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A Comparative Analysis of High-Intensity Laser Therapy vs. Shock Wave Therapy in Diabetic Frozen Shoulder Management

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Abstract

This study aimed to evaluate and compare the effects of high-intensity laser therapy (HILT) and shock wave therapy (SWT) on pain levels, shoulder mobility, and function in individuals with diabetic frozen shoulder (DFS). A total of 84 patients (aged 40–60 years) were randomly assigned into two groups: the shock wave group (G1; n = 41) and the HILT group (G2; n = 43). Shoulder functionality was measured using the American Shoulder and Elbow Surgeons (ASES) score, pain was evaluated using the visual analog scale (VAS), and shoulder flexion ROM was assessed with a goniometer. The participants in group 1 received one session per week of shock wave therapy for 8 weeks (at 5 Hz, 1.5 bar), while group 2 received two HILT sessions per week for 8 weeks, delivering a total energy of 1,080 J across three phases. Both groups also followed a prescribed exercise program. No significant differences were found between groups before the study. Post-treatment results showed a significant reduction in pain in both groups—49.38% in group 1 (P = 0.00) and 60.09% in group 2 (P = 0.00). ROM improvements were also significant: 25.74% in group 1 (P = 0.00) and 19.29% in group 2 (P = 0.00). Shoulder function improved significantly in both groups—96.66% in group 1 (P = 0.00) and 104.58% in group 2 (P = 0.00). When comparing the groups post-study, group 2 showed a significantly greater reduction in pain (VAS, P = 0.0001), and group 1 had a significantly greater improvement in shoulder ROM (P = 0.04), but there was no significant difference in shoulder function (P = 0.19). Overall, shock wave therapy was more effective for ROM improvement, while HILT proved superior for pain relief and shoulder function enhancement.

Keywords: Pain, Diabetic frozen shoulder, Shock wave therapy, Laser therapy

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Introduction

Frozen shoulder (FS), also referred to as adhesive capsulitis (AC), is a condition marked by inflammation that causes pain, stiffness, and limited movement in the shoulder joint. In individuals with diabetes mellitus (DM), the prevalence of AC is about 13.4%, with diabetic patients being five times more likely to develop the condition compared to non-diabetic individuals [1]. The

age group most affected by this condition is typically between 40 and 65 years old [2]. AC not only restricts shoulder movement but also affects the overall quality of life (QOL), leading to gradual and painful limitations in range of motion (ROM) [1].

Despite being a common disorder, the exact cause of AC remains unclear. It is recognized for its characteristic progression, which can be assessed through patient history and clinical examination. Numerous treatment approaches have been researched for both short-term and long-term outcomes [3]. If untreated, AC can severely affect a person's ability to perform daily tasks, diminishing their QOL, and resulting in varying degrees of mobility restriction in the shoulder joint, ranging from partial to total immobility [1]. Treatment options for AC include both conservative and surgical methods, although there is ongoing debate about the most effective approach [4].

Several conservative treatments are available for managing diabetic FS, such as therapeutic ultrasound, manual therapy, taping, and heat application. Among these, extracorporeal shockwave therapy (ESWT) has emerged as a promising alternative, demonstrating positive effects for various musculoskeletal conditions like Achilles tendinitis [5], plantar fasciitis [6], patellar tendinitis [7], and elbow epicondylitis [8].

Recently, high-intensity laser therapy (HILT) has been introduced as a new tool in physical therapy. HILT uses a 1064 nm wavelength and a high-power laser (3 kW), enabling it to treat larger areas and penetrate deeper into tissues than other laser types [9]. Studies have confirmed its effectiveness in treating musculoskeletal disorders, especially for pain reduction [9, 10]. In the context of frozen shoulder, HILT has shown promise in alleviating pain in the short term [11], and when paired with exercise, it has been found to improve functional activity, ROM, and pain relief both during and after treatment, with even better long-term outcomes [12-14]. Although research on HILT for shoulder disorders is limited, it is gaining preference due to its high effectiveness [11, 15, 16].

While ESWT is widely used for various musculoskeletal issues, its application in frozen shoulder treatment remains relatively rare [17-20], and direct comparisons with other treatments are still lacking. As a result, this study aims to compare the effects of shock wave therapy (SWT) and high-intensity laser therapy (HILT) on a diabetic frozen shoulder.

Materials and Methods

Study design

This is a randomized, single-blinded clinical trial.

Sample size calculation

To calculate the appropriate sample size, the G-Power software (version 3.1.9.4 for Windows) was used. Considering two groups, two measurement points (pre- and post-study), a significance level of 0.05, a power of 0.95, and an effect size (Cohen's f) of 0.41, the required sample size was determined to be 80 participants.

Subjects

Patients with type 2 diabetes mellitus (T2DM) for at least 5 years, along with a diabetic frozen shoulder, were invited to take part in this study. A total of 92 patients from Makkah hospitals were initially screened, and after excluding 8 patients, 84 individuals with T2DM and diabetic frozen shoulder were enrolled **(Figure 1)**.

Patients younger than 40 or older than 60 years, smokers, individuals with significant musculoskeletal issues, cardiovascular or cerebrovascular diseases, a history of physical therapy, cancer, severe cardiac or psychiatric conditions, or those with pacemakers or other conditions that could impact treatment or study results were excluded. All participants met the inclusion criteria, had no disqualifying conditions, and provided informed consent for participation and publication of results. The study protocol was approved by the ethical committee at Umm Al-Qura University (TZHT07123).

Before starting, participants were fully briefed about the study's purpose and asked to maintain their usual diet, medication, and lifestyle throughout the trial. Following medical advice, the 84 participants were randomly divided into two groups using computer-generated numbers: the shock wave therapy group (G1; SWT; n = 41) and the high-intensity laser therapy group (G2; HILT; n = 43).

Outcome measures

Each participant underwent a series of assessments to evaluate key factors related to their condition. The primary parameters that were measured included shoulder function, pain intensity, and range of motion.

To assess shoulder function, the American Shoulder and Elbow Surgeons (ASES) score was used. This standardized tool evaluates functional limitations and pain in the shoulder, with a total score of 100 points. The ASES score includes both a self-evaluation portion for

the patient and a section for the physician to collect demographic data and further details.

Pain intensity was measured using the visual analog scale (VAS), where patients were asked to rate their pain on a scale from 0, indicating no pain, to 10, representing the most severe pain.

Shoulder range of motion (ROM) was measured using a goniometer, specifically for shoulder flexion, with the patient seated. This procedure followed standard guidelines for measuring ROM.

All assessments were conducted before the study commenced (evaluation-1) and again at the study's conclusion (evaluation-2). Data collection adhered to established laboratory protocols for consistency and accuracy.

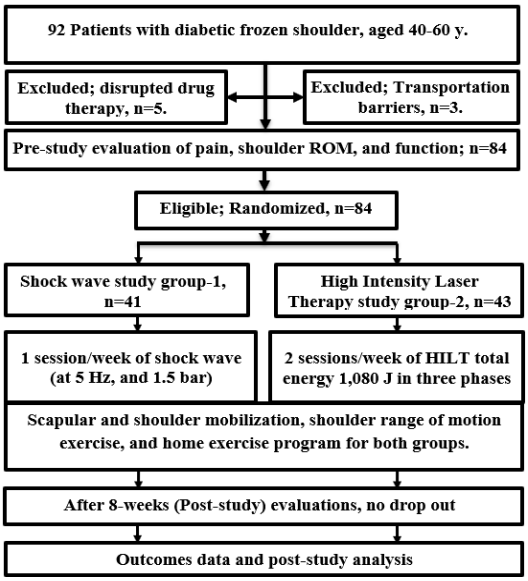

Figure 1. Patients flow chart

Participant assessments

Each participant's physical profile was documented at baseline. Height was measured to the nearest 0.1 cm using a vertical stadiometer (Detectors ProMed® 6129, USA), with the subject standing upright. Body weight was taken using a digital scale, also accurate to 0.1 kg, and calibrated daily with a 50 g standard weight. Body Mass Index (BMI) was calculated using the standard equation: weight in kilograms divided by height in meters squared.

Treatment procedures

Participants followed their assigned treatment plans throughout the intervention period.

Group 1: Shock wave therapy (SWT; n = 41)

Following methods previously described by Kvalvaag *et al.* [21], individuals in the SWT group remained seated for approximately 10 minutes before starting treatment. A conductive gel was applied, and shock waves were administered using the SHOCKMASTER device in a steady, sweeping motion across the soft tissues. Treatment was delivered once weekly for eight weeks, with each session consisting of 2,000 pulses at 5 Hz and 1.5 bar of pressure.

Group 2: High-intensity laser therapy (HILT; n = 43)

Following the protocol of Dundar *et al.* [22], participants in the HILT group also rested for 10 minutes before therapy. HILT was administered via the HIRO 3 device (ASA Laser, Italy), which emits pulsed infrared light at 1,064 nm with a peak power of 3 kW. Each session delivered 1,080 joules of energy in three stages: 500 J applied with a slow-scanning motion to the shoulder joint area, 80 J targeted at eight specific trigger points, and another 500 J applied using a faster scanning mode. Safety glasses were worn by both therapists and patients. Treatment was performed twice a week over the course of eight weeks.

Rehabilitation program (common to both groups)

All participants received the same exercise and mobilization plan from the same physical therapist. This program focused on enhancing shoulder mobility, improving strength, and facilitating scapular function. In addition, patients were given a home-based exercise routine to follow during the intervention period.

Data analysis

Statistical analyses were carried out using SPSS (version 16.0). Descriptive statistics were presented as means and standard deviations. Paired t-tests were used to analyze changes within groups, while independent t-tests compared outcomes between the two groups. A significance threshold of $P < 0.05$ was used throughout.

Results and Discussion

This investigation explored the comparative effectiveness of SWT and HILT on pain relief, shoulder mobility, and functional improvement in patients with diabetic adhesive capsulitis. A total of 84 individuals with type 2 diabetes and frozen shoulder were enrolled and randomly allocated to either the SWT group (G1, n = 41) or the HILT group (G2, n = 43). Key outcome measures—pain (VAS), shoulder flexion (goniometer),

and functional ability (ASES score)—were evaluated before and after the intervention.

Baseline demographics

As shown in **Table 1**, there were no statistically significant differences between the two groups at baseline in terms of age (P = 0.32), weight (P = 0.46), height (P = 0.79), BMI (P = 0.35), blood glucose (P = 0.09), HbA1c (P = 0.38), or diabetes duration (P = 0.43), indicating both groups were comparable before treatment began.

Patient demographics

Table 1 summarizes the baseline demographic data for both treatment groups. No statistically significant differences were observed between the shock wave therapy group (group 1) and the HILT group (group 2) in terms of age, body weight, height, BMI, diabetes duration, random blood glucose, or HbA1c levels (P > 0.05), suggesting a comparable distribution of participants between the two cohorts.

Table 1. Baseline demographic information of participants

Parameter	Group 1 (n = 41) (mean ± SD)	Group 2 (n = 43) (mean ± SD)	F-value	P-value☼
Age (years)	51.46 ± 5.11	52.65 ± 5.65	1.02	0.32**
Weight (kg)	74.52 ± 4.07	73.88 ± 5.9	0.55	0.46**
Height (cm)	168.0 ± 4.0	168.0 ± 1.0	0.80	0.79**
BMI (kg/m²)	26.57 ± 1.77	26.25 ± 1.28	0.88	0.35**
Duration of diabetes (years)	6.27 ± 1.66	6.53 ± 1.40	0.64	0.43**
Random blood glucose (mg/dL)	204.62 ± 20.73	205.03 ± 17.74	0.009	0.09**
HbA1c (%)	8.1 ± 0.11	8.22 ± 0.57	0.78	0.38**

☼Significance level at P < 0.05; *= significant, **= not significant

Effectiveness of interventions

Intra-group comparisons

A statistically significant decline in reported pain levels was observed in both treatment groups following the intervention period. Group 1 showed a 49.38% reduction, while group 2 experienced a 60.09% reduction (P = 0.00). Improvements in shoulder flexion were also significant, with group 1 improving by 25.74% and group 2 by 19.29% (P = 0.00). Functional outcomes, assessed via the ASES score, improved significantly in both groups—group 1 by 96.66% and group 2 by 104.58% (P = 0.00 for both).

Inter-group comparisons

Pre-treatment measurements of pain, shoulder flexion ROM, and ASES scores revealed no significant differences between the two groups (P > 0.05). However, following the interventions, significant differences emerged in pain scores (P = 0.0001) and flexion range of motion (P = 0.04), with HILT showing superior pain relief. The difference in shoulder function was not statistically significant (P = 0.19) **(Table 2)**.

Table 2. Comparison of pre- and post-treatment outcomes within and between groups

Outcome measure	Timing	Group 1 (SWT, n = 41)	Group 2 (HILT, n = 43)	F-value	P-value
Pain (VAS)	Pre-treatment	6.54 ± 1.00	6.63 ± 1.07	0.16	0.69**
	Post-treatment	3.29 ± 0.84	2.63 ± 0.58	17.88	0.0001*
	T, P-values	22.03, 0.00*	29.15, 0.00*		
Shoulder Flexion ROM	Pre-treatment	103.02 ± 11.4	103.14 ± 12.77	0.002	0.97**
	Post-treatment	128.95 ± 10.81	122.77 ± 15.13	4.61	0.04*
	T, P-values	-27.09, 0.00*	-17.89, 0.00*		
ASES Score	Pre-treatment	42.89 ± 12.96	41.50 ± 10.57	0.29	0.59**
	Post-treatment	77.48 ± 9.50	80.62 ± 7.58	2.82	0.19**
	T, P-values	-30.07, 0.00*	-49.45, 0.00*		

Interpretation and literature context

Patients with diabetic frozen shoulder commonly experience pain, stiffness, and difficulty performing daily tasks [17]. This investigation aimed to assess and compare the clinical effects of SWT and HILT on such patients.

Findings from this trial indicated that both therapies contributed positively to pain relief, range of motion, and shoulder functionality. Notably, SWT demonstrated a greater impact on ROM improvements, while HILT provided more substantial pain reduction and enhancement of functional capacity.

These outcomes align with previous studies. For example, Park *et al*. [17] and Kim *et al*. [20] supported the use of ESWT in managing shoulder conditions, citing sustained improvements in pain and motion. The regenerative and anti-inflammatory properties of shock waves are believed to facilitate tissue healing [23, 24], and several researchers [25–30] have confirmed its effectiveness in treating shoulder tendinopathies and rotator cuff issues.

Effectiveness of HILT therapy

Participants receiving high-intensity laser therapy (HILT) exhibited marked improvements in pain reduction, shoulder mobility, and overall function. These findings are consistent with earlier research. Santamato *et al*. [15] demonstrated that HILT was superior to ultrasound therapy in alleviating pain and enhancing joint mobility, muscle strength, and functional capacity of the affected shoulder. Additional studies have supported HILT's efficacy in managing a range of musculoskeletal conditions, confirming its significant analgesic effects [9, 10]. In the context of a frozen shoulder, HILT has shown promising short-term results in pain relief [11]. Furthermore, incorporating HILT with therapeutic exercise has been reported to enhance range of motion, functional performance, and pain relief after six weeks of treatment [12, 13], with these benefits persisting up to four weeks post-treatment [13]. Notably, HILT has also demonstrated sustained therapeutic outcomes during long-term follow-up assessments [14].

Conclusion

Both shock wave therapy (SWT) and high-intensity laser therapy (HILT) were effective in alleviating pain, enhancing shoulder flexion range of motion, and improving overall shoulder function in patients with diabetic frozen shoulder. While SWT was more beneficial in increasing the range of motion, HILT provided superior outcomes in terms of pain relief and functional recovery.

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