Efficacy of Ultrasonic on Heterotopic Ossification of Burned Elbow

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ABSTRACT

Purpose: *the purpose of current study was to investigate the effect of ultrasound on range of motion and pain after heterotopic ossification of elbow joint following thermal burn injury.* ***Methods:*** *Forty patients have been participated in this study. Their age ranged from 20 to 35years old. All patients had thermal burn, with total body surface area ranging from 25 to 55 %, and all of them had deep dermal burn. They were assigned randomly and equally into two groups. Group I (Study group n=20 patients with 26 elbows), they received experimental ultrasound (1MHz, with continuous mode, and average intensity of 1.5W/cm^2 for 10 minutes, per elbow, five days per week, for three months). Group II (Control group n=20, with 24 elbows), they received sham ultrasound. Both groups received active graduated exercises, splinting and superficial heating.* ***Assessment****: assessment of active range of motion of elbow was measured using plurimeter and pain assessment was done through McGill Pain Questionnaire, before treatment and at the ends of treatment.* ***Results:*** *the results showed significant (P<0.05) increased of active range of motion of elbow flexion in the study vs. control group (37.3%vs.27.4%), significant increase of active range of motion of elbow extension (47.55% vs. 15%) for study vs., control group, and significant decreased of pain intensity (29.5%vs.17.2%) for study vs. control group respectively.* ***Conclusion:*** *the results provide evidence that ultrasound therapy is a beneficial when applied on heterotopic ossification in addition to therapeutic exercises, splinting and superficial heating.*
Key wards: *Heterotopic ossification, Burn, Ultrasonic*

INTRODUCTION

Heterotopic ossification (HO) is the formation of new mature lamellar bone in sites outside the normal skeletal structure[1,2].

Heterotopic ossification about the elbow can results from various local or systemic insults including direct injury, trauma to central nervous system, and spinal cord injury, brain injury, burns and genetic disorders[1,3.]

In burned case the skin location is the most common, with formation of plates of variables size that affect the whole thickness of the skin and that may occasions become ulcerated in their central zone[4.]

The para-articular heterotopic ossification can appear as a late complication in patients with burn injury, producing disturbance that range from peri-capsular calcification that resolved spontaneously, to sever situations of heterotopic that might even cause anklylosis of the joint[4.]

The incidence of heterotopic bone formation about the elbow in burned patients ranges from 1 to 35% and is most often deposited from the olecranon to the medical epicondylar region of the humerus in line with medial border of triceps[5,7].

In burned patients, the etiology is not well understood. However many factors considered in its development and include percentage of burn, location of burn, length of bed confinement, associated trauma, time to skin grafting, infections, genetic predisposition and overaggressive physiotherapy[4,5,8,9].

On the other hand heterotopic ossification may adversely affect range of motion of elbow joint and may cause ulnar nerve compression or both that might results in limited self care, and functional independence as well as limitation of vocational activity[8,9].

Furthermore the early clinical presentation of heterotopic ossification includes limitation of active and passive elbow range of motion, local pain and swelling[3,4].

Elbow heterotopic ossification can be prevented in many cases with prophylactic measures. These include chemotherapeutic agents (e.g. diphosponates, and nonsteroidal anti-inflammatory drugs), that has not been proved in the prevention or in the treatment of heterotopic ossification[8].

The second form of prophylaxis is low dose external beam radiation, but evidence for its efficacy is inconclusive[4,10].

The conservative physiotherapy is beneficial for this condition during initial stage, intending to avoid the progress of heterotopic and favor its spontaneous resolution. However there were no controlled studies in literature to support this finding[4,11].

Moreover active and passive exercises, continuous passive motion, dynamic and static splinting, gentle lengthening within limits that will not cause pain to the patients all have been advocated[4].

Ultrasound is used as therapeutic modality for many conditions, its effect in the management of soft tissue disorders found to be of little or no clinical benefit in some studies **[14&15].** However, some studies have shown that the use of ultrasound is effective in improving the symptoms (limited range of motion and pain) of soft tissue disorders[16,17].

Unfortunately little literatures concerning the use of ultrasonic in this problem have been published. Furthermore the results of the study might help the surgeon, physicians and physical therapist to organize a protocol of treatment for patients complaining of heterotopic ossification of burned elbow to decrease pain and increase range of motion.

Therefore the aim of current study was to investigate the effect of ultrasound in conjunction with active range of motion exercises and splinting in post-burn heterotopic ossification of elbow joint.

SUBJECTS, MATERIALS AND METHODS

Subjects

Forty patients from both sexes had been recruited from out-patients' clinic at Om EL Masreen Hospital and participated in this study. Their age ranged from 20 to 35 years old. All patients had thermal burn, with total body surface area ranging from 25 to 55 %, and all of them had deep dermal burn. The mean duration before inclusion in the study was 12 weeks after burn. They were in class IIB, heterotopic ossification, that characterized by limitation of flexion and extension arc of less than 100 degrees [3]. All patients were non diabetic, with absence of underlying osteoportic diseases, arthritis and neurological disorders. They were assigned randomly and equally into two groups. Group I (Study group n=20 patients with 26 elbow), received experimental ultrasound therapy. Group II (Control group n=20, with 24 elbow), received shame ultrasound. Physical and radiological examinations were used to confirm the diagnosis and rule out other conditions. The study design was randomized control trial with pre and post test measurement. The procedure of the study (evaluative and therapeutic) was explained for each patient, who was instructed to assign consent before entering the study.

Instrumentation and Tools

Assessment Instrumentation and Tools

A-McGill pain questionnaire

It was used to quantify three dimensions of pain experience, (sensory, affective, and evaluative).it consists of a list of 78 adjective divided into 20 subclasses. Each subclass contains two to six words and is intended to reflect a specific quality of pain experience.

B- Pluriometer.V.Indinometer

A pluriometer device was used to measure the active ROM of elbow. It is PMW-Type GewZ-NewYork, USA 180 degrees. It consists of a container with a freely moving needle that is counterweighted to keep it in a vertical position. The housing is filled with special oil which lubricates the bearing of axis and dampens the oscillation of the needle-indicator when the instrument is rotated. The housing can be rotated 360 degree. It looks automatically at 90 degrees intervals. The device is held in the middle of metal arm base three cm in length.

Treatment Instrumentation

- Ultrasound device (US-700) manufactured by ITO Co., LTD- Tokyo-Japan. The frequency range was of 1& 3MHz, with pulse, continuous mode and intensity of up to 1.5 W/Cm^2.
- Hot Packs as a source of superficial heating, (Enraf-Nonius), SL90 degree C, type USA.
- Dynamic splint, (thermoplastic splint made in ELG. ARE), screw adjustment.

Procedure

Evaluation procedure

It was performed pre-treatment and at the end of treatment (Post-treatment).

Pain measurement

The McGill pain questionnaire was explained for each patient, each subject was asked to choose no more than one word from each subclass that best describe his / her pain. The evaluation of pain was designed on bases of numerical values of relative intensity of words chosen and the total number of words chosen (the maximum value is 78) as the questionnaire consisted of a list of (78 adjectives). The procedure was repeated three times by the author and anther therapist to insure accuracy of measurements, and the mean value was reported.

Active range of elbow joint

Each patient was instructed to lie in supine position with the arm close to body, forearm was kept in mid-position. The middle point of the pluriometer's arm was fixed in the meeting point of the elbow crease with a line of the lateral aspect of arm and forearm. This point was dotted using greasy pen. Before performing the measurement,the arms of plurimoeter were fixed in its position using elastic strap. Each patient was asked to move his elbow towards his shoulder as possible as he can, then return to original position. Also each patient was instructed to extend his elbow actively as possible as he can. The procedure was repeated by the author three times and other therapist to insure accuracy of measurements and the mean of ROM was recorded. This procedure was performed pre-treatment and at the end of treatment (Post-treatment).

Therapeutic procedure

In the study group (G1); while each patient was sitting on a chair, with his forearm rested on front table. The ultrasonic was set at the 1MHz, with continuous mode, and average intensity of 1.5W/cm^2. After application of aquasonic gel, using slow circular movements, the therapist applied the transducer head over the olecranon to the medical epicondylar region of the humerus in line with medial border of triceps; the treatment duration was 10 minutes[20]. For the patients in sham ultrasonic ;(group two) the device was set to the "Off" mode, the transducer head was applied to the same area using same procedure used for (G1).

The following physical therapy intervention had been advocated for each patient in both groups, after application of ultrasonic.

1- Superficial heating (Hot Packs) for 15 minutes.
2- Active assisted and free range of motion exercises.
3-Dynamic splinting was used to restore elbow range of motion and counteract extension flexion contracture. The patients were instructed to wear these splints for six hours daily and even while they sleep[3]. The duration of exercises was a minimum of 15 minutes. The frequency of physical therapy intervention was 5 days/week for 12 week. All exercises were performed in pain free range.

C- Data analysis

Base line demographic data of both groups were expressed as mean and SD. The student t test for paired measurement was used to detect significant differences within groups, while unpaired t test was use to detect significant difference between both groups. The rate of improvement expressed as percentage. The level of significance was assumed at ($P<0.05\%$) at two tiled test.

RESULTS

The data regarding to patients clinical characteristics that included age, sex duration before inclusion in the study, degrees and cause of burn and percentage of total body surface area, showed no significant differences between the two groups ($P>0.05$).

Results of elbow joint range of motio-

Active ROM of elbow Flexion

As observed in table 1 & demonstrated in fig 1, the mean value of active range of motion of elbow flexion for study group at pretreatment (Pre), was 86.2±6.46 degrees and it significantly (P<0.05) increased to 188.33 ±11.59 degrees at the end of treatment period. As regarding in table 1 & fig 1, the mean value of active range of motion of elbow flexion for control group at pretreatment (Pre), was 86.6±6.34 degrees and it was significantly (P<0.05) increased to 110.33 ±10.6 degrees at the end of treatment. The percentage of improvement was 37.3% vs. 27.4% for study vs. control group respectively.

As observed in table 3& fig 4, there was no significant differences (P>0.05) in the mean value of active range of motion of elbow flexion at pre-treatment (Pre) between study and control group, while there was a significant increase (P<0.05) of active range of motion of elbow flexion at the end of treatment (Post) between study and control group in favor of study group.

Active ROM of elbow Extension

As observed in table 1 &fig 2, the mean value of active range of motion of elbow extension for study group at pretreatment (Pre), was -21.3±8.12 degrees and it was significantly (P<0.05) increased to -11.2 ±5.55 degrees at the end of treatment. As regarding in table 1 & fig 2, the mean value of active range of motion of elbow extension for control group at pretreatment (Pre), was -20±7.55 degrees and it significantly (P<0.05) increased to -17 ±9.41 degrees at the end of treatment. The percentage of improvement was 47.55% vs. 15 % for study vs. control group respectively.

At the other hand, as observed in table 3& fig 5, there was no significant differences (P>0.05) in the mean value of active range of motion of elbow extension at pre-treatment (Pre) between study and control group, while there was a significant differences (P<0.05) of active range of motion of elbow extension at the end of treatment (Post) between study and control group in favor of study group.

Results of pain assessment

As observed in table 2 &fig 3, the mean value of pain intensity for study group at pre-treatment (Pre), was 75.9±12.79 and it significantly (P<0.05) decreased to 53.5 ±13.8 at the end of treatment. As regard to table 2 & fig 3, the mean value of pain intensity for control group at pre-treatment (Pre), was 77.22±15.5 cm and it was significantly (P<0.05) decreased to 64 ±15.17 at the end of treatment (Post). The percentage of improvement was 29.5 % vs. 17.2% for study vs. control group respectively.

Furthermore & as observed in table 4& fig 6, there was no significant differences (P>0.05) in the mean value of pain intensity at pre-treatment (Pre) between study and control group, while there was a significant differences (P<0.05) of pain intensity at the end of treatment (Post) between study and control group in favor of study group.

Table (1): The mean value of elbow ROM before treatment (Pre) and after the end of treatment (Post) for study and control

Statistics	ROM Assessment							
	Flexion				Extension			
	Study Group		Control Group		Study Group		Control Group	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
X	86.2	118.33	86.6	110.33	-21.3	-11.2	-20	-17
±SD	6.46	11.59	6.34	10.6	8.12	5.55	7.55	9.41
T-value	-21.08		-20.09		6.67		3.15	
P-value	0.001		0.001		0.001		0.001	
Level of significant	S		S		S		S	
% of improvement	37.3%		27.4%		47.55%		15%	

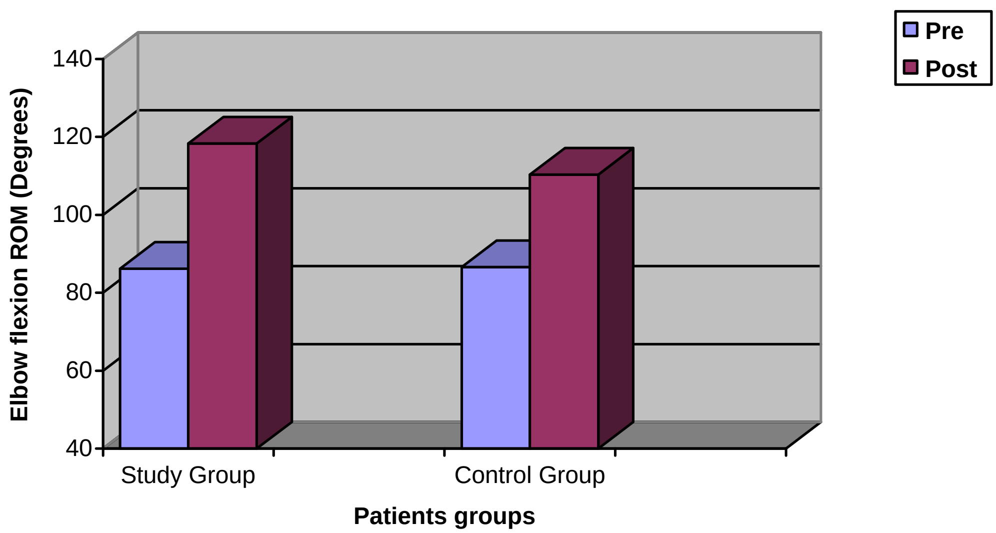

Fig. (1): The mean value of active range of motion of elbow flexion in (degrees) before (Pre), and after the end of treatment (Post) for study and control group.

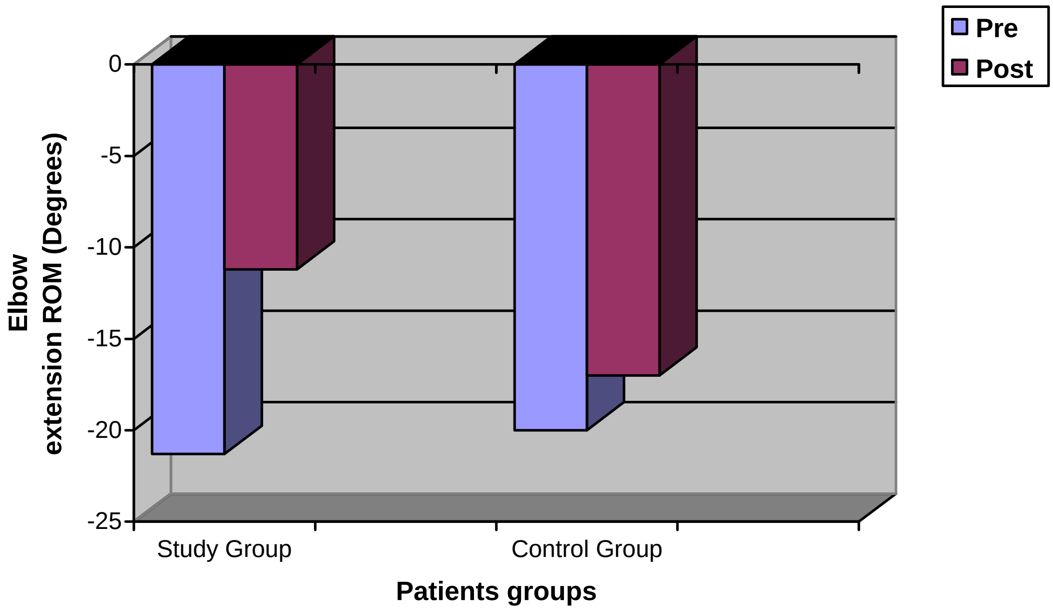

Fig. (2): The mean value of active range of motion of elbow extension in (degrees) before (Pre), and after the end of treatment (Post) for study and control group.

Table (2): The mean value of pain intensity before (Pre) and after the end of treatment for study and control group.

Statistics	Pain Assessment			
	Study group		Control group	
	Pre	Post	Pre	Post
X	75.9	53.5	77.22	64
±SD	12.79	13.8	15.5	15.17
T-value	21.35		2.71	
P-value	0.001		0.014	
Level of significant	S		S	
% of improvement	29.5%		17.2%	

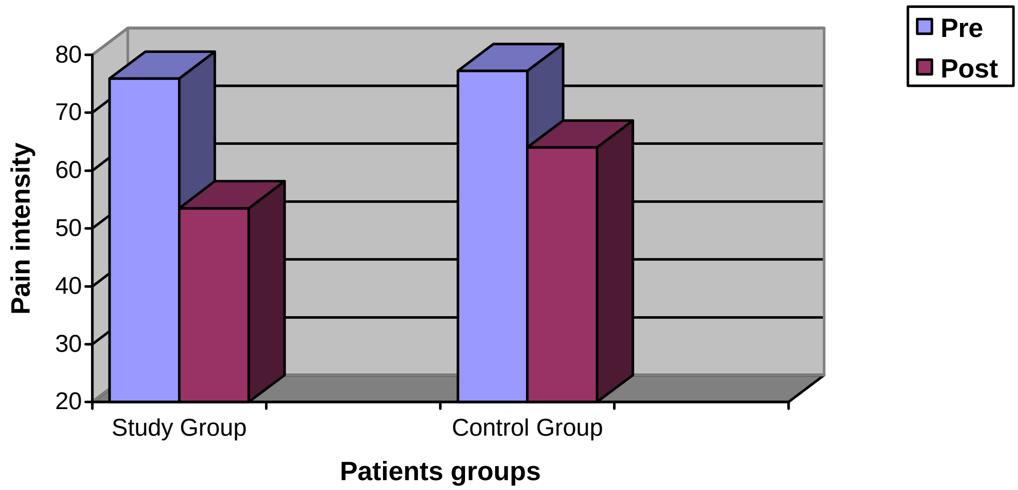

Fig. (3): The mean value of pain intensity before (Pre), and after the end of treatment (Post) for study and control group.

Table (3): The mean value of active elbow ROM assessment before (Pre) & after the end of treatment between study and control group.

Statistics	ROM Assessment							
	Flexion				Extension			
	pre		Post		pre		Post	
	Study	Control	Study	Control	Study	Control	Study	Control
X	86.2	86.6	118.33	110.3	-21.3	-20	-11.2	-17
±SD	6.46	6.34	11.59	10.6	8.12	7.55	5.55	9.41
T-value	-0.17		1.97		0.46		-2.05	
P-value	0.8		0.05		0.6		0.04	
Level of significant	NS		S		NS		S	

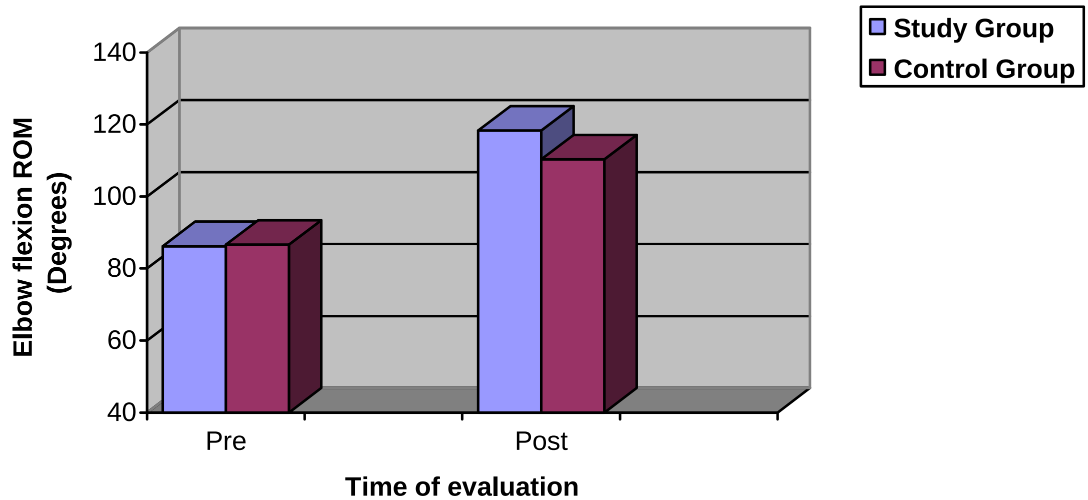

Fig. (4): The mean value of active range of motion of elbow flexion in (degrees) before treatment (Pre), and after treatment (Post) between both groups.

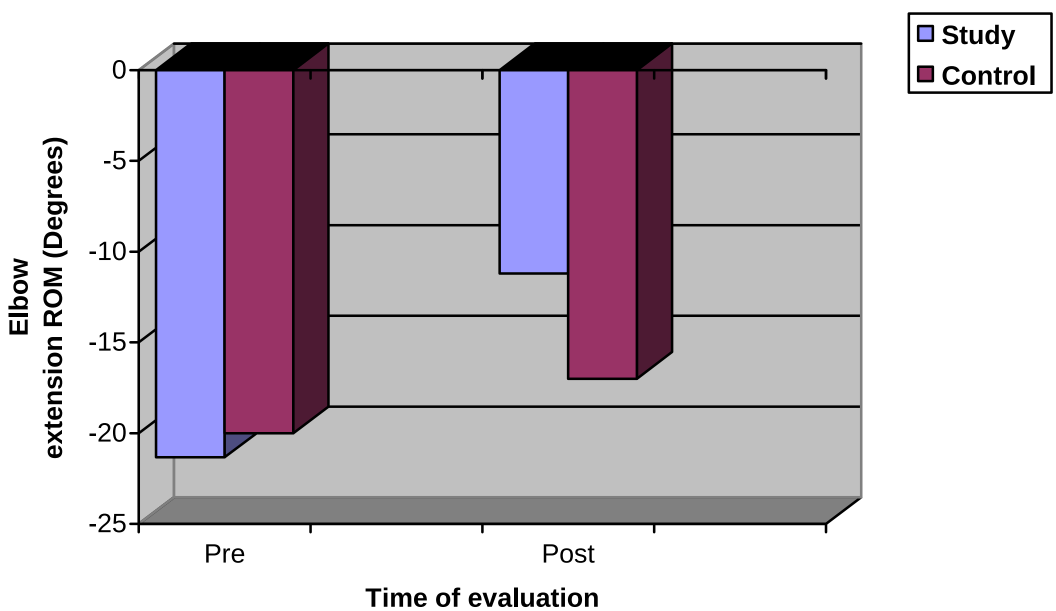

Fig. (5): The mean value of active range of motion of elbow extension in (degrees) before (Pre), and after the end of treatment (Post) for study and control group.

Table (4): The mean value of pain intensity before (Pre) &after the end of treatment between study and control group.

STATISTICS	PAIN ASSESSMENT			
	Pre Treatment		post treatment	
	Study	Control	Study	Control
X	75.9	77.22	53.4	64
±SD	12.79	15.65	13.83	15.17
T-value	-0.25		-3.8	
P-value	0.8		0.001	
Level of significant	NS		S	

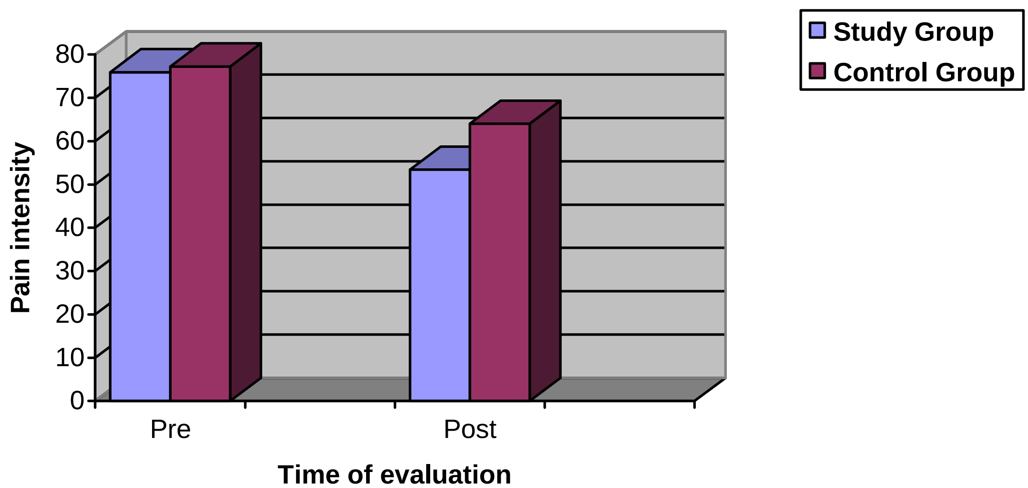

Fig. (6): The mean value of pain intensity before (Pre), and after treatment (Post) for the study and control group.

DISCUSSION

This study was designed to evaluate the efficacy of ultrasound therapy on early phase of rehabilitation of patients with heterotopic ossification of elbow post thermal burn injury.

The ultrasound has been used for more than 30 years for management of soft tissue disorders, the physiological effects of ultrasound include, increased blood flow, vascular permeability, and cell metabolism; enhancement of fibrous tissue extensibility; and muscle relaxation .It also promote healing and regeneration in inflamed tissue, reduce pain and improve range of motion[18,21].

Several authors have reported that there were no differences between subjects with soft tissue disorders who received ultrasonic and those who receive shame ultrasonic on the outcome measured (Pain & range of motion)[14,15,22].

Moreover, it was reported that ultrasonic therapy has no effect on joint range of motion (elbow, and wrist) and pain following thermal burn injury. Despite this result the author recommended the use of ultrasonic therapy in burn care setting and concluded that lack of significant effect of ultrasound may be due to small sample size(10 patients), or short duration of treatment (6session for two weeks)[23].

On the other hand some researchers supported the efficacy of ultrasound therapy in improving pain, range of motion, activities of daily living, and quality of life[16,17,24].

The variation in the parameter of ultrasound therapy (treatment duration, pulse frequency, treatment intensity, and localization of ultrasound application) was not the same in all of the trial cited. This explained the rare of failure and success when using ultrasound therapy.

In this study the frequency of ultrasonic wave was set at 1MHz and intensity of US was $1.5W/Cm^2$ which was similar to that used by many investigators**,** all of them showed significant improvement in pain intensity and range of motion after application of ultrasound therapy[15,16,18] .

This can be explained on the light of the previous researches; that topical ultrasound increase range of motion and decrease pain. It is known that tissue with high collagen contain such as muscles, connective tissues have the ability to absorb a large amount of ultrasound energy that increase tissue temperature, reduce muscle spasm, and enhance relaxation and extensibility of connective tissue. Also it was found that pain threshold has been increased after application of ultrasound[26].

In general the reported physiological effect of ultrasound includes increase soft tissue extensibility, and tissue metabolism, increase blood flow, and cell membrane permeability, increase calcium transport across the cell membrane as well as soft tissue and bone healing, which might help in increase range of motion and decrease ossification of elbow[27].

Furthermore in the present study ultrasonic was applied in addition to use of superficial heat, and exercises therapy as well as splinting.

Moreover, it was observed that patients who received passive and active assisted range of motion to the elbow beyond range of pain – free motion often developed progressive heterotopic bone formation. On contrarily patients who followed program of active exercises within the pain free range gained excellent range of motion[4,19,25].

It was reported a success rate of 40% when following the same conservative treatment of active exercises within the pain free range, while remainder (60%) developed ankylosis requiring surgery[9].

Conclusion

In conclusion, the results of current study showed that there were significant differences ($P<0.05$) in range of motion and pain intensity reduction between the two groups in favoring of the study group in which ultrasound therapy was applied. This provides evidence that ultrasound therapy is beneficial when applied in addition to some commonly used interventions including superficial heating, splinting and exercises therapy.

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الملخص العربى

فاعلية الموجات فوق الصوتية في تكلس العشوائي غير المنتظم لحرق الكوع

الغرض من البحث الحالي تقييم تأثير الموجات فوق الصوتية علي المدي الحركي والألم بعد التكلس العظمي العشوائي غير المنتظم للكوع بعد الحرق اللهبي . أشتملت الدراسة علي أربعين مريض تراوحت أعمارهم ما بين (20-30 سنة)، يعانون من حريق لهبي عميق بمساحة تتراوح ما بين (25 إلي 55%) من مساحة الجسم. وقد تم تقسيمهم عشوائيا إلي مجموعتين متساويتين المجموعة الأولي (مجموعة الدراسة) واشتملت علي عشرين مريضا يعانون من حريق لهبي بالكوع (26 كوعا) وقد تلقوا علاجا بواسطة الموجات فوق الصوتية (1 ميجاهرتز، مستمرة وبمتوسط شدة 1.5 وات/سم2 ، لمدة عشرة دقائق للكوع، خمسة أيام أسبوعيا، لمدة ثلاثة أشهر) المجموعة الثانية (المجموعة الضابطة): وأشتملت علي عشرين مريض يعانون من حرق لهبي بالكوع (24 كوعا) تلقوا علاجا وهميا بواسطة الموجات فوق الصوتية. وقد تلقت المجموعتين تمرينات متدرجة وجبائر، وتسخين سطحي. تم تقيم المدي الحركي للكوع بواسطة البيلرومتير، والألم بواسطة ماكجيل للآلام. وذلك قبل العلاج وبعد الإنتهاء من العلاج . أوضحت النتائج زيادة ذات دلالة احصائية في المد الحركي للثني والفرد الكوع بسبة تحسن (37.3% مقابل 4.27%) للثني (59.9% إلي 41%) للمد للمجموعة الدراسية مقابل المجموعة الضابطة، ونقصلن ذات دلالة إحصائية في شدة الآلام بنسبة 29.5% مقابل 17.2%) للمجموعة الدراسية مقابل المجموعة الضابطة . وقد خلصت الدراسة لوجود فائدة عالية للموجات فوق الصوتية في علاج التكلس العشوائي غير المنتظم بالاضافة إلي التمرينات العلاجية وكذلك الجبائر، والتسخين السطحي لمفصل الكوع .

الكلمات الدالة: (الموجات فوق الصوتية، حرق لهبي، الكوع، تكلس عظمي عشوائي)