost, from a health service perspective, might affect the study's findings. Additionally, relatively few numbers participated in the trial. Also, the intervention period was short (only eight weeks). The present research did not assess the effectiveness of PHILT in terms of hand function, range of motion, or the healing process.

As a result, the authors highlight the need for further examination to strengthen the proof reinforcing the usage of PHILT in improving PsHA symptoms. Coming studies should include bigger sample sizes and diverse contexts to evaluate the generalizability of the results. It is also promising to analyze the long-term effects of interspersing PHILT with tolerated exercises and use geometry, functional scales, and ultrasonography for assessment. Moreover, future investigations should examine the cost-efficacy of PHILT compared to classic rehabilitation programs to sufficiently comprehend its financial viability and potential advantages.

Clinical implications

PHILT is a non-invasive restorative modality integrated with conventional physiotherapy. Therefore, it may be recommended to physical therapists plus patients as a treatment option for PsHA manifestations, as it appears to have no adverse effects.

CONCLUSION

According to the gathered data, merging PHILT with a typical physical therapy approach for people with PsHA may supply a sufficient strategy to promote HGS. At the same time, diminished pain, joint swelling, and tenderness tallies.

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Conflicting interests declaration

There was no disclosure of any conflicts of interest related to this research.

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