Ultrasound Therapy for Reflex Sympathetic Dystrophy

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ABSTRACT

Reflex sympathetic dystrophy (RSD) is a clinical syndrome marked by burning pain, vasomotor changes, edema and decreased functions of the involved limb. If left untreated, it may spontaneously resolve or develop into chronic pain syndrome with muscle and skin atrophy. This study was a trial to treat RSD syndrome of the hand by ultrasound therapy (subaquous technique). Nine of twelve patients responded to a daily low dose US (o.5 watts / cm^2 x 7 minutes) therapy to the carpal tunnel and palmar nerve distribution of the hand. The total duration of treatment was one month. Two of the nine cases had been refractory to more standard therapy for RSD, including pharmacologic agents. All of the included patients preferred a conservative approach to surgical sympathectomy. No complications were observed, and all nine cases revealed a significant improvement of hand function and relieving of pain and other vasomotor disturbances. We hypothesized that US may have affected peripheral sympathetic nerve fibers of the hand. However, more indirect effects of US such as increased blood flow to the involved limb, may be part of the action mechanism as well.

Key words: *Reflex sympathetic dystrophy, neuralgia, ultrasound.*

INTRODUCTION

Reflex sympathetic dystrophy (RSD) is a syndrome generally occurring after trauma or after an operation on an extremity[14]. Although it is usually associated with some type of trauma or peripheral nerve damage, such as seen in the classic causalgia, RSD may also be seen after strokes, myocardial infarctions[20] or it may appear spontaneously. The injury initiating RSD of the upper limb may be a contusion, dislocation or a fracture. In pros pective studies, the incidence of RSD after Colle s fracture varied from 7% to 37%. Carpal tunnel release, tumour resection, arthroscopy, or nail extraction are examples of operations on upper extremity that can induce RSD. Braverman et al.,[3] mentioned that: RSD is a disorder of pain modulation, usually initiated by trauma to a nerve plexus, or soft tissue. It usually affects one limb, but may involve multiple extremities or virtually any part of the body. Also, common injuries that may require immobilization of the elbow may lead to RSD, resulting in a painful restricted limb[25]. As defined by Schutzer and Gossling[22], RSD is an excessive response manifested by four characteristics: intense prolonged pain, vasomotor disturbances, delayed functional recovery and various associated trophic changes.

At present, there is no consensus about the pathophysiology of RSD. As its name indicates, one theory is that the illness is induced by an abnormal reflex of the

orthosympathetic system. However, blockade of the orthosympathetic system is not always an effective treatment[8,21]. For this reason, RSD was recently named complex regional pain syndrome (CRPS)[23]. Also, RSD is the preferred name of Sudeck s atrophy[2]. Sudeck, in 1942[24] introduced the hypothesis that RSD is based on exaggerated inflammatory response to injury or operation. The acute phase of RSD is characterized by classical signs and symptoms of inflammation (edema, increased skin temperature, redness of the skin, limited range of motion and pain). Histologic and scintigraphic studies support this theory[19,27], in which oxygen derived free radicals and / or neuropeptides may play a role[10,26]. RSD should be diagnosed early and treated immediately in order to obtain the best results. Reported treatments include wet compresses[16], battery heated stockings[12], transcutaneous nerve stimulation[4] and systemic steroids[13]. Most often, these treatments are implemented in conjunction with an active physical therapy program that emphasizes range of motion, decreasing edema and active use of the extremity. Surgical treatment of RSD with sympathetic blocks is not easy since the sympathetic ganglia are deep and in adjacent to major blood vessels. Therefore, the patient or physician may wish to take a more conservative or noninvasive approach. Since ultrasound (US) causes blockage of nerve impulses, I hypothesized that if a specific nidus of pain could be found after an injury and the area approximated a peripheral nerve distribution, applying low dose of US to the involved area of the upper limb will decrease nerve impulses and act as peripheral nerve block. This study was designed to investigate the effect of daily administration of low dose subaquous ultrasound therapy to the carpal tunnel and palmar nerve distribution in a selected cases of RSD of the hand.

SUBJECTS AND PROCEDURES

Patients Criteria

Twelve patients (8 women and 4 men), were selected from the outpatient clinic of Kasr El-Eni Hospital. Their age ranged from 21 to 32 years, ($\bar{X}$ 27 ± 42). Most of patients were referred from orthopaedic and general surgery departments. They were diagnosed clinically and radiologically as RSD of the hand according to the following criteria[28]:

1- At least four of the following: Unexplained pain within the hand area; difference in skin color compared with other hand; edema of the affected area; coldness and limited active range of motion.
2- The occurrence of or increase in the above signs and symptoms after the extremity was used.
3- All of the above signs and symptoms present in an area larger than the area of primary injury or operation, including the area distal to the primary injury. These signs and symptoms present at the time of first examination were noted in a fixed patient record file.
4- All the patients suffered from RSD post injury or fracture of the upper limb. They started to complain after clinical and radiological healing of fractures (at least 6 weeks after immobilization period).
5- X-rays of the hand and wrist were normal.

Patients Evaluation

Patients had wrist joint active range of motion (AROM) and functional ability measurements taken prior to and following 2 weeks of US therapy.

Instruments

A standard full circle universal goniometer and goniomertic measurements of functional ability were obtained by the self-report Functional Status Index designed by Jette,[27]. The interviewer recorded the subject s pre US therapy response to the degree of assistance, pain, and difficulty experienced in the performance of activities of daily living concerning the hand (such as writing and opening containers). Three functional status dimensions were recorded: Assistance / dependence (the degree of help or assistance a person needs to perform an activity using a scale of 1 (independent) to 5 (unable or unsafe to do activity) difficulty, (how easy or hard it is to perform an activity using a scale of 1 (no difficulty to 4 (sever difficulty) and pain (the degree of discomfort or sensation of hurting experienced when performing an activity using scale of 1 (no pain) to 4 (sever pain). Overall functional status score equals the sum of the three dimensions scores. Patients evaluation included also a regular recording of radial pulsation and hand temperature (by using electronic surface thermometer). Test techniques and positions established by Norkin and White,[17] were used to obtain degrees of active range of motion (AROM) for the involved wrist joint. The body and 0 180° scale of the goniometer were covered to block the scale from the examiner s vision as the stationary and moving arms were placed on marked bony prominences referenced for wrist joint and to ensure objective measurement by the examiner. Bony prominences were marked with a washable color marker to ensure consistency of measurements within subjects.

Ultra Sound Treatment

Subaqueous US technique had been used: 1) A horizontal plastic bucket was filled with worm water. It was deep enough to allow the hand and forearm to be submerged completely, 2) The transducer was placed into the water and turned on the unit for the prescribed dosage which was identical to the dosage for manual techniques (0.5 - 1 watts / cm^2), 3) The timer was adjusted to 5 to 8 minutes.

Procedure

Daily administration of US therapy was done for one month with regular active exercises for all the joints of the involved limb.

Statistical Analysis

A one-group pre-treatment post treatment evaluation measures was utilized in this study. Analysis of variance (ANOVA test) was conducted to answer the question: Whether subjects engaged in US therapy experienced a change in AROM and / or improvement of hand function over time?

RESULTS

Data obtained from regular assessment of range of motion (ROM) of the wrist joint and pain while functioning the hand were fed into IBM computer. Statistical analysis of these data showed the following: Nine cases responded dramatically to US treatment. There was a significant difference between flexion of wrist (the mean pretherapy range 65.26° and post therapy 73.52°). Also the wrist extension ROM was significantly improved (the mean pretherapy 57.32° and post therapy 80.91°), table (1) and figure (1). Restriction of radial and ulnar deviations were recorded only for 3 cases. These cases showed observable improvement of ulnar deviation with little increasing of radial deviation range.

Table (1): Pre and post therapy active range of motion (AROM) means

Wrist movement	Pre-therapy $\bar{X}$ SD	Post-therapy $\bar{X}$ SD	P
Flexion	65.26 ± 0.44	73.52 ± 0.34	0.530
Extension	57.32 ± 0.56	80.91 ± 0.43	

P: Probability value

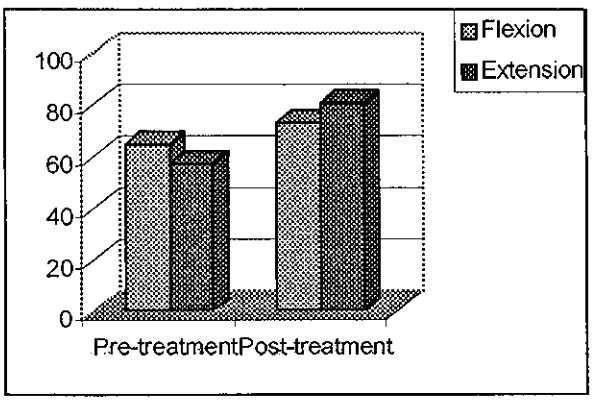

Fig. (1): Pre and post-treatment AROM

There was a fair to good intrarater reliability of the three trials of goniometric measurements taken.

Assessment of hand pain while functioning revealed the following: on a scale of 3 (independent, no pain, no difficulty) to 13 (unable or unsafe to do the activity, sever pain, sever difficulty), there was a significant difference in the groups overall. Pre-therapy and post therapy functional status means ($F_{1,12}$ =6.81, P<0.0251) as shown in table (2). On a scale of 1 to 4 there was also a difference in the pre- and post therapy degree of pain ($F_{1,12}$ =6.41, P<0.0230) and of difficulty ($F_{1,12}$ =7.00, P<0.0324) experienced while performing activities of daily living.

Table (2): Pre-therapy and post- therapy functional status differences

Functional status variable	Pre-therapy $\bar{X}$ SD	Post-therapy $\bar{X}$ SD	P value
Assistance	5.81 ± 0.24	2.41 ± 0.31	< 0.0251
Pain	6.41 ± 0.32	2.81 ± 0.41	< 0.0230
Difficulty	7.00 ± 0.41	2.73 ± 0.33	< 0.0324
Function status	6.81 ± 0.51	7.94 ± 2.55	< 0.0251

There was also a significant improvement of hand temperature post US therapy as shown in table (3) and figure (2).

Table (3): The effect of US therapy on skin temperature of the hand.

	Mean	SD	P
Pre-treatment	21.53	0.67	< 0.05
Post-treatment	28.31	1.40	

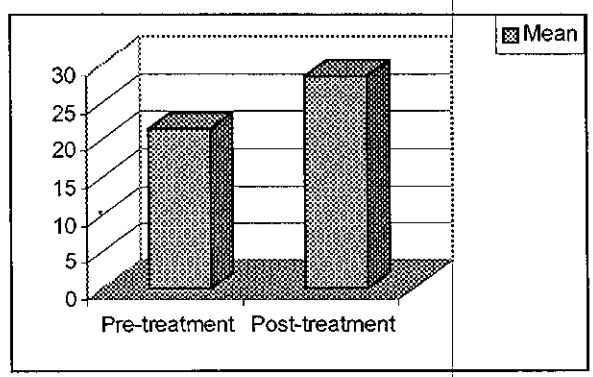

Fig. (2) Pre and post treatment skin temperature differences

DISCUSSION

The different methods for treating RSD are sympathetic blocks, intravenous resperine and surgical interference. Most of cases searching for other noninvasive alternatives. So in this study, ultrasound therapy was tried to treat such cases especially those who failed to find relief with other more conventional therapeutic regimens. Treatment was based on nerve block. If US applied to the sympathetic

ganglia the sympathetic activity will be decreased and if the sympathetic ganglia were inaccessible to the effect of US, I questioned whether US would work in a fairly exposed peripheral nerve (median nerve). Since small diameter sympathetic fibers were thought to be more sensitive to the effects of the US, I administrated a small dose.

Other physiological effects of US should not be overlooked. Heating involved structures with compensatory vasodilatation has been known to be helpful in some cases[12], as the vascular response may decrease pain. It is also known that US can decrease nerve impulse propagation. Therefore, another effect of blocking or decreasing afferent impulses to either C or small A delta fibers may contribute to decreased pain. This decrease in pain allows greater improving of the extremity function. These effects were significantly recorded in this study. Increased use of the involved hand has been shown to help in RSD treatment. In a clinical notes by Portwood et al.,[19], they reported that three cases of RSD of lower extremity responded dramatically to US therapy. Also, the authors mentioned that whatever the underlying mechanism, the three patients noted the first significant decrease in pain after initiation of US therapy.

CONCLUSION

In this study, it may be concluded that application of low-dose US to the definit site of pain in a cases of RSD can be considered in order not to subject patients to more invasive procedures. Although it is time-consuming form of treatment, low-dose US is an effective and safe treatment modality with no complications noted in our patients.

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الملخص العربي

استخدام الموجات فوق الصوتية في علاج الاضطرابات المنعكسة عن إصابة العصب الثمباثاوى

استهدفت هذه الدراسة جدوى استخدام الموجات فوق الصوتية في علاج الاضطرابات المنعكسة عن إصابة العصب الثمباثاوى الطرفي لليد والناتجة عن بعض الإصابات والكسور التي تصيب الطرف العلوي للجسم . ولقد اشتملت الدراسة على ١٢ حالة (٨ سيدات و ٤ ذكور) تم تشخيصهم إكلينيكيا بواسطة الجراح أو طبيب العظام حيث تم تقيمهم لتحديد مدى إمكانية الاستفادة من هذا العلاج. ولقد تم علاجهم يومياً باستخدام الموجات فوق الصوتية تحت الماء وبجرعات منخفضة تركزت على منطقة اليد والرسغ ولقد استمر العلاج لمدة شهر واحد بالتوازي مع التمارين العلاجية أثناء الجلسات وبالمنزل ولقد أثبتت النتائج تحسن نسبة كبيرة من المرضى كما تحسن الأداء الوظيفي لليد في أنشطة الحياة اليومية كما قلت أيضا شكوى المرضى من الآلام المصاحبة للحالة بنسبة كبيرة مما يفيد إمكانية استخدام الموجات فوق الصوتية كوسيلة أساسيه وحديثة لعلاج الاضطرابات المنعكسة عن إصابة العصب الثمباثاوى.