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The Effect of High-Intensity Laser Therapy on Pain and Functionality in Patients with Chronic Shoulder Pain

Kronik omuz ağrılı olgularda yüksek yoğunluklu lazer terapinin ağrı, fonksiyonellik ve yaşam kalitesi üzerine etkisi

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ÖZ

Amaç: Bu çalışmanın amacı, kronik omuz ağrılı hastalarda geleneksel tedaviye eklenen yüksek yoğunluklu lazer tedavisinin (HILT) ağrı ve fonksiyonellik üzerine etkilerini araştırmaktı.

Gereç ve Yöntem: Çalışmaya (18-75 yaşları arasında) kronik omuz ağrısı olan 50 kişi katıldı. Hastalar rastgele iki gruba (CT grubu veya CT+HILT grubu) ayrılarak her iki gruba da 3 hafta boyunca, haftada 5 seans olmak üzere geleneksel terapi programı uygulandı ve sadece CT+HILT grubuna (n=25) geleneksel tedaviye ek olarak HILT uygulandı. Üst ekstremite hareket açıklığı, ağrı eşiği, kas kuvveti ve engellilik durumu tedavi öncesinde ve hemen sonrasında değerlendirildi.

Bulgular: Gruplar arası karşılaştırmalarda Independent-Samples T-test ve grup içi karşılaştırmalarda Paired-Samples T-test; normal dağılıma uymayan verilerin karşılaştırılmasında ise Mann Whitney-U and Wilcoxon testleri kullanıldı. Analizler $p<0.05$ güven aralığında anlamlı kabul edildi. Her iki grupta da tedavi sonrasında tüm sonuç ölçümlerinde iyileşme olduğu gözlemlendi. Değerlendirilen değerler arasındaki farklar ve yüzdelerdeki artış açısından iki grup arasında omuzun iç rotasyonel kuvveti artış yüzdesi haricinde ($p=0,04$) anlamlı bir fark yoktu.

Sonuç: Her iki grup da tedaviden yararlandı, ancak tedavilerin etkinliği birbirlerinden üstün değildi. Kronik omuz ağrısının tedavisinde HILT'in geleneksel tedaviye eklenebilecek alternatif bir seçenek olabileceği düşünülmektedir.

Anahtar Kelimeler: Omuz ağrısı, kronik ağrı, lazer terapi, fizyoterapi

ABSTRACT

Objective: The purpose of this study was to investigate the effects of high-intensity laser therapy (HILT) added to conventional therapy (CT) on pain and functionality in patients with chronic shoulder pain.

Methods: Fifty people with chronic shoulder pain (18-75 years) participated in the study. Participants were randomized into two groups (CT group or CT+HILT group), and both received CT program for 3 weeks, 5 sessions a week and only CT+HILT group (n=25) received HILT in addition to CT. Upper extremity range of motion, pain threshold, muscle strength, and disability were assessed before and immediately after the treatment.

Results: For intergroup comparisons Independent-Samples T-test and intra-group comparisons Paired-Samples T-test were used and for the data that did not show normal distribution Mann Whitney-U and Wilcoxon tests were used. Analyzes were considered significant at a confidence interval of $p<0.05$. After the treatment, improvements in all outcome measures were observed in both groups. There was no significant difference between the two groups in terms of the differences between the outcome measures and increase in the percentages, except shoulder internal rotational strength ($p=0.04$).

Conclucion: Both groups benefited from the treatment, but the efficacy of the treatments was not superior to each other. In the treatment of chronic shoulder pain, HILT might be an additive option to CT.

Keywords: Shoulder pain, chronic pain, laser therapy, physiotherapy

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INTRODUCTION

The third most common type of musculoskeletal pain is the shoulder pain (Herin et al., 2012) which is associated with muscle weakness, joint motion limitations, and decreased functional capacity (El Mughrabi et al., 2016). The prevalence of shoulder pain in the general population varies between 5%-47% (Luime et al., 2005), increasing up to 70% among those exposed to repetitive shoulder loading in the occupational life (Hoozemans et al., 2002; Lecler et al., 2004; Luime et al., 2005; Yeung et al., 2003) and with a peak incidence in those aged between 45-64 years (Van der Windt et al., 1995).

The main purpose in the treatment of chronic shoulder pain is to reduce pain and restore shoulder movements. The most preferred method is conservative treatment, generally including medical treatment and physiotherapy. Such physiotherapy methods are electrotherapy agents, exercises, and manual joint mobilizations (Hanratty et al., 2012). In recent years, some research have been conducted on high-intensity laser therapy (HILT) (Angelova & Ilieva, 2016; Choi et al., 2017; Ciplak et al., 2018), which is an alternative treatment method in terms of accessibility and cost. HILT stimulates oxidation of mitochondria and adenosine triphosphate (ATP) creation by delivering high energy output inside the tissues and with this photochemistry effect, metabolism and blood circulation is increased resulting HILT to cause quick absorption of edema and removal of exudates (Santamato et al., 2009). Although there are many nonsurgical treatments for chronic shoulder pain have been introduced so far, there is a paucity of research on HILT. To help answer this, the aim of our study was to investigate the effect of HILT on pain and functionality as an add-on application to the conventional therapy (CT) program applied in individuals with chronic shoulder pain.

2. MATERIAL AND METHODS

2.1. Study Design and Participants

The present study was approved by Istanbul Medipol University Non-Invasive Research Ethics Committee [approval number: 217 / date: 28.03.2018]. All participants were informed about the purpose of the study, its duration, and the treatments to be applied throughout the study before enrollment without offering any incentives and the 'Informed consent form' was signed by the participants. The study was carried out in accordance with the institutional guidelines and principles of the Declaration of Helsinki.

A total of 61 people with chronic shoulder pain were evaluated for the present study in ... Medical Center between April 2018 – December 2018, and 56 of those who complied with the inclusion criteria were randomized into two equal groups (Figure 1) according to the order of their arrival at the clinic before the treatment. Inclusion criteria for the study were being diagnosed with chronic shoulder pain, being between 18-75 years of age; and exclusion criteria were having not sufficient cooperation to follow the exercises, having communication problems or psychiatric problems, and presence of any cardiac or orthopedic discomfort that may prevent the application of outcome measures. The participants were blinded to their allocation.

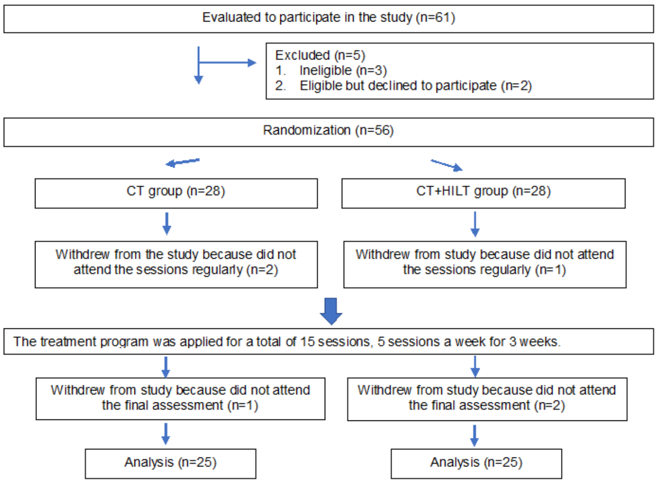

Figure 1: *Clinical Study Flow Diagram*

2.2. Treatment Program

The treatment program consisted of 15 sessions in total, 5 sessions a week for 3 weeks. CT was applied to all participants which included exercises and application of 15 minutes of hot-pack, 20 min. of transcutaneous electrical nerve stimulation (TENS), 5 min. of ultrasound (US), 20 min. of interference current (IC) with vacuum electrodes. The protocol of hot-pack application was based on the study by Yeldan et al. (Yeldan et al., 2009), and TENS and US application was based on the study of Uçurum et al. (Ucurum et al., 2018). TENS was applied in conventional mode with 4 adhesive electrodes using Sportx32 (Sport, China) device and the current was increased as the participants felt a comfortable sensation. US was applied with multifunctional Enraf Nonius – Sonopuls 692 device at a magnitude of 1.5 W/cm2 and frequency of 1 MHz. Same multifunctional device was used for vacuum application. IC was applied to the shoulder area at a frequency of 4 Hz, 80 Hz pulse frequency, 1/1 rectangular spectrum. Exercise program included (all exercises were applied as 1 set of 10 repetitions in each direction) Codman exercises applied in 3-directions, wand exercises applied in 4-directions, exercises using the shoulder wheel applied in 2-directions, exercises with exercise band applied in 5-directions, exercises on the finger ladder applied as 1 set of 10 repetitions in both directions; and shoulder capsule stretching exercises performed in 1 set of 12 repetitions by asking the subjects to wait 20 seconds where the tension was felt (Rubin & Kibler, 2002).

2.3. Application of HILT

In addition to the CT program, only CT+HILT group has received HILT (BTL 6000, BTL Industries, Inc., USA) application to the shoulder area in the analgesic mode of the device at a frequency of 25 Hz with a power of 10 W and a dosage of 12 j/cm2 for 2 minutes: 5 sessions a week for 3 weeks and 15 sessions in total. To avoid direct contact of the laser to the eyes both the therapist and the participants wore glasses during the application.

2.4. Outcome Measures

All participants in the study were evaluated before and immediately after the study. Shoulder flexion, extension and abduction, elbow flexion and extension range of motion (ROM) were measured three times with a standard goniometer (Elite Medical Instruments EMI, United States of America (USA)) and the average values were recorded. Disability status of the participants was evaluated with the self-reported Turkish version of the Disabilities of the Arm, Shoulder and Hand – DASH questionnaire which is developed by the American Academy of Orthopedic Surgeons (AAOS) that reflects the patients' functional status and symptoms from their own point of view (Duger et al., 2006). Pressure pain threshold measurement was measured with an algometer device. The algometer used in our study (JTECH Medical – Algometer Commander, USA) is a digital algometer with LCD screen. There are various studies in the literature regarding the validity and reliability of the algometer device (Vaughan et al., 2007). A hand dynamometer 'myometer' (JTech Medical – Commander PowerTrack, USA) was used to measure the muscle strength. The measurements were repeated 3 times and the arithmetic mean was accepted. The test was repeated with 5 seconds rest breaks. 5 seconds of resistance was applied during shoulder movement (Benfica et al., 2018).

2.5. Statistical Analysis

The sample size was calculated before the study with 'G*Power 3.1' program (Faul et al., 2007) and according to the results, the smallest number of participants to detect an effect size of 0.85 estimated from independent samples was 29 participants in total. On the assumption of 30% attrition, minimum 28 participants per group were targeted to be included in the study to obtain statistically significant results. The Statistical Package for Social Sciences (SPSS) Version 25 (SPSS inc., Chicago, IL, USA) was used for the analysis of the data obtained. The compliance of these data to normal distribution was evaluated by drawing histograms and the "One-Sample Kolmogorov-Smirnov" test. For intergroup comparisons of parameters determined to be suitable for normal distribution, Independent-Samples T-test and intra-group comparisons were performed by Paired-Samples T-test. Data that did not show normal distribution were compared using the Mann Whitney-U and Wilcoxon tests. Analyzes were considered significant at a confidence interval of p<0.05.

3. RESULTS

Participant characteristics are shown in Table 1. In total 50 participants were analyzed and there was no statistically significant difference between the groups in terms of baseline characteristics of the patients (Table 1).

Table 1: *Baseline Characteristics of the Participants*

	CT group (n=25) Mean ± SD (min – max)	CT+HILT group (n=25) Mean ± SD (min – max)	p
Age, years	63.8±7 (53 – 79)	64.7±7.5 (50 – 78)	0.67
Female, n (%)	8 (32)	15 (60)	
BMI, kg/m²	25.2±2.9 (19.9 – 31.7)	23.9±3.7 (17.9 – 31.8)	1.86
Shoulder ROM			
Flexion	108.8±8.4 (92 – 125)	110.3±9.4 (95 – 130)	0.55
Extension	44.1±2 (40 – 47)	44.4±2.7 (40 – 48)	0.72
Abduction	106.7±9.2 (90 – 125)	107.9±10.2 (93 – 130)	0.65
Internal Rotation	53.4±4.9 (45 – 65)	53.7±4.8 (46 – 64)	0.84
External Rotation	54.5±4.6 (47 – 65)	54.6±5.1 (45 – 66)	0.90
Elbow Flexion ROM	102.6±3.7 (96 – 110)	103.3±4.4 (95 – 110)	0.51
DASH	68.1±4.5 (60 – 75)	67.7±4.4 (55 – 75)	0.77
Pain threshold			
Anterior	52.2±0.4 (51.2 – 52.7)	52.2±0.5 (50.7 – 53)	0.92
Lateral	28.5±0.4 (27.4 – 29.1)	28.5±0.3 (27.9 – 29.1)	0.59* -0.53**
Supraspinal	70.1±0.5 (68.7 – 70.7)	70.2±0.4 (69.2 – 70.7)	0.92* -0.97**
Shoulder muscle strength			
Flexion	42.4±1.7 (39.9 – 45)	41.5±1.7 (39.7 – 44.4)	0.07* -1.76**
Extension	62.1±9.6 (46.2 – 90.2)	61.8±5.5 (52.8 – 78.2)	0.62
Abduction	37.7±1.6 (35.2 – 45)	37.1±1.7 (35 – 39.8)	0.16* -1.38**
Internal rotation	33.7±0.9 (32.1 – 34.9)	33.4±1.1 (31.8 – 35)	0.16
External rotation	32.1±0.8 (30.4 – 33.4)	31.9±0.9 (30 – 33.6)	0.47
Elbow muscle strength			
Flexion	67.2±1.0 (65.2 – 69.2)	67.1±1.1 (65 – 68.9)	0.60
Extension	29.1±0.8 (27.4 – 30.4)	28.9±0.9 (27 – 30.6)	0.49* -0.69**

*Independent samples t-test; **z value. BMI: Body mass index; DASH: Disabilities of the arm, shoulder, and hand; Max: Maximum; Min: Minimum; ROM: Range of motion; SD: Standard deviation.

In both groups statistically significant results were obtained when before and after the treatment outcomes scores compared to each other, both groups showed improvement after the treatment (p<0.05). After treatment scores are shown in Table 2. There was no statistically significant difference between the groups when after the treatment scores compared. Only in shoulder flexion muscle strength values of the groups after treatment had a significant difference (p<0.05), but there was no statistically significant difference found in other muscle strength values (p>0.05).

Table 2: *Evaluations of the Participants after Therapy*

	CT group (n=25) Mean ± SD (min – max)	CT+HILT group (n=25) Mean ± SD (min – max)	p
Shoulder ROM			
Flexion	141.8±6.9 (118 – 155)	144.5±8.2 (125 – 158)	0.10* -1.61**
Extension	59.6±1.8 (56 – 64)	59.6±2.1 (56 – 63)	0.88
Abduction	137.9±8.1 (115 – 155)	141.6±9.4 (120 – 155)	0.15
Internal Rotation	69.8±4.5 (60 – 78)	69.4±4.7 (60 – 77)	0.80
External Rotation	69.9±4.1 (60 – 77)	69.8±4.1 (61 – 77)	0.89
Elbow Flexion ROM	121.8±3.3 (118 – 129)	122.6±3.6 (115 – 128)	0.84* -0.19**
DASH	38.6±3.1 (32 – 45)	38.7±2.8 (33 – 45)	0.92
Pain threshold			
Anterior	55.4±0.3 (54.7 – 55.9)	55.5±0.3 (54.9 – 56)	0.19
Lateral	32.4±0.4 (31.1 – 33.6)	32.3±0.4 (31.6 – 33.9)	0.11* -1.56**
Supraspinal	76.2±0.5 (74.7 – 77)	76.5±0.4 (75.8 – 77.1)	0.06
Shoulder muscle strength			
Flexion	50.8±1.9 (47.9 – 54)	49.7±1.8 (47 – 53.3)	0.04
Extension	66.1±1.9 (62.5 – 69.5)	65±2.1 (62.3 – 69)	0.69
Abduction	43.3±1.5 (47.7 – 45.2)	42.6±1.7 (40 – 45.2)	0.14* -1.47**
Internal rotation	39.7±0.8 (38.1 – 41)	39.4±1.01 (37.8 – 41)	0.36* -0.90**
External rotation	38.2±0.8 (36.5 – 39.3)	37.9±0.9 (36.2 – 39.6)	0.38
Elbow muscle strength			
Flexion	79.1±1.5 (76.9 – 82.9)	79.3±1.6 (76.5 – 82.8)	0.78
Extension	40.1±0.8 (38.2 – 41.3)	39.7±1.8 (31.9 – 41.3)	0.33

*Independent samples t-test; **Mann Whitney U test. DASH: Disabilities of the arm, shoulder, and hand; Max: Maximum; Min: Minimum; ROM: Range of motion; SD: Standard deviation.

Two groups benefited from the treatment methods applied, but the treatments are not superior to each other in terms of their effectiveness (Table 3). When differences (between before and after the treatment outcome measures) obtained were compared between the two groups, there was no statistically significant difference observed except that there was only a statistically significant difference in the increase of the shoulder internal rotation muscle strength (p=0.04) (Table 4).

Table 3: *Comparison of the Groups in Terms of Evaluation Parameters Before and After Treatment*

	CT group (n=25)		CT+HILT group (n=25)	
	p	Z	p	Z
Shoulder ROM				
Flexion	0.01**	-4.38	0.01**	-4.38
Extension	0.01**	-4.37	0.01**	-4.38
Abduction	0.01*		0.01*	
Internal rotation	0.01*		0.01*	
External rotation	0.01*		0.01*	
Elbow flexion ROM	0.01**	-4.38	0.01**	-4.38
DASH	0.01*		0.01*	
Pain threshold				
Lateral	0.01**	-4.38	0.01**	-4.38
Supraspinal	0.01**	-4.37	0.01**	-4.38
Shoulder strength				
Flexion	0.01**	-4.37	0.01**	-4.37
Extension	0.01*		0.01*	
Abduction	0.01**	-4.37	0.01**	-4.37
Internal rotation	0.01**	-4.42	0.01**	-4.41
External rotation	0.01*		0.01*	
Elbow flexion muscle strength	0.01*		0.01*	
Elbow extension muscle strength	0.01*	-4.40	0.01**	-4.39

*Independent Samples T-Test; **Mann Whitney-U Test; DASH: Disabilities of the Arm, Shoulder, and Hand; ROM: Range of motion.

Table 4: *Change in Increase of Percentages of Shoulder Internal Rotation Strength*

	CT group Mean ± SD	CT+HILT group Mean ± SD	F	t	p*
Percentage change in shoulder internal rotation muscle strength	17.8±2.1	18.3±0.8	0.03	-2.07	0.04

*Independent samples t-test; SD: Standard deviation; Min: Minimum; Max: Maximum

4. DISCUSSION

In the present study, 50 participants completed the study. The participants were randomly divided into two equal groups (CT group and CT+HILT group), and both received CT program for 3 weeks, 5 sessions a week and only CT+HILT group (n=25) received HILT in addition to CT. Upper extremity ROM, pain threshold, muscle strength, and disability were assessed before and immediately after the treatment. There was no significant difference between the two groups in terms of the differences between the outcome measures and increase in the percentages, except shoulder internal rotational strength. Both groups benefited from the treatment, but the efficacy of the treatments was not superior to each other.

Shoulder pain is one of the most common health problems observed in the clinic, causing different problems. In a systematic review on outcome measurements used to evaluate the efficacy of the treatments applied for shoulder pain, they found that pain, ROM, functionality, and joint stiffness were the most commonly used outcome measures (Ozdincler, 2005). ROM limitations caused by pain in shoulder problems significantly affect the daily lives of individuals (Michener et al., 2003). In the present study, before the treatment, there was no significant difference in all the shoulder ROM values of the groups. After the treatment, ROM increased in both groups. When the mean change within the groups was evaluated, there was no superiority between the groups in terms of ROM. This might be explained by both groups undertaking the same CT program. Upper extremity functions are also affected by shoulder pain (Neer, 2005). In the present study, functionality and disability status were evaluated with the most preferred DASH scale for the shoulder joint (Angst et al., 2011). Before treatment, DASH scores were similar between groups. After the treatment, changes in DASH scores of both groups were observed in both groups, but when the changes were compared, there was no statistically superiority between the groups. For the evaluation of pain algometer was used, which provides objective data instead of subjective questionnaires, to assess pain. When the pain perception thresholds of the groups were compared before the treatment, there was no statistically significant difference in between. Pain thresholds increased in both groups after the treatment. When the changes in pre – and post-treatment data were compared between the groups, no statistically significant difference was found.

Celik et al. examined the relationship between shoulder pain and muscle strength in patients with subacromial impingement syndrome (SIS) and found that the pain causes weakness in the middle trapezius, serratus anterior, supraspinatus and anterior deltoid muscles. In their study, the muscle strength of the patients was evaluated bilaterally with a hand dynamometer, and they reported that the muscle strength was significantly lower in the subacromial impingement sides compared to the healthy sides, and there was a significant reverse correlation between pain and muscle strength (Celik et al., 2011). In the present study, muscle strength was evaluated using myometer and before the treatment, the muscle strengths of both groups were similar. After the treatment, an increase in muscle strength was observed in both groups. When comparing the groups, no significant difference was found between the increases.

In a study by Kim et al., the short-term effects of HILT on frozen shoulder were investigated. The participants were randomized into two groups; placebo laser or HILT was applied to the groups. After the treatment, they observed a decrease in Visual Analogue Scale (VAS) scores at the 3rd and 8th weeks. On the 12th week, no significant difference was found between the two groups (Kim et al. 2015). In a randomized study by the Vecchio et al., participants with rotator cuff tendinitis received either placebo laser or Low-Level Laser Therapy (LLLT) twice a week for a total of 8 weeks and after the treatment, ROM increased whereas pain and functional limitation decreased in both groups compared to the baseline, but no significant difference was observed between the two groups (Vecchio et al., 1993). In a study investigating the effect of adding LLLT to conservative treatment (exercise, non-steroidal anti-inflammatory drugs, and paracetamols), conservative treatment was applied to both groups, while LLLT was applied to one of the groups in addition, for 10 sessions, 5 days a week, and home exercises (3 times a day, 20 repetitions). Evaluations were made before the treatment, on the 15th day and on the 45th day and outcome measures included VAS and Constant score. Significant improvement was observed in pain, activities of daily life, active ROM and muscle strength after treatment in both groups, but it was reported that laser did not provide any additional benefit against exercise and medical therapy (Karabulut, 2006). In a systematic review investigating the effectiveness of rehabilitation in patients with SIS, Michener et al. reported that LLLT was more effective than a placebo laser in studies where it was applied alone, but it did not have an additional contribution in terms of decreasing pain and increasing functionality when applied with exercise. In the same study, they reported that they do not know whether there is a difference between applying laser therapy alone or with joint mobilization (Michener et al., 2004). Taşcıoğlu et al. investigated the effectiveness of LLLT in patients with SIS, 57 participants were randomized into two groups and both groups received hot-packs, US, TENS, and exercise program while another group received LLLT in addition. The participants were evaluated 3 times in total (before, after the treatment, and 6 months after) by VAS and constant score, and as a result, significant improvements were observed in all the outcomes in both groups. However, they reported that laser therapy did not provide any additional benefit to conservative physiotherapy and exercise program (Tascioglu et al., 2003).

Reducing pain and inflammation, protecting, and improving ROM, restoring lost functions, and increasing functionality are among the main goals of treating shoulder problems. The first choice in the treatment is conservative treatment and there are studies showing the effectiveness of many of these techniques. In the high-qualified clinical studies, different exercise techniques have been proven to be effective (Dickens et al., 2005). In addition, other methods such as steroid injection, radialextracorporeal shock wave therapy (ESWT), taping, orthotic support, and proprioceptive neuromuscular facilitation (PNF) are recommended. Surgical treatments may also be preferred in case non-surgical treatments are not effective (Brox et al., 1993; Dickens et al., 2005; Michener et al., 2003). In the literature, conventional physiotherapy is applied in the treatment of the control group in comparative studies examining the effectiveness of new physiotherapy approaches for shoulder problems (Bennell et al., 2010). In the light of this information, in the present study, evidence-based methods were preferred as the main treatment program in both groups. In terms of efficiency and cost, when the two modalities (TENS and HILT) used for analgesic purposes compared, HILT device is more expensive than TENS, but HILT can be applied in a few minutes, in a shorter time compared to TENS, so HILT device can be preferred to save some time.

One of the limitations of the present study might be not evaluating the participants in the long-term which might lead to different results. Another limitation might be application of the same CT to both groups. As a result of our study, it can be said that the dose and duration of laser application differed in many studies available in the literature. More studies should be conducted in a controlled manner with more participants to understand the effectiveness of the laser therapy and to determine the ideal dose and time to be applied.

5. CONCLUSION

The aim of this study was to examine the effect of HILT added to the CT program on pain and functionality in patients with chronic shoulder pain. This study showed that both groups benefited from the treatment methods applied, but they were not superior to each other in terms of the effectiveness of the treatments. In the treatment of chronic shoulder pain, HILT has improved all evaluation parameters, but its addition to CT program has no advantage. It is thought that HILT can be an alternative treatment option as an easy-to-use and effective electrotherapy agent with its analgesic effect in CT applications. The use of HILT in the clinics is getting more popular which causes a need in investigating its effectiveness on various body parts.

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