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High-Intensity Laser Therapy for Hemiplegic Shoulder Pain: An Investigation of Efficacy

Hemiplejik Omuz Ağrısı için Yüksek Yoğunluklu Lazer Terapisi: Bir Etkinlik Araştırması

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High-Intensity Laser Therapy for Hemiplegic Shoulder Pain: An Investigation of Efficacy

ABSTRACT

Objective: Hemiplegic shoulder pain is one of the most common complications after stroke. High-intensity laser therapy is a new treatment option between conventional treatment strategies. We aimed to compare the effectiveness of conventional physical therapy agents and high-intensive laser therapy in this study.

Material and Method: Randomized, case-control trial. Participants (n=43) were randomized into two groups. Group 1: high-intensive laser therapy (n=22), and group 2: conventional physical therapy (n=21), and additionally, therapeutic exercise programs were applied both groups. Patients were assessed before treatment and after treatment for clinical parameters with a visual analog scale, an arm motor ability test, functional independence measure scores, and modified ranking scores. Patients underwent sonographic diagnostic evaluation.

Results: Sociodemographic characteristics and clinical data and ultrasonographic findings were similar between groups (*p>0.05*). In both groups, within-group comparisons showed a significant decrease in activity and nocturnal pain scores and a significant increase in arm motor ability test function and movement scores and functional independence measure scores (*p<0.05*). Compared to the conventional physical therapy group, the HILT group showed a significantly greater improvement in the VAS night score (*p<0.05*).

Conclusion: Our study results indicate that both treatment interventions were efficacious in the management of hemiplegic shoulder pain. Therefore, high-intensity laser therapy presents as a potential alternative therapeutic modality for hemiplegic shoulder pain, demonstrating a comparable level of effectiveness.

Keywords: Hemiplegia, laser therapy, physical therapy modalities, shoulder pain, ultrasound therapy.

NIH Clinical Trials registration number: NCT06407596

ÖZET

Amaç: Hemiplejik omuz ağrısı, inme sonrası en sık görülen komplikasyonlardan biridir. Yüksek yoğunluklu lazer terapisi, konvansiyonel tedavi stratejileri arasında yeni bir tedavi seçeneğidir. Bu çalışmada, konvansiyonel fizik tedavi ajanları ile yüksek yoğunluklu lazer terapisinin etkinliğini karşılaştırmayı amaçladık.

Gereç ve Yöntem: Randomize, vaka-kontrol çalışması. Katılımcılar (n = 43) iki gruba randomize edildi. Grup 1: yüksek yoğunluklu lazer tedavisi (n = 22) ve grup 2: geleneksel fizik tedavi (n = 21) ve ayrıca her iki gruba da terapötik egzersiz programları uygulandı. Hastalar tedavi öncesi ve tedavi sonrası görsel analog skala, kol motor yetenek testi, fonksiyonel bağımsızlık ölçüm puanları ve modifiye rankin puanları ile klinik parametreler açısından değerlendirildi. Hastalara ultrasonografik tanı değerlendirmesi yapıldı.

Bulgular: Sosyodemografik özellikler ve klinik veriler ve ultrasonografik bulgular gruplar arasında benzerdi (*p>0,05*). Her iki grupta da grup içi karşılaştırmalar aktivite ve gece ağrısı skorlarında anlamlı bir azalma ve kol motor yetenek testi fonksiyon ve hareket skorlarında ve fonksiyonel bağımsızlık ölçüsü skorlarında anlamlı bir artış gösterdi (*p<0,05*).

Sonuç: Çalışma sonuçlarımıza göre her iki tedavi uygulaması da hemiplejik omuz ağrısı için etkiliydi. Sonuç olarak, yüksek yoğunluklu lazer tedavisi hemiplejik omuz ağrısı için güncel bir tedavi seçeneği olabilir.

Anahtar Sözcükler: Ağrı, hemiplejik omuz ağrısı, inme, konvansiyonel fizik tedavi, lazer tedavisi.

Introduction

Hemiplegic shoulder pain (HSP) is one of the most common complications following stroke, negatively impacting rehabilitation outcomes and significantly reducing patients' quality of life (1,2). HSP can begin within the first week after stroke, but it is more frequently observed during the first 2–3 months and may become chronic, thereby delaying functional recovery.

The etiology of HSP is multifactorial and may involve conditions such as adhesive capsulitis, subacromial bursitis, shoulder subluxation, rotator cuff tears, complex regional pain syndrome, brachial plexus injuries, heterotopic ossification, and spasticity (3). Treatment of HSP is generally conservative and includes a wide range of physical therapy modalities such as analgesic medications, therapeutic exercises, proprioceptive training, kinesiology taping, thermotherapy, ultrasound (US), transcutaneous electrical nerve stimulation (TENS), extracorporeal shock wave therapy, pulsed electromagnetic fields, microwave diathermy, and low-level laser therapy (4,5).

TENS is a non-invasive modality that works on the basis of the gate control theory and primarily targets sensory nerve fibers (6). Therapeutic US physiologically induces increased blood flow, vascular permeability, and local metabolism, while also enhancing fibrous tissue extensibility and promoting muscle relaxation (7–9). Both modalities are commonly used in the treatment of shoulder pain, including HSP, within conventional physical therapy programs.

In recent years, high-intensity laser therapy (HILT) has emerged as a novel therapeutic approach for shoulder pain. HILT exerts photothermal, photomechanical, and biostimulator effects in deeper tissues, contributing to enhanced microcirculation, reduced inflammation and edema, and stimulation of tissue regeneration (10-12). While the literature includes studies investigating the effectiveness of High-Intensity Laser Therapy (HILT) in patients with hemiplegic shoulder pain, their number remains limited (13-15).

Musculoskeletal ultrasound is a non-invasive and dynamic imaging technique widely used for diagnosing hemiplegic shoulder pain. It is a valuable tool not only for structural evaluation but also for identifying prognostic factors before treatment. Compared to other imaging techniques, ultrasound offers several advantages including real-time visualization, absence of ionizing radiation, and cost-effectiveness (14,16). Generally sonographic evaluations in studies focusing on painful hemiplegic shoulder following stroke, common findings include effusion of the biceps tendon, tendinosis of the supraspinatus tendon, subacromial-subdeltoid (SA-SD) bursitis, partial-thickness tears of the rotator cuff, and full-thickness tears of the rotator cuff (17).

This study aims to compare the efficacy of high-intensity laser therapy (HILT) and conventional physical therapy (CPT) modalities (US, TENS) in the treatment of hemiplegic shoulder pain in post-stroke patients. Previous studies have investigated the effects of high-intensity laser therapy (HILT) on specific ultrasonographic changes in shoulder pathologies. In contrast, the present study broadly examined common ultrasonographic findings observed in hemiplegic shoulders and evaluated their potential impact on treatment response.

Specifically, this study aimed to investigate the relationship between clinical outcomes and sonographic findings and determine whether the presence of such sonographic abnormalities has predictive value in assessing the clinical efficacy therapeutic interventions and also , providing a comprehensive analysis of HILT's therapeutic potential in this specific patient population.

Material and Method

Trial design and Participants

This randomized, case control study was performed in the rehabilitation ward of a university hospital between June 2022 and February 2023. Ethical approval for the conduct of this research was acquired from the hospital's Institutional Review Board. The decision number is E2-22-1902. The study was executed in conformity with the principles of Declaration of Helsinki. Written informed consent was received from all patients participating in the study. Large Language Models (LLMs) were not used in our study.

Sixty eligible participants were initially recruited for this study. The inclusion criteria; patients have shoulder pain after stroke on hemiplegic side, male

or female between the ages of 18-75, first-ever unilateral stroke, pain visual analog scale (VAS) score ≥3cm, time since stroke ≥6 months, and time since last local intervention treatment >6 months.

The exclusion criteria were as follows: (1) a history of shoulder pain prior to stroke; (2) an unstable medical condition or uncontrolled systemic diseases (such as respiratory failure, congestive heart failure, liver and kidney dysfunction, or disorders affecting neuromuscular function); (3) bilateral hemiplegia; (4) those demanding cardiac pacemaker (5) administering any nonsteroidal anti-inflammatory drugs for shoulder pain prior to the study; (6) disturbance of awareness, severe visual, and cognitive impairment.

Baseline assessment and Randomization

Potentially qualified patients were eliminated through physical examination and clinical assessments. Patients were provided with comprehensive information about the aims and nature of the study, both verbally and in the form of an information sheet. The same physician performs all follow up assessments and interventions were performed by a physiotherapist. A total of 60 patients underwent assessment. Following the application of inclusion criteria and obtaining informed consent, 43 patients were enrolled in the study. Figure 1 demonstrates the study flow chart. The patients were randomly allocated to either the HILT group or the CPT group with a computer randomization programe. Computer generated random numbers were used for simple randomization of subjects.

Interventions

High Intensive Laser Therapy

Measurements before (at baseline) and after treatment (at the end of week 3) were evaluated by a single researcher. Group 1 (HILT group, n = 21) received HILT was administered three times per week for three weeks, resulting in a total of nine sessions. This was complemented by a therapeutic exercise program conducted five times per week for three weeks. A therapeutic exercise program for HSP, including passive, active-supported, and active range of motion exercises, stretching, and strengthening exercises were given both of group according to patient's motor recovery during follow up. Exercise program lasting 20-30 minutes, 3 sets of 10 repetitions, twice a day, was applied to both groups under the supervision of a physiotherapist.

Participants in Group 1 received HILT using a neodymium-doped yttrium aluminum garnet (Nd:YAG) laser device (HIRO1.0, ASA). The physiatrist administered HILT beams longitudinally to the rotator cuff muscles, specifically targeting the supraspinatus and deltoid muscles. The pulsed Nd:YAG laser delivered ultrashort pulses, penetrating 3-4 cm into the tissue and providing a homogeneous distribution of light energy without excessive thermal effects. A standardized handpiece with fixed spacers ensured a consistent 90-degree angle and 3 cm distance between the laser source and the skin, with a 5 mm spot size as shown in Figure II. Each HILT session comprised three phases. Phase 1(Fast Scanning) rapid scanning of the upper trapezius, deltoid, and supraspinatus muscles at a frequency of 25 Hz, power of 8 W, and energy dose of 16 J/cm^2 for a total energy of 400 J over 2 minutes. Phase 2(Intermediate phase), direct application of the laser to trigger points at a frequency of 15 Hz and an energy dose of 6 J/cm^2 to 25cm2 area for a total energy of 150 J over 6 minutes, until a pain reduction of 70% to 80% was achieved with biostimulation effect. Phase 3; slow scanning of the previously treated areas at a frequency of 25 Hz/120 s until a total energy dose of 2,500 J was achieved. The time to apply all 3 stages of HILT was approximately 10 minutes (14). Protective goggles were utilized by both the practitioner and the patient during all laser applications

Conventional physical therapy

Group 2 (n=21) received conventional physical therapy by total of 15 sessions and a three-week therapeutic exercise program, consisting of five sessions per week, was implemented for individuals with HSP. Conventional physical therapy (TENS+US) were applied to group 2 by the same physiotherapist. TENS application was applied to the hemiplegic shoulder region with a Chattonoga brand device, using 4 adhesive electrodes of 5x5 cm in size, conventional current at a frequency of 80 Hz and 180ms current for 20 minutes. Ultrasound application, which is a deep heating method, was performed directly to the skin using a BTL brand device with a 3 MHz frequency and a dose of 1.5 Watt/cm^{2}intensity over 25 cm2 surface area for 5 minutes (18) with the help of ultrasound gel. The application was performed in

a 50% pulsed mode for 5 minutes by using gel and performing continuous circular motions. Furthermore, a comprehensive therapeutic exercise program for HSP was incorporated into the intervention, encompassing both passive and active supported and active range of motion exercises, stretching, strengthening, and mobilization exercises were performed to all patients by physiotherapists.

Clinical examination and the administration of patient-reported questionnaires were employed to assess adverse effects. These assessments were conducted immediately following the completion of the HILT and CPT procedures, as well as at all subsequent follow-up visits. Adverse events for HILT include temporary redness, skin irritation, a warm sensation during treatment, and a temporary increase in pain or discomfort. Adverse events for CPT include skin redness, tenderness, and increased pain and rare side effects include skin burns, heart rhythm disturbances, skin hypersensitivity, blood pressure changes, muscle-tendon damage-rupture during the release of joint restrictions, and bone fractures. No post-treatment complications were evident in any of the study participants

Clinical and Ultrasonographic Assessment

Demographic data including age, gender, marital and educational status, job, alcohol use, smoking and clinical features as stroke type, and hemiplegic side were recorded before treatment. The patients were assessed clinically at 0 (baseline) and at the end of week 3 after treatment. Pain intensity, measured using the Visual Analog Scale (VAS), served as the primary outcome measure. Secondary outcome measures included functional assessment as measured by the Functional Independence Measure (FIM) and the evaluation of upper extremity daily living activities. The shoulder of the patients on the painful side was evaluated with musculoskeletal ultrasonography at baseline. Shoulder ultrasonography examinations were conducted on all study participants by a physician possessing expertise in musculoskeletal ultrasonography. To ensure objectivity, the radiologist performing the examinations was blinded to the treatment group allocation of each participant. A 5-12 MHz linear-array transducer was employed for all examinations (LOGIC P5 Ultrasound System, used 11L liner prob). Ultrasonographic findings were recorded. Subacromial-subdeltoid (SA-SD) bursitis was diagnosed when ultrasonography revealed an effusion within the bursa exceeding 2 mm in thickness, accompanied by increased power Doppler signal. Rotator cuff tendinitis was identified by the presence of hypoechoic changes and a tendon thickness greater than 2 mm compared to the contralateral side. A full-thickness tear of the rotator cuff was diagnosed based on the following sonographic criteria: absence of the rotator cuff, exposed humeral tuberosity, focal areas of the cuff not visualized, discontinuity or a hypoechoic cleft within the cuff, herniation of the deltoid muscle or the subacromial-subdeltoid bursa into the cuff, or compression of the tendon (19). SA-SD bursitis, bicipital tendinosis, partial rupture, total rupture, calcific tendinitis findings were investigated with ultrasonographic assessment. And correlation analysis between ultrasonographic findings and improvements in pain and disability scales in the treatment groups were recorded.

The patients' movement and night pain were assessed through the use of Visual Analog Scale (VAS) to evaluate pain intencity and recovery. The VAS is used to measure pain on a 10-cm horizontal axis between a left endpoint of "no shoulder pain" and a right endpoint of "worst pain ever" (20).

The Modified Rankin Scale (MRS) is a widely used, ordinal scale designed to assess the level of disability or dependence commonly in stroke. It provides a standardized method for evaluating functional outcomes and is a critical tool in clinical practice. The mRS consists of seven ordinal levels, ranging from 0 (no symptoms) to 6 (death). Each level corresponds to a specific degree of disability, encompassing physical, cognitive, and social impairments (21).

FIM is a widely used tool that assesses patient's ability to perform daily activities after stroke. It covers basic self-care, moving around, managing toileting, communication, and social thinking. Scores range from 1 (needing total help) to 7 (completely independent). Higher scores mean the person is more independent in daily life (22).

Arm motor ability test (AMAT) assesses the disability and functional capacity of the upper extremity (UE) in activities of daily life. The measure requires clients to perform 13 common unilateral and bilateral UE tasks. The higher score means the

fewer activity limitations and the lower score means more activity limitations (23,24).

Statistical Analysis

The power analysis was performed using G-Power version 3.1.94, determining that a sample size of 40 patients (20 per group) was needed for an effect size of 0.925, a 0.05 margin of error, and 80% power in the study by Korkmaz et al. on shoulder pain after hemiplegia (14). Data were analyzed with SPSS version 25.0. Normality was assessed with the Shapiro-Wilk test. Continuous variables with normal distribution were reported as mean and standard deviation, while those without were reported as median and interquartile range (IQR). Categorical data were analyzed with Chi-square, Fisher's exact, or Yate's Continuity correction tests. Numerical variables were compared using independent samples t-tests or Mann-Whitney U tests, and within-group comparisons of repeated measurements were conducted with the Wilcoxon signed-rank test. Spearman correlation analysis assessed relationships between ultrasonographic findings and changes in pain, spasticity, and disability scales. A 95% confidence interval and 5% margin of error were used, with *P<0.05* considered statistically significant.

Results

In our study, total of 43 patients were allocated to the HILT group(n:22) and to the control group (n:21). Since 1 patient from the HILT group could not continue the treatment so the study was completed with 21 patients in the HILT group. Sociodemographic characteristics of the groups are summarized in Table I. There was no statistically significant difference between the groups. Treatment groups were similar in terms of clinical data and sonographic findings (Table II).

Figure I. Study Flow Chart

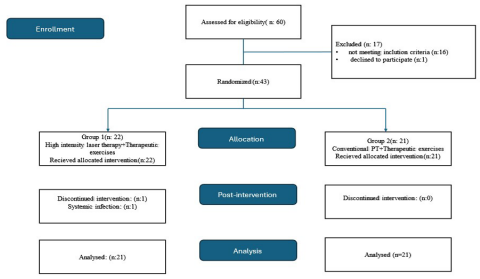


Figure 1: Study flow chat

In both groups, within group comparisons showed a significant decrease in VAS movement and night scores and a significant increase in AMAT-function, movement and FIM scores (*p<0.05*). On the other hand, there was no significant difference was found between the groups in terms of decrease in VAS movement scores, increase in AMAT-function and movement scores and FIM scores after treatment (*p>0.05*). Only the improvement in VAS night score was more significant in the HILT group compared to the conventional physical therapy group (*p=0.047*). No significant difference was found between the groups in pre-treatment, post-treatment MRS values and the difference of pre-treatment and post-treatment values (*p>0.05*). Table III shows the pre-treatment and post-treatment values of VAS, AMAT- function and movement, FIM scores differences between pre- treatment and post-treatment scores and MRS scores.

Table I. Sociodemographic Data of the Treatment Groups

	HILT group (n=21)	Conservative treatment group (n=21)	*p*
Age (median, IQR)	60.0 (17.0)	63.0 (9.0)	*0.571**
Gender (n/%) Female Male	 8 (38.1) 13 (61.9)	 10 (47.6) 11 (52.4)	*0.756*†
Marital status (n/%) Married Single Widow	 16 (76.2) 3 (14.3) 2 (9.5)	 18 (85.7) 1 (4.8) 2 (9.5)	
Educational status (n/%) Illiterate Primary-secondary Highschool License Postgraduate	 1 (4.8) 11 (52.4) 6 (28.6) 2 (9.5) 1 (4.8)	 1 (4.8) 12 (57.1) 5 (23.8) 3 (14.3) -	
Job (n/%) Housewife Deskwork Worker Retired	 7 (33.3) 3 (14.3) 4 (19.0) 7 (33.3)	 9 (42.9) 1 (4.8) 5 (23.8) 6 (28.6)	
Use of alcohol (n/%) Yes No	 1 (4.8) 20 (95.2)	 1 (4.8) 20 (95.2)	
Smoking (n/%) Smoker Non-smoker	 5 (23.8) 16 (76.2)	 5 (23.8) 16 (76.2)	*1.000*†

* Mann-Whitney U test, † Chi-square test,HILT: High-intensity laser treatment

The correlation analysis revealed that both the HILT and conservative treatment groups exhibited distinct relationships between USG findings and clinical outcomes. In HILT group, a strong negative correlation was observed between the presence

of Subacromial-Subdeltoid Bursitis condition and reductions in nighttime pain (VAS-night) (*Rho=-.626, p<0.01*), and functional movement (AMAT-movement) (*Rho=-.442, p=0.045*).

Table II. Clinical Features of the Treatment Groups

	HILT group (n=21)	Conservative treatment group (n=21)	*p*
	N/%		
Type of hemiplegia Ischemic Hemorrhagic	20 (95.2) 1 (4.8)	18 (85.7) 3 (14.3)	*0.599**
Side of hemiplegia Right Left	9 (42.9) 12 (57.1)	12 (57.1) 9 (42.9)	*0.538*†
Radiological findings SA-SD bursitis Bicipital tendinosis Partial rupture Total rupture ACJ joint degeneration	16 (76.2) 10 (47.6) 7 (33.3) 8 (38.1) 5 (23.8)	16 (76.2) 9 (42.9) 12 (57.1) 4 (19.0) 8 (38.1)	*1.000** *1.000** *0.215** *0.306** *0.505**
MAS score-Deltoid 0 1 1+ 2 3 4	13 (61.9) 4 (19.0) 2 (9.5) - 2 (9.5) -	17 (81.0) 2 (9.5) - 2 (9.5) - -	
MAS score-Biceps 0 1 1+ 2 3 4	8 (38.1) 3 (14.3) 7 (33.3) 2 (9.5) 1 (4.8) -	13 (61.9) 2 (9.59 1 (4.8) 4 (19.0) 1 (4.8) -	
MAS score-pronator 0 1 1+ 2 3 4	8 (38.1) 5 (23.8) 5 (23.8) 2 (9.5) 1 (4.8) -	14 (66.7) 4 (19.0) 2 (9.5) 1 (4.8) - -	
MAS score-wrist 0 1 1+ 2 3 4	8 (38.1) 6 (28.6) 4 (19.0) 1 (4.8) 2 (9.5) -	15 (71.4) - 2 (9.5) 4 (9.5) - -	
Brunnstrom-upper extremity 1 2 3 4 5	6 (28.6) 9 (42.9) 4 (19.0) 2(9.5) -	10 (47.6) 3 (14.3) 6 (28.6) 1 (4.8) 1 (4.8)	
Brunnstrom-lower extremity 1 2 3 4 5	5 (23.8) 4 (19.0) 7 (33.3) 4 (19.0) 1 (4.8)	4 (19.0) 10 (47.6) 2 (9.5) 4 (19.0) 1 (4.8)	
Brunnstrom-hand 1 2 3 4 5	8 (38.1) 7 (33.3) 3 (14.3) 2 (9.5) 1 (4.8)	9 (42.9) 6 (28.6) 4 (19.0) 1 (4.8) 1 (4.8)	

*Chi-square with Yate's correction, † Fischer exact test, HILT: High-intensity laser treatment

A strong negative correlation was found between bicipital tendinosis and reductions in nighttime pain (VAS-night) (*Rho=-.655, p<0.01*). This indicates that patients with tendinosis had significant improvements in nighttime pain relief after HILT. A moderate negative correlation was found between complete rupture and improvements in both functional and movement scores (AMAT-functional and AMAT-movement) (*Rho=-.480, p=0.028; Rho=-.540, p=0.012*) (Table IV). No significant correlations were found between USG findings and clinical outcomes in the conservative treatment group, indicating that the presence of specific shoulder pathologies did not influence the treatment response to conservative interventions. No correlation was found between USG findings and pain and disability scales in the conservative treatment group (*p>0.05*) (Table V).

Table III. Comparison of the Pre and Post-treatment Scores of Visual Analog Scales, Disability and Functional Independence Questionnaire scores between the Groups

	HILT (n=21)	CPT group (n=21)	*p*†
	Median (IQR)		
VAS-movement before treatment VAS-movement after treatment VAS-movement difference between before and after treatment p* (intra-group comparisons)	7.0 (1.0) 5.0 (3.0) 3.0 (2.0) ***<0.001***	7.0 (3.0) 5.0 (4.0) 2.0 (1.5) ***<0.001***	*0.158* *0.808* *0.192*
VAS-night before treatment VAS-night after treatment VAS-night difference between before and after treatment p* (intra-group comparisons)	5.0 (3.0) 2.0 (4.0) 2.0 (2.0) ***<0.001***	4.0 (5.0) 3.0 (4.0) 1.0 (2.0) ***<0.01***	*0.334* *0.889* *0.047*
FIM-before treatment FIM-after treatment FİM-difference between before and after treatment p* (intra-group comparisons)	47.0 (26.0) 58.0 (32.0) 2.0 (7.5) ***<0.001***	46.0 (19.0) 47.0 (20.0) 2.0 (2.5) ***<0.001***	*0.715* *0.308* *0.377*
MRS-before treatment	4.0(1.0)	4.0(1.0)	*0,693*
MRS -after treatment	4.0(1.0)	4.0(1.0)	*0,670*
MRS-difference between before and after treatment	0.0 (0.0)	0.0 (0.0)	*0.638*
p* (intra-group comparisons)	*0.083*	*0.157*	

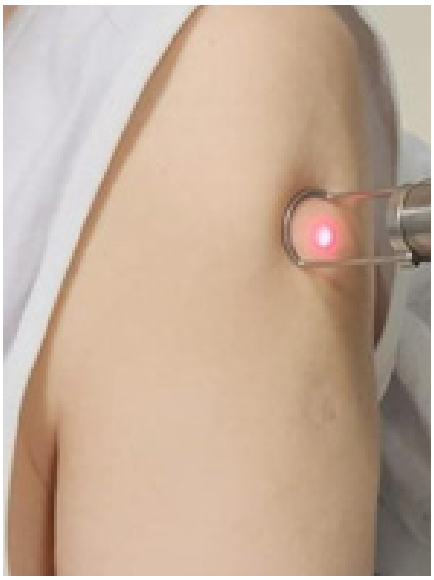
* Wilcoxon-signed ranks test, † Mann-Whitney U test,HILT: High-intensity laser treatment, CPT: Conventional physical therapy, VAS: Visual analog scale, FIM: Functional independence measurement,MRS: Modified rankin scale

Table IV. Spearman Correlation Analysis Between Ultrasonographic Findings and Improvements in Pain, Spasticity, and Disability Scales in the High-Intensity Laser Group

		Improvement in VAS-rest scores	Improvement in VAS-movement scores	Improvement in VAS-night scores	Improvement in MRS scores	Improvement in AMAT functional scores	Improvement in AMAT movement scores	Improvement in FIQ scores
Subacromial-subdeltoid bursitis	Rho	-.362	-.339	**-.626**	-.091	-.244	**-.442**	-.355
P	*0.107*	*0.133*	*0.002*	*0.694*	*0.286*	*0.045*	*0.114*	
N	21	21	21	21	21	21	21	
Bicipital tenosynovitis	Rho	-.179	-.313	**-.655**	.156	.233	-.049	.311
P	*0.438*	*0.167*	*0.001*	0.500	0.309	0.832	0.170	
N	21	21	21	21	21	21	21	
Tendinosis	Rho	.257	-.009	.057	.411	.098	.212	.420
P	*0.260*	*0.968*	*0.807*	*0.064*	*0.674*	*0.357*	*0.058*	
N	21	21	21	21	21	21	21	
Partial rupture of any rotator cuff muscles	Rho	.155	-.213	.009	-.289	.388	.313	.143
P	*0.502*	*0.355*	*0.971*	*0.204*	*0.082*	0.168	0.535	
N	21	21	21	21	21	21	21	
Complete rupture of any rotator cuff muscles	Rho	-.326	.066	-.150	-.040	-.480	-.540	-.410
P	*0.149*	*0.776*	*0.517*	*0.863*	*0.028*	*0.012*	*.065*	
N	21	21	21	21	21	21	21	

VAS: Visual analog scale, MRS: Modified ranking scale, AMAT: Arm motor ability test, FIQ: Functional independence questionnaire

Figure II. High Intensity Laser Application



Discussion

In this present study, we compared the results obtained after treatment with HILT and conventional physical therapy methods combined therapeutic exercise in subjects diagnosed with hemiplegic shoulder pain. Both the HILT and conventional therapy groups exhibited statistically significant improvements in pain and disability, and functional daily life activity in upper extremity immediately posttreatment compared to pre-treatment. Improvements in movement pain, disability and function were similar in two groups in the pre- and post-treatment evaluation. Only the HILT group demonstrated a greater improvement in nocturnal pain.

SA-SD bursitis, bicipital tendinosis and partial rupture were the most common pathologies that reported for hemiplegic shoulder pain as ultrasonographic finding by Lin in a study (17). Also, Wu et al. reported rotator cuff tears and subacromial-subdeltoid bursitis, conditions that can occur concurrently, are soft tissue injuries that may significantly contribute to the pathogenesis of HSP (25). We also detected similar pathologies in ultrasonographic assessment of our patients.

Recent clinical practice has witnessed the application of HILT across a spectrum of musculoskeletal conditions, including shoulder pain and hemiplegic shoulder pain (26). In a two-week study, Korkmaz et al. investigated the comparative efficacy of HILT and ultrasound therapy in patients with hemiplegic shoulder pain, a statistically significant reduction in pain intensity was observed. Furthermore, the HILT group demonstrated statistically significant intergroup differences in movement outcomes, functional scores, and muscle strength compared to the ultrasound therapy group after 10 treatment sessions. In this study the laser device produces a maximum of 12W power and emits wavelength of 1064 nm (Nd: YAG laser). used the device to the rotator cuff muscles area in two phases phase I and phase II. The pulse modality was used in phase I for

Table V. Spearman Correlation Analysis Between Ultrasonographic Findings and Improvements in Pain, Spasticity, and Disability Scales In The Conservative Treatment Group

		Improvement in VAS-rest scores	Improvement in VAS-movement scores	Improvement in VAS-night scores	Improvement in MRS scores	Improvement in AMAT functional scores	Improvement in AMAT movement scores	Improvement in FIQ scores
Subacromial-subdeltoid bursitis	Rho	.351	.259	.311	.181	-.127	-.399	-.105
	p	0.119	0.257	0.170	0.431	0.583	0.073	0.652
	N	21	21	21	21	21	21	21
Bicipital tenosynovitis	Rho	.035	-.198	-.234	.047	-.310	-.189	-.205
	p	0.882	0.389	0.307	0.840	0.172	0.412	0.374
	N	21	21	21	21	21	21	21
Tendinosis	Rho	.232	-.105	.012	.331	.258	.036	.174
	p	0.312	0.650	0.959	0.143	0.259	0.875	0.452
	N	21	21	21	21	21	21	21
Partial rupture of any rotator cuff muscles	Rho	.026	-.099	-.033	-.047	.310	.189	-.237
	p	0.911	0.669	0.885	0.840	0.172	0.412	0.300
	N	21	21	21	21	21	21	21
Complete rupture of any rotator cuff muscles	Rho	.348	-.094	.042	.256	-.367	-.433	-.165
	p	0.122	0.686	0.856	0.263	0.101	0.050	0.475

VAS: Visual Analog Scale, MRS: Modified Ranking Scale, FIM: Functional Independence Measurement; SS:subacromail subdeltoid,RCM: Rotator Cuff Muscle

the analgesic effect. A standard frequency of 25 Hz is applied. The first four therapy sessions were analgesic effect, using a power of 8 W, a dose of 12 J/cm^2, to 25 cm^2 area, for a total of 300 J of energy, for 2.5 min. The continuous wave modality was used in phase II for biostimulation effect. The subsequent five sessions were biostimulation effect, using a power of 7 W, a dose of 100 J/cm^2, to 25 cm^2 area, for a total of 2500 J of energy, for 5 min and 57 s (14). In another study, Santamanto et al. employed the following application dosages for HILT in three steps during the initial and final phases of treatment: 510, 610, and 710 mJ/cm^2, respectively. Consequently, the total administered energy in their study was approximately 2,050 J (27). In our study, although there was a significant improvement after treatment compared to before treatment in both groups, no significant difference in motor recovery, movement and functional activity was found in the analysis between HILT and CPT groups. Our HILT dosage was similar to Korkmaz et al. study with little differences. We added one more phase and applied three phases in accordance with the diagnostic specific program suggested by the device.

In another study Santamato et al. conducted a comparative study of HILT and ultrasound therapy in patients diagnosed with subacromial impingement syndrome, a significant reduction in pain and statistically significant intergroup differences favoring the HILT group in terms of movement, functional scores, and muscle strength compared to the ultrasound treatment group (11). Concurrent research examining the management of shoulder pain has indicated that HILT constitutes an effective therapeutic intervention, demonstrating significant reductions in pain and disability both post-treatment and during subsequent short-term follow-up periods (27). In our present study in both groups pain scores and functional scores were similary better after treatment according to baseline. Nevertheless, intergroup assessment in HILT group only VAS night score decreased more than conventional physical therapy group after treatment. In this study US therapy applied continuous US for 10 minutes with a frequency of 1 MHz, an intensity of 2 W/cm^2 (27). In another study, Ökmen et al. applied the ultrasound device at a frequency of 3 MHz and an intensity of 1.5 W/cm^2 over a surface area of 25 cm^2 (18). Our US therapy dosage was similar with this study.

HILT employs a multimodal approach, harnessing thermal, mechanical, and electrical energy to stimulate cellular and tissue responses. This stimulation is thought to induce beneficial effects, including increased blood flow and cellular activity, which may contribute to HILT's efficacy in reducing inflammation and edema (26, 28). In our study, we found that the HILT group experienced a significant decrease in nocturnal pain compared to the control group in the early period. Sonographic findings of subacromial-subdeltoid bursitis and bicipital tendinosis were

associated with increased nocturnal shoulder pain. Following HILT treatment, a significant reduction in night pain, as measured by VAS scores, was observed in this patient group. We believe that this is due to the anti-inflammatory and anti-edema effect of HILT therapy.

Unlike traditional laser therapy that uses concentrated light, HILT employs high-intensity laser radiation that scatters throughout the treated area. This diffused light penetrates deeper due to a slower absorption process, potentially making it more effective for treating larger areas. Studies suggest HILT offers a faster path to pain and inflammation relief 10. Additionally, we know from the recent literature HILT can induce photochemical and photothermic effects rapidly and thus increases blood flow, cell metabolism and vascular permeability (29). Our findings suggest that the lower nighttime VAS scores in the HILT group could be related to this mechanism of action.

The limitations of this present study are small sample size and the absence of a placebo control group and long-term follow-up results. Due to the limited sample size, the study may have lacked sufficient power to detect statistically significant effects. The absence of a control group prevents us from drawing conclusions about the comparative effectiveness of the two therapeutic methods. Ultrasonography findings were not evaluated after treatment due to the short follow-up period because no change was expected. A longer follow-up examination may be useful in determining ultrasonographic changes. Therefore, further large-scale, prospective, long-term outcomes, placebo-controlled studies are needed to confirm these findings.

Conclusion

In our study no significant superiority was observed between the two treatment options. However, a thorough assessment of HSP at the beginning of the rehabilitation program is crucial due to its potential negative impact on the rehabilitation process of existing shoulder pain in patients. Therefore, we believe that implementing HILT or CPT when necessary can be beneficial to accelerate the rehabilitation process. Long-term studies with a longer follow-up, including placebo groups, are needed. Moreover, there are still no guidelines on the dose, duration, and frequency of HILT in specific disorders.

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