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Physiotherapy for the Frozen Shoulder: A Comparative Trial of Ultrasonic and Short-Wave Diathermy Therapies. *

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ABSTRACT

This study intended to evaluate the role of ultrasound therapy versus short-wave diathermy (SWD) in the treatment of women patient with frozen shoulders. A pilot double-blind randomized clinical trial was carried out on 30 patients suffering from frozen shoulders. The intervention included continuous 3 MHz, 1.5 w/cm2 Ultrasound, applied for the first group, and short-wave diathermy with 27.12 MHz was applied for the second group. Pain by visual analog scale (VAS), range of shoulder motion (ROM), and muscle power were assessed at the baseline, after 12 sessions of treatment, and at a 4-week follow-up. A significant effect of both treatments was observed compared to the baseline, ROM, and muscle strength of both biceps was increased during the session and the follow-up. There was a significant difference between the ultrasound and short-wave therapies, where short-wave was more effective in all measurement variables except the flexion index.

Keywords: Frozen shoulder, Ultrasound therapy, short wave diathermy, visual analogue scale (VAS), oxford scale.

1. Introduction

The first recorded description of a frozen shoulder was reported by Duplay in 1872 in his description of a “peri arthritis scapulohumeral” [1], though the term frozen shoulder was first used in 1934 by Codman, who described the common features of a slow onset of pain felt near the insertion of the deltoid muscle, inability to sleep on the affected side, and restriction in both active and passive

elevation and external rotation, yet with a normal radiological appearance [2]. Frozen shoulder is thought to have an incidence of 3%-5% in the general population and up to 20% in those with diabetes [3,4]. Its peak incidence between the ages of 40 and 60 and is rare outside these age groups and in manual workers [5,6], and is slightly more common in women [7]. Further the development of a frozen shoulder is correlated with Dupuytren's disease, hyperthyroidism, and hypothyroidism. There is no evidence in the current literature indicating that the development of a frozen shoulder is correlated with specific sports activities in the physically active population [8].

The pathophysiology of frozen shoulder is not completely clear. A commonly accepted theory is that fibrosis causes thickening of the glenohumeral joint capsule, which becomes tighter [9]. Usually, frozen shoulder involves 3 phases: (I) the painful phase, which usually lasts for 2–9 months and leads to progressive stiffness; (II)the stiffness phase, which usually lasts for 3–9 months, during which the pain gradually subsides but marked stiffness develops in all planes of the shoulder joint; (III) the thawing phase, which usually persists for 12–42 months, during which there is a slow gain in motion and comfort [10, 11].

Several treatments can be used for the frozen shoulder, primarily, a non-surgical treatment is chosen such as physical therapy and supervised home exercises, medical treatment like non-steroidal anti-inflammatory drugs, both oral and intra-articular, are the main agents used [12]. However, when a patient has refractory symptoms after adequate conservative treatment, surgical options can be considered which can include manipulation under anesthesia (MUA), arthroscopic capsular release, and capsular distension [13]. Non-surgical treatments for shoulder pain involve heating the affected shoulder using short-wave or hot-peak methods. The thermal effects are unclear, but they can decrease intermolecular bonding and partially destabilize collagenous tissue, enhancing viscous flow properties. Temperature affects mechanical behavior under tensile stress, increasing extensibility and causing permanent elongation and viscous stress relaxation [14].

The therapeutic effects of Ultrasound are classified as thermal and non-thermal as well. Ultrasonic energy increases molecular motion which in turn, raises tissue temperature and affects tissue in different ways; such as changing nerve conduction velocity and increasing pain threshold, increasing collagen extensibility, increasing local blood flow, and reducing muscle spasm. Nonthermal or mechanical effects of Ultrasound are the result of cavitation and microstreaming that can alter cell membrane permeability and thus facilitate soft tissue healing [15]. The main objective of this pilot

study was to evaluate the effectiveness of therapeutic continuous Ultrasound on pain, function, and ROM of patients suffering from adhesive capsulitis in comparison short-wave diathermy.

2. Material and Methods

2.1. Participants

Thirty women aged 40–60 years, 15 females were referred to the Imam Al-Hassan Al-Mujtaba Hospital - Karbala, Iraq, 10 females from Musayyib Teaching Hospital, and 5 females from Al-Zahra University Educational Clinic in Karbala, Iraq. They had been diagnosed with frozen shoulders regardless of the etiology. The study excluded patients who were heat-sensitive or who had previously received heat therapy.

2.2. Treatment procedures

The study was carried out from November 2022 till April 2023, The participants of the study were divided into two groups 15 women in each. Control group (1) underwent treatment by ultrasound therapy, and group (2) was treated by short-wave diathermy. The participants in the ultrasound and short-wave groups received the respective treatments 3 times per week for 4 weeks. Each treatment session lasted for 20 min. A short-wave diathermy machine (Mega Pulsed Senior 265 EMS, UK) with an operating frequency of 27.12 MHz was used to deliver the treatment. The ultrasound treatment was completed by (Primo Ultra Sound Therapy, UK) with 3 MHz, the subjects were positioned comfortably sitting on a wooden chair with their back and affected arm supported. A pair of disc electrodes were placed on the anterior-posterior aspects of the affected glenohumeral joint, separated by a breadth from the surface of the body. The intensity of the current was adjusted according to the patient's subjective feeling of comfort.

2.3. Outcome measures

The level of shoulder score index by visual analog scale (VAS), the joint's ROM was measured using a standard goniometer, while the muscle power was measured by Oxford scale (degrees 0-5).

2.4. Data analysis

The demographic characteristics of the participants were summarized using the descriptive statistics of frequency, mean, standard deviation, and percentages as appropriate. Data analysis was performed using the software package SPSS version 26. A repeated measures analysis of variance was performed to examine the change in each outcome measure among the treatment groups and

across treatment sessions. the results were presented as mean + standard division, and the level of significance (alpha) was set at 0.05.

3. Results

Table 1 summarizes the distribution of Sociodemographic Characteristics of the Study Sample. This table shows that half of the female patients (15 women) were in the age group of fifty to sixty years, and (33%) were in the age between forty-six to fifty, while the percentage of the patients between forty to forty-five was (5%). Regarding their marital status, half of the patients were married. For the level of education, nearly half of the patients (40%) are illiterate. Table 2 shows that frozen shoulders in most of the patients (70%) were caused by disease diabetes.

Table 1: Sociodemographic characteristics of the studied patients.

	Patients (*n* =30)	
	No	%
Age in years		
40 – 50	15	50
50 - 60	15	50
Marital status		
Married	15	50
Separated	8	27
Widowed	5	17
Single	2	7
Educational level		
Illiterate	12	40
Primary school	5	17
High school	5	17
Graduate	8	27

Table 2: Clinical characteristics of the sample.

	Patients (*n* =30)	
Cause of frozen shoulder	No	%
Diabetes	21	70
Arm fracture	4	16.6
Trauma	3	10
other	2	6.6

By session 12, the pain index in the ultrasound group had decreased by 56.9%, compared with 75.7% in the short wave group (Table 3), the improvement was well maintained or a further improvement

was noted at the 4-week follow-up session. There is a significant difference ($p < 0.001$) between the two groups after physiotherapy. In session 12, the shoulder flexion range had increased by 34.9% in the ultrasound group and 22.9% in the short-wave group (Table 3). A between-groups difference was found ($p < 0.0001$), and the ultrasound therapy was superior in improving the shoulder flexion.

Table 3: Mean and SD of VAS, and Range of Motion for continuous US and short-wave groups at baseline, after treatment, and at follow-up (plus p values for baseline comparison).

	Ultrasound Mean ± SD	Short wave Mean ± SD	p-value (between-group)
Pain			
Baseline	8.2±0.86	8.8±1.15	
Session 12	3.53±1.25	2.133±1.13	0.0001*
4-week follow-up	3.32±0.25	1.98±2.05	
p-value (within-group)			
Flexion index			
Baseline	112.66±24.9	139.66±20.56	
Session 12	152 ±17.4	171.66 ±3.61	0.001*
4-week follow-up	159.12±0.18	177 ±0.67	
p-value (within-group)	0.001‡	0.0001‡	
Abduction			
Baseline	100.66±12.97	100.66±16.24	
Session 12	135.33±22.94	146.66±17.59	0.001*
4-week follow-up	140±0.14	154±0.20	
p-value (within-group)	0.0001‡	0.0001‡	
Internal rotation			
Baseline	64±9.85	66±10.55	
Session 12	78±6.49	83.33±8.99	0.0001*
4-week follow-up	83±0.66	91±1.76	
p-value (within-group)	0.001‡	0.0001‡	
Muscle power			
Baseline	3±0.000	3±0.000	
Session 12	4.2±0.41	4.2±0.41	1
4-week follow-up	4.78±0.87	4.81±0.36	
p-value (within-group)	0.001‡	0.001‡	

‡ Significant differences in mean in each group after treatment, * Significant differences of change in mean between

groups

By session 12, the abduction range of the short-wave therapy group demonstrated a 45.69% cumulative improvement. By contrast, the corresponding figure was only 34.4% for the ultrasound group, The treatment effects were more or less maintained in the ultrasound and short-wave groups in the 4-week follow-up session. At the same time, the short-wave group demonstrated a 26.25% gain in shoulder internal rotation, compared with 21.87% in the ultrasound group. For both abduction and internal rotation measurements there was a significant between-group difference ($p < 0.0001$). The results showed that the short-wave group achieved a greater abduction and internal rotation range than did the ultrasound group.

The muscle power increased progressively over time. By the end of 12 sessions, there was a cumulative increase of 40% in both of ultrasound and short-wave groups. there was no significant between-group difference in muscle power ($p = 1$).

4. Discussion

Our study confirms that symptom onset is most common in the 6th decade. and diabetes is one of the most common reasons for a frozen shoulder. It was reported by DosSantos et al. (2018) that of the 223 patients, 31 (14%) were diabetic, (16.6 %) were caused by Arm fractures, and (10%) of patients suffered from frozen shoulders after trauma, while there is (6.6%) were caused by other reasons. In the current study, both groups improved significantly regarding VAS by a mean difference of 4.67 and 6.67 during the first 12 sessions of treatment and well along by a total mean of 4.88 and 6.82 up until the follow-up in the real Ultrasound and the short-wave groups respectively. In addition, we witnessed a significant increase in the flexion, abduction, and internal rotation range of motion in both groups equally during the first 12 sessions of treatment and up until the follow-up. Also, both groups improved functionally measured by Oxford Shoulder Scale with a mean difference of 29.12 and 26.12 during the treatment sessions and later by a total mean of 1.78 and 1.81 until the follow-up in Ultrasound and short-wave groups correspondingly.

The mechanism of action of physical modalities for alleviation of joint pain is not clear yet. It has been reported that superficial and deep heaters act by raising the temperature of tissues and causing an increase in blood flow. Increased blood flow leads to better tissue perfusion, increased metabolic activity, and muscle relaxation. Low-frequency electrical currents are also thought to induce

endogenous opioid secretion and modulate ascending pain-control pathways [17].

Nazar and Tahir (2020) found that short wave proves to be a better option for treatment than ultrasonic therapy; in relieving aches and increasing the motion range of the shoulder joint. The mean decrease in pain intensity; recorded on VAS for Group A was 4.2 and for Group B was 3.1. The mean increase on the R.O.M scale; in the range of shoulder joints recorded for Group A was 1.5 and for Group B was 1.2. By comparing ultrasonic therapy to sham US, Dogru et al. (2008) noted that ultrasonic gives no relevant benefit in the treatment of Adhesive capsulitis. As well as Balci et al. (2008) mentioned that adding ultrasound treatment to a combination of physical therapy modalities did not provide any additional benefits for the treatment of adhesive capsulitis. Statistical research demonstrated that, when it came to relieving pain by stretching, ultrasonic therapy with the maximum level of mobilization outperformed cryotherapy. It is therefore appropriate to suggest it for the treatment of adhesive capsulitis [23]. According to the results of Uysal et al. (2023) US therapy and high-intensity laser therapy were effective in the improvement of pain, ROM, and functional conditions of patients in the treatment of Adhesive capsulitis (AC), and there was no significant difference between the two groups.

It was reported by Leung and Cheing (2008) that SWD and Hp produced a significant increase in the shoulder score index within the group across the study period. And showed that the SWD group had a greater increase in the shoulder score index than the HP group. In studies on individual cases, high-resolution ultrasound therapy results in pain relief and increased shoulder flexibility in two patients with frozen shoulders [23] pulsed shortwave diathermy treatment helped restore the range of motion after 6 treatments and maintained it for 2 years post-surgery in a 53-year-old patient with adhesive capsulitis [24]. At the same time, the combination of physiotherapy interventions with the modality of Short-Wave Diathermy (SWD) resulted decline in pain, enhancement of joint motion in flexion movement, abduction, exploitation, and endorotation of the left shoulder to active and passive movement, and there was an enhancement of muscle strength on a patient with Frozen Shoulder condition [25].

5. Conclusions:

The present study compared the effectiveness of ultrasound with short waves in combination with the management of a frozen shoulder. Our findings demonstrated that short-wave and ultrasound significantly decreased the shoulder-score index, and increased all of the flexion index, abduction,

Internal rotation, and muscle power. There was a difference between the two therapies where ultrasound produced a significantly greater gain in the ROM of most shoulder movements than did the ultrasound. While short-wave therapy causes higher improvement in abduction and internal rotation. Thus, it is important to address the issue of combining these two therapies in the management of joint disorders such as frozen shoulder.

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