Comparative Effectiveness of Interferential Current and Therapeutic Ultrasound in Treatment of Shoulder Pain

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ABSTRACT

Background and purpose: *Shoulder pain is one of the most common musculoskeletal problems seen in an outpatient setting. The purpose of this study was to evaluate and compare between the effects of interferential current and continuous ultrasound, both applied in addition to hot packs and exercise therapy in treatment of patients with shoulder pain disorders.* ***Subjects:*** *Forty male patients, their age ranged from 39 to 56 years with mean age 47.3± 4.4 years diagnosed as periarticular soft tissue disorder of the shoulder were participated in the study.* ***Methods:*** *subjects were divided randomly and equally into two groups, group (A) that received interferential current, hot packs and exercise therapy, and group (B) that received ultrasound, hot packs and exercise therapy. Pain intensity, shoulder joint (flexion, abduction and external rotation) ROM and functional shoulder activities were measured before and after 8 weeks of treatment program.* ***Results:*** *There were significant improvements of all measuring variables in both groups as compared with their pre-treatment results. Significant differences were observed in the post-treatment results of ultrasound group when compared with the post-treatment results in the interferential group.* ***Conclusion:*** *It can be concluded that both interferential current and therapeutic ultrasound when applied in addition to hot packs and exercise therapy are effective in treatment of shoulder pain, but ultrasound has more efficacy than interferential current.*

Key words: *shoulder pain, Ultrasound, interferential current, periarticular pain, exercise therapy.*

NTRODUCTION

Shoulder pain is a major reason for referral to physical therapy. About 10% of the population suffersfrom one or more of episodes of soft tissue disorders of the shoulder in the course of their life[12]. The main symptoms of soft tissue disorders of the shoulder are pain and functional impairment that limits the ability to perform daily activities and restricts the range of motion[2]. In general, soft tissue impairments and pathologies such as inflammation of the tendons and bursa surrounding the glenohumeral joint are often diagnosed even in patients without a history trauma[27].

The traditional medical approach of these patients includes the use of drugs such as non-steroidal anti-inflammatory drugs (NSAIDs), as well as physiotherapy[30]. Reports of clinical trials on shoulder disorders showed little benefit from NSAIDs and steroid injections[28].

Exercises therapy is considered to be one of the corner stones of physiotherapy for shoulder disorders[13]. In addition, the use of electrotherapy and ultrasound, mainly as adjuvant to exercises therapy, has been reported[11]. Both modalities are supposed to add to the effect of exercises therapy in recovery from soft tissue disorders[23].

Therapeutic ultrasound is one of the most commonly used electro physical agents for the management of musculoskeletal injuries due to its physiological effects and its clinical results[25]. The rational for the use of US in patients with localized inflammatory condition of soft tissue is based on an increase

of temperature of soft tissue with a high density of protein. This temperature increase should result in promotion of cellular metabolic rate, acceleration of tissue repair, and reduction in pain threshold and increase in the range of motion [22, 29]. When US enter the body, it can affect the cells and tissues through thermal and nonthermal mechanisms. Nonthermal effects are claimed to promote healing, increase the rate of cell membrane permeabilities and diffusion, increases in intracellular calcium, and changes the electrical activity of nervous tissue[3].

Reviews of clinical trials on shoulder disorders have shown US to be of little or no clinical benefit in treatment of such cases[24, 30, 32]. Some studies[1, 20], however, have shown US seems to be effective in improving the symptoms of shoulder problems. The contradiction between the two opinions may return to the different methods and US doses, subject selection and also is likely that the underlying pathology in these patients was at various stages of healing.

Interferential current (IFC) is noninvasive, analgesic technique used to relieve pain, reduction of swelling and the restoration of function associated with muscle weakness[16]. IFC is based on the crossing of two different medium-frequency sine waves usually between 4000 and 4100 Hz. The two currents create waves which interfere to produce a beat frequency that is called amplitude modulation[14]. Medium-frequency currents encounter low skin resistance and can therefore, penetrate into the deeper tissues which makes IFC potentially effective in elicit a physiological response that leads to pain relief[17]. The rational for the use of IFC in the treatment of soft tissue disorders is supposed to result in electroanalgesic effects, such as increase in the pain threshold and promotion of muscle relaxation[6].

The purpose of this study was to evaluate and compare between the effects of interferential current and continuous ultrasound, both applied in addition to superficial heat and exercise therapy, for patients with shoulder pain disorders.

SUBJECTS, MATERIALS AND METHODS

Subjects

Forty male patients with soft tissue disorders of the shoulder, their age ranged from 39 to 56 (mean age 47.3 ± 4.4 years), were selected for this study. The study was carried out at outpatient clinic of physiotherapy at Riyadh Medical complex, Riyadh, Saudi Arabia, after confirmed diagnosis by orthopedic surgeon.

The inclusion criteria included

1- patients with shoulder pain and limitation of movement for at least 4 weeks prior to the study to eliminate acute pain that may recover spontaneously).
2- All patients received a clinical evaluation to confirm the diagnosis of shoulder's soft tissue disorders (e.g. supraspinatus tendonitis, subdeltoid bursitis or bicipital tendonitis.
3- patients who are not engaged in drug therapy**.**

The exclusion criteria included

1- Patients with inflammatory arthritis, calcific tendonitis or fracture
2- Absence of underlying neurologic, inflammatory rheumatic disease or referring pain to the shoulder due to cervical spondylosis.

All patients who fulfilled the selection criteria and signed informed consent, were divided randomly and equally into two groups, group A that received interferential current,

hot packs and exercise therapy (IFG), and group B that received continuous ultrasound, hot packs and exercise therapy (USG).

Experimental design. This study was prospective, randomized clinical trial with a 8-week follow-up.

INSTRUMENTATION

A- Instrumentation for evaluation

1- Visual Analoge Scale (VAS), to measure pain intensity.
2- A universal plastic goniometer, to measure shoulder active ROM.
3-Functional assessment questionnaire (FAQ), to measure shoulder functional activities.

B- Instrumentation for treatment

1- Ultrasound machine (Phyaction 190, Uniphy, Netherlands)
2- Aquasonic transmission gel (Aquasonic 100, Parker Laboratories, INC, USA).
3- Interferential machine (Phyaction E, Uniphy, Netherlands).
4- Hot pack (Enraf-Nonius, Netherlands).

PROCEDURES

Prior to assignment to group, all subjects were assessed for pain intensity, active ROM for shoulder (flexion, abduction and external rotation), and functional assessment questionnaire. All subjects were evaluated prior and after 8 weeks of treatment program.

Evaluation procedures

1- Pain intensity was measured using a 10-cm VAS; in which 0 indicated "no pain" and 10 indicated maximum intense pain[34]. Subjects were asked to mark the scale at a point which represents their pain intensity immediately after performance of a standardized reaching task, as reaching a shelf.
2- Active ROM for shoulder flexion, abduction, and external rotation were measured in degrees using a universal plastic goniometer. The subject was placed supine with the thorax firmly relaxed to the table to prevent compensation for shoulder movements.

For shoulder flexion; the tested arm were initially relaxed at the side of the body (0 degrees glenohumeral joint); the tested arm was raised in a sagittal plane (thumb pointing upwards) from 0 to the limit of pain (normal range from 0 to 180º). The flexion angle was formed by aligning the goniometer axis with the acromin process of the scapula, the stationary arm placed along the midaxillary line of the trunk, and the movable arm placed along the lateral longitudinal midline of the humerus.

For shoulder abduction; the tested arm was moved away from the side of the body in a coronal plane (palm pointing forwards) from 0 to the limit of pain (normal range from 0 to 180º). The abduction angle was formed by aligning the goniometer axis on the anterior portion the acromin process of the scapula, the stationary arm placed on the lateral aspect of the anterior surface of the chest, parallel to the midline of the sternum and the movable arm on the anterior aspect of the arm, parallel to midline of the humerus.

For shoulder external rotation; the tested arm was abducted to 90º, and the elbow flexed 90º, with forearm in pronation, and the palm facing the feet. The subject moved actively the affected arm to the end of active range of shoulder external rotation (normal range from 0 to 90º). The external rotation angle was formed by aligning the goniometer with the olecranon process of the ulna, the stationary arm placed perpendicular to the floor, and the

movable arm along the ulnar shaft, directed toward the styloid process of the ulna.

3- Shoulder functional activities were assessed using FAQ, which consists of 9 distinct categories; that reflect the current level of pain and assess limitations in specific shoulder function with general daily activity (Appendix 1). Each section was scored on a scale of 0 to 5, where (5) indicates no pain and limitation at all, to (0) that indicates inability to perform the activity. The scores of all sections were summed with a maximum possible score 45 points representing no limitation in the shoulder. The FAQ showed test-retest reliability in assessing shoulder function[4].

Treatment procedures

After the baseline measurements, subjects were divided randomly and equally into two treatment groups; group "A", who received interferential current, hot packs and exercise therapy and group "B", who received continuous ultrasound, hot packs and exercise therapy. The treatment program consists of three sessions per week for total of 8 weeks.

Superficial heat was applied to the shoulder area using hot packs (60ºC) for 20 minutes.

Interferential current was applied using rubber bipolar plate electrodes (6x8 cm) over the anterior and posterior region of the glenohumeral joint. The current used was sinusoidal biphasic electric current with a carrier frequency of 4000Hz, with an amplitude- modulated frequency of 100Hz. The intensity was set according to the sensory threshold level of each patient, and the treatment time duration was 20 minutes.

Exercises for the shoulder joint included passive and active range of motion for all movements, stretching exercises for the anterior and the posterior shoulder musculature along with the posterior joint capsule, and repetitive low-intensity dynamic exercises with pain free from the involved tissues, the duration of exercises were ranged from 15 to 30 minutes.

Continuous US at a frequency of 1.0 MHz and at intensity of 1.0 w/cm^2 were applied while subject sitting on chair, with his glenohumeral joint in extension placed his arm with the hand supinated in his lap. The treated shoulder was insonated with the use of aquasonic transmission gel, by applying the transducer head ($4cm^2$) over the anterior and superior periarticular region of the glenohumeral joint using slow circular movements for about 10 minutes.

Statistical Analysis

All dependent variables (pain intensity, shoulder "flexion, abduction and external rotation" ROM and FAQ were analyzed pre and post treatment. Difference between pre and post treatment for each dependent variable was analyzed within and between groups using Paired and Independent T-test. The level of significance was set at 0.05 for all tests.

RESULTS

This study included 40 subjects with periarticular shoulder pain; they were divided randomly and equally into two groups, group A (IFG) and group B (USG).

General characteristics of subjects

No statistically differences between age and duration of illness between the two groups (Table-1).

***Table (1): Characteristics of the subjects*.**

	IFG.	USG.
Age (Year) Mean ± SD	47.85 ± 4.18	46.80 ± 4.78
Duration since onset (week) Mean ± SD	13.35 ± 2.97	12.95 ± 2.25

IFG: Interferential group USG: Ultrasound group

Initial comparison between both groups as regards to their pre treatment pain intensity, shoulder (flexion, abduction and external rotation) ROM, and FAQ revealed no significant differences in all variables (P>0.05).

I. Comparison of the pre and post treatment within and between groups

Pain intensity

The mean value of pain intensity in IFG group was decreased from 6.58 ±0.83 pre treatment to 1.53± 0.41 post treatment which was significant (p<0.05). In USG group, it decreased from 6.33±0.70 pre treatment to 0.83±0.20 post treatment which was significant (p< 0.05), table 2. Comparing the post-treatment mean values of pain intensity for IFG and USG revealed significant improvement in the mean value of USG as shown in figure 1.

Table (2): Comparison of the pre and post treatment values of pain intensity within and between the two groups.

		IFG. Mean ±SD	USG. Mean ±SD	P. value between groups
Pain	Pre	6.58 ±0.83	6.33±0.70	0.322*
	Post	1.53± 0.41	0.83±0.20	0.001**
Mean difference		5.05±0.81	5.50±0.80	
P. value within group		p<0.05**	p<0.05**	

IFG: Interferential group USG: Ultrasound group * = Non-significant ** = Significant

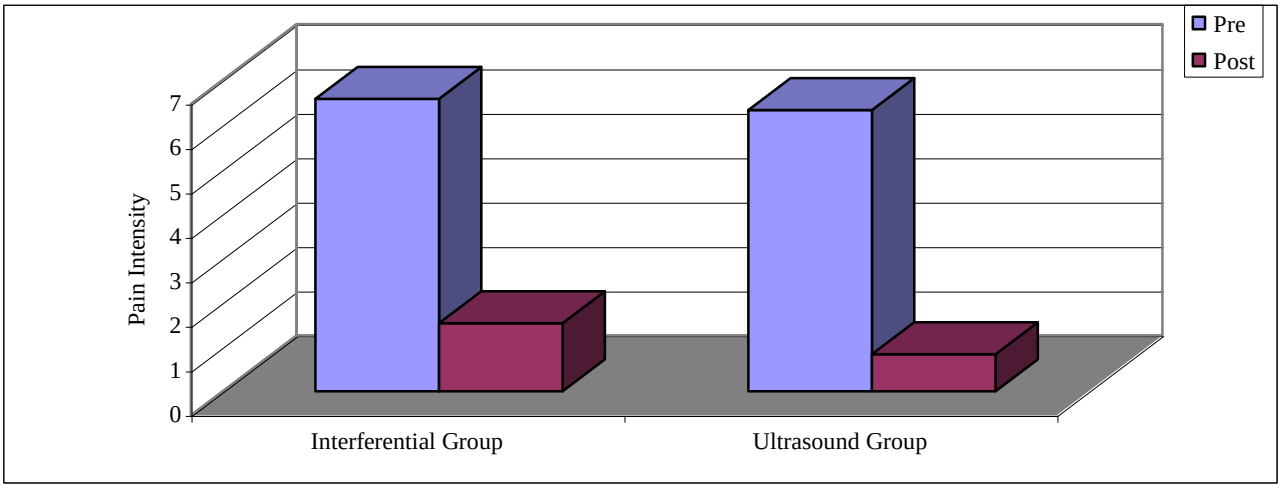

Fig. (1): Comparison of the pre and post treatment values (mean ± standard deviation) of pain intensity in the two groups.

Shoulder joint ROM

The mean values of shoulder flexion, abduction and external rotation ROM in IFG group were increased from 88.65 ± 8.98, 83.90 ± 8.42, and 60.75 ± 6.33 pre-treatment to 137.90 ± 9.62, 129.90 ± 11.47, and 80.70 ± 6.38 post-treatment, respectively which was significant (P<0.05). In USG group, the mean values of shoulder flexion, abduction and external rotation ROM were increased from 87.60 ± 8.62, from 83.75 ± 8.31, and from 61.15 ± 6.07 pre-treatment to 150.00±10.40, 143.15±12.15, and 84.45±7.20, respectively which were highly significant (P<0.05), table 3. Comparing the post-treatment mean values of shoulder flexion, abduction and external rotation ROM for IFG and USG revealed significant improvement in the mean value of USG as shown in figure 2, 3, and 4.

Table (3): Comparison of the pre and post treatment values of shoulder ROM within and between the two groups.

		IFG. Mean ±SD	USG. Mean ±SD	P.value between groups
Flexion	Pre	88.65 ±8.98	87.60±8.62	0.708*
	Post	137.90± 9.62	150.0±10.40	0.001**
Mean difference		49.25±8.53	62.40±10.56	
P. value within group		p<0.05**	p<0.05**	
Abduction	Pre	83.90 ±8.42	83.75±.8.31	0.941*
	Post	129.90± 11.47	143.15±12.15	0.002**
Mean difference		46.00±12.08	59.40±12.17	
P. value within group		p<0.05**	p<0.05**	
Ext. Rot	Pre	60.75 ±6.33	61.15±6.07	0.246*
	Post	80.70± 6.38	84.45±7.20	0.001**
Mean difference		19.95±7.59	23.30±7.39	
P. value within group		p<0.05**	p<0.05**	

IFG: Interferential group USG: Ultrasound group * = Non-significant ** = Significant

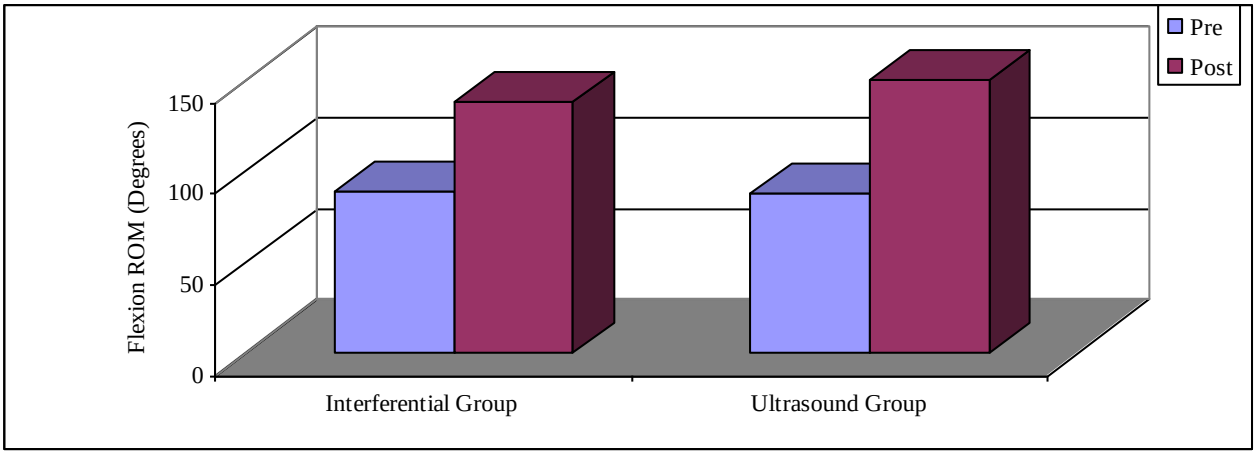

Fig. (2): Comparison of the pre and post treatment values (mean ± standard deviation) of shoulder flexion ROM (degrees) in the two groups.

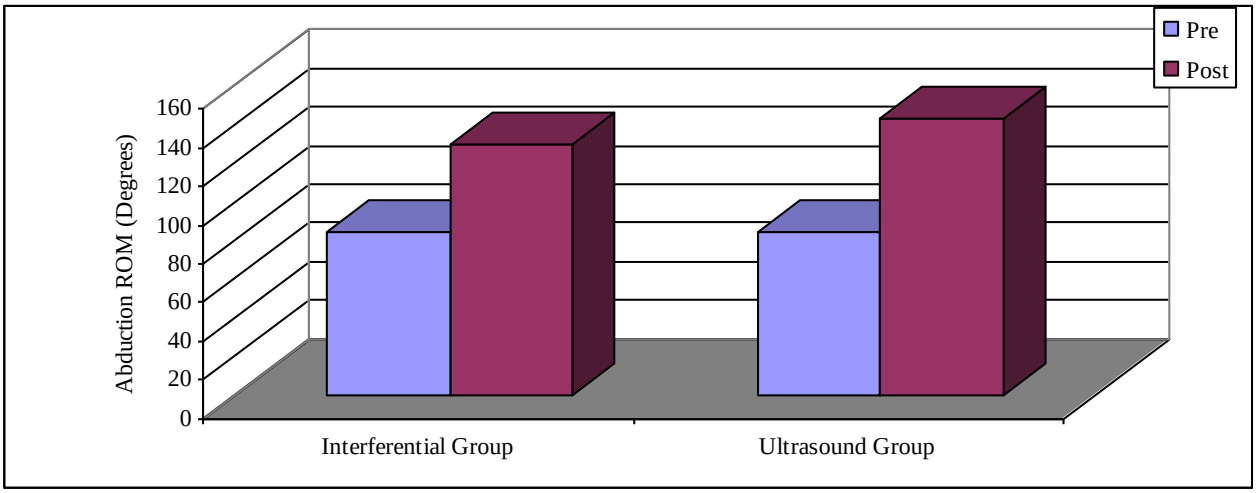

Fig. (3): Comparison of the pre and post treatment values (mean ± standard deviation) of shoulder abduction ROM (degrees) in the two groups.

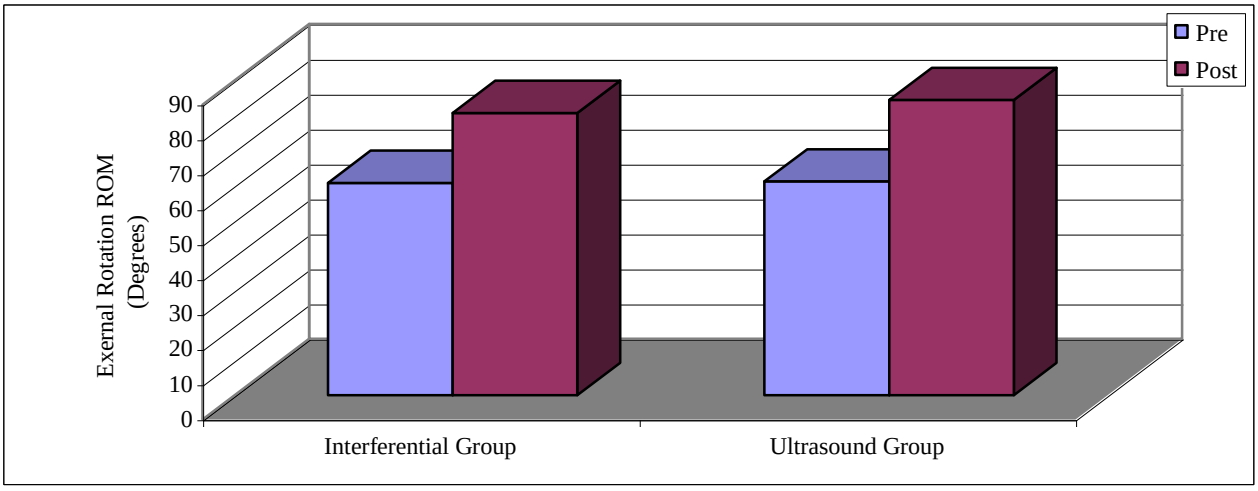

Fig. (4): Comparison of the pre and post treatment values (mean ± standard deviation) of shoulder external rotation (degrees) ROM in the two groups. Ext.Rot: External Rotation.

The Functional assessment Questionnaire (FAQ):

The mean values of FAQ in IFG group were increased from 26.85 ± 5.82 pre-treatment to 37.20 ± 2.01 post treatment, which was significant ($P < 0.05$). In USG group, it increased from 25.95 ± 4.39 pre treatment to 40.75±1.55 post treatment, which was highly significant ($P < 0.05$), table 4.

Comparing the post-treatment mean values of FAQ for IFG and USG revealed significant improvement in the mean value of USG as shown in figure 5.

Table (4): Comparison of the pre and post treatment values of Functional Assessment Questionnaire (FAQ) within and between the two groups.

		IFG. Mean ±SD	USG. Mean ±SD	P.value between groups
FAQ	Pre	26.85 ±5.82	25.95±4.39	0.584*
	Post	37.20± 2.01	40.75±1.55	0.001**
Mean difference		10.35±5.68	14.80±4.81	
P. value within group		p<0.05**	p<0.05**	

IFG: Interferential group USG: Ultrasound group * = Non-significant ** = Significant

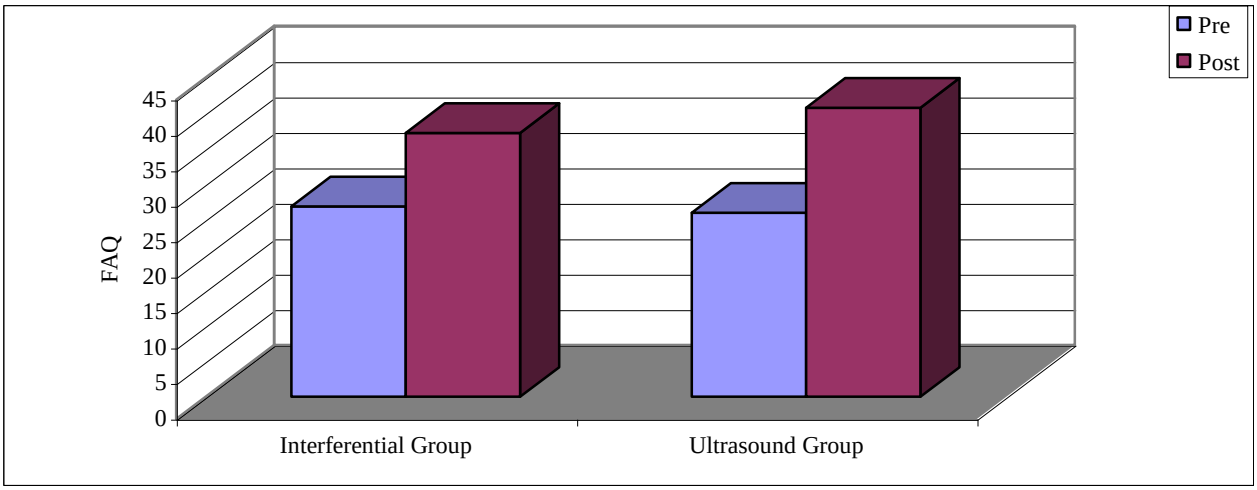

Fig. (5): Comparison of the pre and post treatment values (mean ± standard deviation) of Functional Assessment Questionnaire (FAQ) in the two groups.

II. Correlation between pain intensity and shoulder ROM

Spearman correlation coefficient showed significant strong correlation between pain intensity scores and all shoulder joint (flexion, abduction, and external rotation) ROM in both groups with P<0.05.

DICUSSION

This study was conducted to evaluate and compare between the effects of interferential current and continuous ultrasound, both applied in addition to hot packs and exercise therapy in treatment of patients with shoulder pain disorders. Shoulder pain is a common condition which restricts shoulder motion and limits daily activities, causing disability in general practice[2]. Management of this condition includes the use of analgesics and non-steroidal anti-inflammatory drugs (NSAIDs), steroid injections and thermal modalities, ultrasound and exercises programs[30].

In the management of soft tissue disorders of all joints including the shoulder joints, US has been used to promote healing and regeneration of inflamed tissue, to reduce pain, and to improve ROM[33]. previously published studies have demonstrated that continuous high dose US has been shown to be most effective for increasing tissue temperature, which will increase tissue extensibility and thus facilitate greater gains in ROM[8]. The use of low intensities US ($1.0W/cm^{2)}$, as used in this study, is

recommended to achieve maximum healing rate in inflamed tissue[5].

In a systematic review of randomized clinical trials for patients who received physical therapy for soft tissue disorders of the shoulder, the effects of US were found to be of acceptable methodological quality. However, US did not seem to be effective in placebo-controlled trials and was no better than cold therapy, steroid injection, NSAIDs, acupuncture, or transcutaneous electrical stimulation[30]. In another systematic review, Van der Windt et al[32], showed a lack of sufficient data to support positive results about the effectiveness of US for musculoskeletal disorders, including soft tissue disorders of the shoulder.

Several authors [7,21,29] reported that there were no differences between subjects with soft tissue disorders of the shoulder who received true US and those who received sham US. Studies by other researcher[1, 20], on the other hand, support the efficacy of US therapy in improving pain, activities of daily living, and quality of life. Another study compared the effect of US and TENS along with the cold therapy and exercises in the treatment of shoulder pain, have found that both modalities were effective with better results obtained among patients given US[26]. The effect of pulsed US compared with placebo US in treatment of painful shoulder have concluded the discourage of adding pulsed US therapy with the variables used to the conservative treatment of the painful shoulder. This conclusion can not be generalized in our opinion because the method utilized may have not allow the US from reaching the source of pathology and also patients with other shoulder pain conditions should be examined.

Several reviews have shown the effectiveness of US and electrotherapy for shoulder disorder, but these results seems to be insufficient evidence for their effectiveness. Both modalities are supposed to add to the effect of exercises therapy in recovery from soft tissue disorders including the shoulder joint. This effect is supposed to depend on the adequacy of the applied dose, rather than on the origin and anatomical site of the soft tissue disorders [9,13, 18,30,]

The application of interferential current in conjunction with exercise has been show to have analgesic effects [10,15]**.** It works by stimulating muscle fibers and improve the circulation, thus bringing faster healing of the muscles[34]. During IFC, central inhibition of activity of the sympathetic nerve system and peripheral stimulus habituation[29]. It was reported that beat frequency between 0-150 Hz has supposed to have beneficial effects via decreasing inflammation in and around the joint, which including decreasing pain, decreasing edema, and increasing range of motion[32]. Another study found no effect of IFC on subjects with soft tissue shoulder disorders [29].

Superficial heat in the form of hot packs was used in addition with US in this study, due to its further effects in promoting the healing process in people with soft tissue disorders[19]. The effect of exercises in increasing the ROM was in consistence with other report which demonstrated better outcomes than did subject who received no intervention[11].

The results of this study showed that both IFC and US have beneficial effects in decreasing pain, increasing ROM and improve the functional shoulder activities in treatment of patient with shoulder pain. But ultrasound is more efficacious than interferential when applied in addition to commonly used physical therapy programin.

Conclusion

Based on the results of this study, it can be concluded that both IFC and US are effective, with better results obtained among patients given US more than IFC both applied in addition to heat and exercises, in treatment of shoulder pain conditions.

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Appendix 1. Functional assessment questionnaire categories and examples of descriptive statement for functional category of raising arm overhead

Category	Score	Descriptive statement example for raising arm overhead
1. Overall pain intensity	5	I have no pain raising my arm overhead
2. Raising arm overhead	4	I can raise my arm overhead, but I have mild pain
3. Behind the back activities	3	I can raise my arm overhead, but I move slowly and carefully
4. Reaching across body	2	Pain prevents me from raising my arm overhead with some activities
5. Lifting with affected arm	1	Pain prevents me from raising my arm overhead with most activities
6. Lying on shoulder	0	I cannot raise my arm overhead at all
7. Pushing and pulling		
8.Carrying an object with arm at side		
9. Performance of usual physical activity		

الملخص العربي

مقارنة فاعلية التيار المتداخل والموجات الصوتية العلاجية في علاج ألم الكتف

تهدف الدراسة الحالية إلى تقييم ومقارنة فاعلية التيار المتداخل والموجات الصوتية العلاجية عند إضافتهما مع الكمادات الساخنة والتمرينات العلاجية في علاج اضطرابات ألم الكتف. أشتملت الدراسة على أربعين مريضا من الرجال ممن يعانون من ألم الكتف ومتوسط أعمارهم 47.3 ±4.4 عاما. وقد تم تقسيمهم عشوائيا إلى مجموعتين متساويتين فى العدد تم علاجهم كالتالي: المجموعةالأولى (أ) تم علاجها بالتيارالكهربائى المتداخل بالإضافة إلى الكمادات الساخنة والتمرينات العلاجية والمجموعة الثانية (ب) وتم علاخها بالموجات الصوتية المستمرة بالإضافة إالى الكمادات الساخنة والتمرينات العلاجية بمعدل ثلاث جلسات أسبوعية لمدة ثمانية أسابيع. وقد تم قياس شدة الألم، المدى الحركي لمفصل الكتف واستبيان النشاطات الوظيفية لمفصل الكتف وذلك قبل وبعد البرنامج العلاجي. أظهرت النتائج حدوث تحسن ذو دلالة إحصائية لمتغيرات التجربة في المجموعتين عند مقارنتهما بالنتائج الأولية قبل إجراء البحث. كذلك وجود فروق دات دلالة إحصائية واضحة على نتائج المجموعةالضابطة والتى عولجت بالموجات الصوتية عند مقارنة نتائج العلاج للمجموعتين . يستخلص من نتائج هذا البحث فاعلية كل من التيار المتداخل و الموجات الصوتية العلاجية عند إضافتهما مع الكمادات الساخنة والتمرينات العلاجية في علاج اضطرابات ألم الكتف ولكن تطبيق الموجات الصوتية له تأثير أكثر فاعلية فى العلاج.