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ORIGINAL ARTICLE

Effectiveness of Electromagnetic Field Therapy in Upper Extremity Complex Regional Pain Syndrome Type I: a randomized controlled study

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Purpose: The aim of this study was to investigate effectiveness of electromagnetic field therapy (EMFT) on pain, kinesiophobia and functionality in individuals with upper extremity Complex Regional Pain Syndrome Type-1 (CRPS-1).
Methods: Forty-two individuals were randomly assigned into either EMFT (N=21) or placebo EMFT (p-EMFT) (N=21) groups. There was no statistical difference between the groups in terms of the demographic and clinical characteristics of the cases at the baseline. The EMFT group was treated with 100 Gauss intensity and 50 Hz frequency and p-EMFT group received placebo treatment with same device being turned off. The treatment was applied 60 minutes, once a day, five times a week, for 6 weeks. Physiotherapy program including stretching and range of motion (ROM) exercises were applied for both groups. Pain (visual analogue scale (VAS)), ROM (goniometer and fingertip-to-distal palmar crease distance), kinesiophobia (Tampa scale of kinesiophobia), grip strength (hand dynamometer), edema (figure-of-eight method), and functional ability (Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) scale) were assessed.
Results: Significant improvements were observed in all outcome variables ($p<0.05$) in both groups. However these improvements were found to be significantly greater in EMFT group regarding pain, wrist flexion-ROM, wrist extension-ROM, fingertip-to-distal palmar crease distance, Tampa Scale of Kinesiophobia, grip strength, edema, and Q-DASH ($p<0.05$).
Conclusions: EMFT may use as a treatment option to reduce pain, kinesiophobia and edema, and to improve functional ability, grip strength and ROM in treatment of CRPS-1.
Keywords: Magnetic field therapy, Reflex sympathetic dystrophy, Pain, Range of motion.

Tip I kompleks bölgesel ağrı sendromunda elektromanyetik alan tedavisinin etkinliği: rastgele kontrollü çalışma

Amaç: Bu çalışmanın amacı, elektromanyetik alan terapisinin (EAT) üst ekstremite Tip 1 Kompleks Bölgesel Ağrı Sendromu (KBAS-1) olan bireylerde ağrı, kinezyofobi ve fonksiyonellik üzerine etkinliğini araştırmaktı.
Yöntemler: Kırk iki birey randomize olarak EAT (N=21) veya plasebo EAT (p-EAT) (N=21) gruplarına dahil edildi. Çalışmanın başlangıcında bireylerin demografik ve klinik özellikleri açısından gruplar arasında fark tespit edilmedi. EAT grubu 100 Gauss yoğunluğu ve 50 Hz frekansı ve p-EAT grubu aynı cihazla ancak cihaz kapalı olarak plasebo tedavisi ile tedavi edildi. Tedavi, 6 hafta boyunca haftada 5 kez, günde bir kez 60 dakika uygulandı. Her iki gruba germe ve eklem hareket açıklığı (EHA) egzersizlerini içeren fizyoterapi programı uygulandı. Ağrı görsel analog skala (GAS) ile , EHA gonyometre ve parmak ucu-distal palmar kıvrım arasındaki mesafe ile, kinezyofobi Tampa kinezyofobi ölçeği ile, kavrama kuvveti el dinamometresi ile, ödem sekiz şekilli yöntem ile ve fonksiyonel beceriler ise ve kol omuz ve el sorunları anketi-hızlı (Q-DASH) formu ile değerlendirildi.
Bulgular: Her iki grupta da tüm sonuç değişkenlerinde anlamlı gelişmeler gözlendi ($p<0,05$). Ancak bu gelişmeler EAT grubunda ağrı GAS, el bileği fleksiyon-EHA, el bileği ekstansiyon-EHA, parmak ucu-distal palmar kıvrım mesafesi, Tampa kinezyofobi ölçeği, kavrama kuvveti, ödem ve Q-DASH açısından anlamlı derecede daha yüksek olduğu bulundu ($p<0,05$).
Tartışma: KBAS-1'in tedavisinde, ağrı, kinezyofobi ve ödemi azaltmak ve fonksiyonel becerileri, kavrama kuvvetini ve eklem hareket açıklığını artırmak için EAT kullanılabilir.
Anahtar kelimeler: Manyetik alan tedavisi, Refleks sempatik distrofi, Ağrı, Eklem hareket açıklığı.

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Complex Regional Pain Syndrome Type-1 (CRPS-1) is a severe medical condition characterized by pain, edema, sensorial disturbances, trophic, autonomic and motor abnormalities.[1] Also, this syndrome is an uncomfortable and incapacitating condition which is difficult to treat effectively.[1,2] Due to the differences in symptoms of this syndrome and lack of a full understanding of the pathologic mechanisms of CRPS-1, various treatment options have been developed to treat this condition.[2]

Harden et al. published a guideline and provided interdisciplinary working system for the management of CRPS-1.[3] But there is not any agreement about the treatment options for CRPS-1. Although various therapeutic approaches, including physiotherapy and rehabilitation, surgical procedures, psychotherapy, neurostimulation and occupational therapy in addition to a hundred different drugs, valid evidence of clinical efficacy exists only for a few of them.[3,4]

Evidence-based physiotherapy is being increasingly used for management and treatment of CRPS-1. Initially, these physiotherapy programs aim to decrease pain, skin temperature and limb volume, and to increase active mobility.[4,5] Many authors claim that physiotherapy is one of the most important components of CRPS-I treatment.[4] These physiotherapy programs include various techniques or applications such as exercise, electrotherapeutic modalities, electromagnetic field therapy (EMFT), massage, ultrasound, splinting, biofeedback, etc.[4-6] EMFT is a method that can be used for various conditions such as fractures, some cognitive problems, inflammatory problems, tissue injuries.[7,8] EMFT methods are often used in order to decrease pain and edema in strain and contusion injuries, as well as wound healing.[9] In a study conducted by Durmus et al., the effects of EMFT were compared to the ones of placebo EMFT (p-EMFT). As a result of the study, improvements were reported in both groups in terms of pain and edema following the treatment, but there was no difference between the two groups.[7] Moreover, another study demonstrated that application of EMFT along with physiotherapy agents reduced pain and edema in patients with CRPS-1.[4]

Considering the above-mentioned studies; effectiveness of electromagnetic field therapy in individuals with complex regional pain syndrome type-1 is not fully understood and remains to be unclear. Therefore, in this study, it was hypothesized that electromagnetic field therapy will help treat complex regional pain syndrome by not only reducing pain and kinesiophobia, but also increasing hand function. The main aim of this study was to investigate the effects of electromagnetic field therapy on pain, range of motion, edema, kinesiophobia, functional ability and grip strength in complex regional pain syndrome type-1. Moreover, this study compared these effects to the effects of placebo electromagnetic field therapy in CRPS-1.

METHODS

Participants

The patients who were diagnosed with CRPS-1 by a physical medicine specialist from Ahi Evran University Traininig and Resarch Hospital, according to the criteria determined by "Commitee on Taxonomy of chronic pain conditions of the International Association for the Study of Pain" were included in this study.[10] The inclusion criteria were; being diagnosed with CRPS-1, being volunteer to participate in the study, having had anupper extremity trauma causing CRPS-1, and being inacute phase of CRPS-1. Participants who were pregnant or in menopausal state, had malignant or infectious diseases, used pacemakers, had previously recieved treatment related to CRPS-1, were under 18 or over 64 years of age, had contraindictions for physical agents, and suffered neurological abnormalites not related to CRPS-1 were excluded. Written informed consent was obtained from each participant in accordance with the guidelines approved by the local ethical committee (2014-151) and the Declaration of Human Rights, Helsinki.

Design and randomization

This study was a randomized, single-blinded and placebo-controlled trial conducted between September 2014 and February 2016. Randomization was carried out using the sealed envelope system.[11] Each participant picked up one of the 46 prepared envelopes that contained a card in a specific color. They were

placed in either EMFT or p-EMFT group depending on the color of the card inside their envelope. After the groups were formed, an experienced physiotherapist who did not take part in the rest of the study applied the EMFT interventions as he was instructed by the researchers about the interventions without being informed about randomization of the participants. Assessments and evaluations, however, were done both at baseline and at the end of the training by same researcher.

Intervention

All individuals took the same medications including nonsteroidal anti-inflammatory drugs and/or analgesics. The adjuvant treatments such as corticosteroids, free radical scavengers, peripheral vasodilatators, however, were not used.[4]

The EMFT (MG WAVE Magnetotherapy, Via Canapa, Italy) was applied with the following parameters: 100 Gauss intensity and 50 Hz frequency, 60 minutes, once a day, five times a week, for 6 weeks (total of 30 sessions). Participants were asked to lie down in supine and their affected extremity was placed within a "sliding coil" electrode.

In p-EMFT application; the very same position of the patients and electrodes were used. However, the device was switched off. So, everything was the same as the EMFT application, except for the fact that the device did not supply current. Additionally; the same exercise program was applied in both groups.

This exercise program included gentle stretching for wrist (flexion, extension, radial and ulnar deviation) and fingers (flexion and extension). For the first two weeks passive, for the third and fourth weeks active-assistive, and for the last two weeks active daily range of motion (ROM) exercises for wrist (flexion, extension, radial and ulnar deviation) and fingers (flexion and extension) were administered. Individual dose of the exercises was limited to the pain threshold. These exercises were scheduled in 3 sets of 10 repeats and were performed for 30 treatment sessions after the application of EMFT or p-EMFT.[2] Meanwhile, instructions and informative explanations were given to the patients during each treatment session.[4]

Outcome Measures

Pain, kinesiophobia and functional skills were assessed as the primary outcomes of this study. The secondary outcomes of this study were wrist flexion and extension ROM, fingertip-to-distal palmar crease distance (FT-PCD), edema, and grip strength. All evaluations were done by the same researcher both at the beginning and end of the study in the same conditions (the same day, hour and place).

Assessment of pain using visual analogue scale (VAS) ranging from 0-10 appears to have fairly consistent interpretation across disease states. Participants were asked to mark the average pain they felt in the affected hand over the past week on a 10 cm scale anchored by 'none' to 'extreme'.[12,13]

ROM was evaluated using wrist flexion and extension ROM and FT-PCD method. ROM of wrist flexion and extension was evaluated using a hand goniometer.[14] Distance between the third finger tip and the distal palmar crease was measured with ruler and recorded.[15]

The figure-of-eight method was used for the assessment of edema. Patient's arm was supported on a table with the forearm in pronation, and wrist and fingers in neutral position. The measurements were taken using a 5 mm tape measure passing around the hand. The measurement started with the tape placed on the distal head of the ulna on the dorsal side. The tape passed across the anterior surface of the wrist just distal to the styloid process of radius. It continued diagonally across the dorsum of the hand with the distal end of the tape aligned over the fifth metacarpal phalangeal joint. The tape passed across the palmar surface of the hand with the distal end of the tape resting along the metacarpal phalangeal joint crease. The tape continued around the second metacarpal head and was placed diagonally across the dorsum of the hand back to the start point. The measurement results were recorded in centimeter.[16-18]

Kinesiophobia is evaluated using the Turkish version of Tampa Scale of Kinesiophobia (TSK). Reliability and validity of this scale have already been demonstrated. Each item on the scale is scored using a 4-point scale (1: strongly disagree; 4: strongly agree). Final score ranges between 17 and 68 points, and higher scores indicate greater perceived kinesiophobia.[19,20]

Quick-Disabilities of the Arm, Shoulder and Hand (Q-DASH) Scale was used to determine the functional ability of the patients. Q-DASH is a self-administered questionnaire that assesses the physical function and symptoms of patients with upper extremity impairments. At least 10 out of 11 items should be answered in order to calculate a Q-DASH score. The questionnaire uses a 5-choice response scale for each subscale and the total score is calculated from the sum of the subscores (0=no disability, 100=most severe disability).[21,22]

Jamar Dynamometer (Lafayette Instrument, Model 7498-05, USA) was used to measure the grip strength. Measurements were taken with the patient in sitting position with the elbow at 90° of flexion, and the forearm and wrist in neutral position. The average of 3 measurements was calculated and used in the analysis. Grip strength was considered as "0" in patients who could not grip the Jamar dynamometer in any evaluation. The measurement results were recorded in kg.[23]

Required Sample Size

Previous literature examining the effect of physiotherapy and rehabilitation program on CRPS-1 was investigated.[6,7,24] The reports indicated a large effect size (0.71-1.19). Therefore, with a statistically significant level of 5% (p=0.05), a statistical power of 80%, and an effect size of 0.8, a minimum of 21 participants were required per group. Considering the drop-out rate of 10%, 23 patients were recruited into the study.

Statistical analysis

Statistical analyses were carried out using IBM SPSS version 20.0 (IBM Corporation, Armonk, NY) software. Before the analysis, the Shapiro-Wilk test was used to detect the normal distribution of data. As all data of our study were normally distributed, parametric tests were used. Baseline characteristics of the cases were analyzed using t test for continuous variables and Chi-square analysis for qualitative data. Meanwhile, categorical data were recorded as percentages (%). The differences in dependent variables at baseline and after the treatment were analyzed with a two way repeated measure of analysis of variance (ANOVA) to assess the overall group as well as time and groups interaction effects. Pair wise comparisons were conducted to investigate the difference between the baseline and after treatment periods. Effect size (ES) of 0.2, 0.5, 0.8 was considered small, moderate and large, respectively.[25] The threshold for statistical significance was set at $p<0.05$.[24]

RESULTS

The study population of 42 patients included 21 patients (12 female, 9 male) in EMFT group and 21 patients (11 female, 10 male) in p-EMFT group. All patients successfully completed the whole treatment program. The mean ages were 36.2±8.54 years in EMFT group, and 34.4±7.45 years in p-EMFT group. The demographic characteristics of the patients are given in Table 1. There were no statistically significant differences between the two groups in terms of age (p=0.124), body mass index (p=0.095), gender (p=0.892), dominant hand (p=0.875), affected side (p=0.584), causes of CRPS-1(p>0.05), and duration of disease (p=0.285).

Out of the all outcome measured analyzed with "Two-way repeated measures ANOVA", only TSK scores were found to have statistically significant changes (p<0.001). When the differences between the two groups were examined in terms of TSK scores, it was found that following the treatments there were significant changes in the EMFT group compared to the p-EMFT group (p <0.001) (Table 2).Statistically significant changes were found in all outcome measures at the end of treatment in both EMFT and p-EMFT groups (p<0.05). TSK score was the only outcome measure that showed no significant changes in the p-EMFT group after the treatment. In addition, when the efficacy of the treatment was examined, it was found that the EMFT group had a larger "effect size" in all outcome measures (Table 3).

DISCUSSION

Present study compared the effects of EMFT and p-EMFT in a randomized single-blinded placebo controlled trial. Although significant improvements were found in both groups, the EMFT group showed better results than the p-EMFT group on all outcome measures, including pain, active wrist and

finger motions, swelling, fear of movement, upper limb function and strength.

The most common symptoms of CRPS-1 are pain, hyperalgesia, edema, and contracture; although the underlying cause is still unclear.[26] Due to pain, movements of the affected limb might get difficult and joint stiffness may occur gradually. Sudomotor and vasomotor changes can lead to edema and changes in the skin color.[27] Because of the incomplete understanding of the cause of CRPS-1, many different treatment techniques are suggested[5] such as EMFT. However, there are few rigorous studies describing the effectiveness of EMFT in CRPS-1.

In a parallel group, single-blinded, randomized controlled trial study designed by Durmus et al, while EMFT, stretching exercises and calcitonin were applied to the first group; p-EMFT, stretching exercises and calcitonin were applied to the second group.[7] Comparing pre and post-treatment results showed that in both groups, there were significant differences in terms of resting pain, activity pain and ROM. However, there was no statistically significant difference between the post-treatment results of the two groups in terms of resting pain, activity pain and ROM after treatment. Lukovic et al. included 36 cases in their study designed as prospective single blind case series. After applying their treatment program consisting of EMFT, exercise, and electrotherapy, they reported a decrease in pain and improvement in ROM.[4] To the best of our knowledge, there are only the two above-mentioned studies in the literature that investigate the application of EMFT in CRPS-1.[5,9] Among these two, the study of Lukovic et al. lacks sufficient evidence level due to its design. In our study, similar to the study by Durmus et al.[7], positive changes and improvements were found in terms of pain and ROM values before and after treatment within each group. However, in contrast to the study of Durmus et al. where no significant difference was reported between the two groups in terms of pain and ROM values, in our study, the magnitude of treatment in the EMFT group was statistically different from the p-EMFT group in terms of pain and ROM. Amongst the possible causes of this difference, might be the effective exercises which were given as individual dosing limited with the pain threshold.[28, 29]

Table 1. The demographic characteristics of Electromagnetic Field Therapy (EMFT) Group and Placebo Electromagnetic Field Therapy (p-EMFT) Group.

	EMFT (N=21)	p-EMFT (N=21)	p
Age (years)	36.2±8.54	34.4±7.45	0.124
Body mass index (kg/m²)	26.2±3.14	24.5±1.47	0.095
Gender (*n* (%))			
Female	12 (57.1)	11 (52.3)	0.846
Male	9 (42.9)	10 (47.7)	
Dominant hand ((*n* (%))			
Right	19(90.4)	18 (85.7)	0.745
Left	2 (9.6)	3 (14.3)	
Affected side (*n* (%))			
Right	12 (57.1)	11(52.3)	0.694
Left	9 (42.9)	10 (47.7)	
Duration of disease (weeks)	5.71±1.45	5.14±1.89	0.576
Causes of Complex Regional Pain Syndrome Type-1 (*n* (%))			
Elbow Fx	6 (28.5)	5 (23.8)	
Distal radius Fx	5 (23.8)	5 (23.8)	
Styloid process of ulna Fx	3 (14.3)	- (0)	
Tendon injury	5 (23.8)	4 (19.0)	
Contusion of the hand	2 (9.5)	3 (14.3)	
Humerus collum Fx	- (0)	3 (14.3)	
Index finger Fx	- (0)	1 (4.7)	

EMFT: Electromagnetic Field Therapy. p-EMFT: Placebo Electromagnetic Field Therapy. Fx: Fracture.

Table 2. Outcome measures of the study at baseline and after treatment.

	Baseline Mean (CI)	After treatment Mean (CI)	p2
Pain (Visual analog scale, cm)			
EMFT	5.4 (4.2-6.7)	2.1 (0.8-3.3)	0.489
p-EMFT	5.5 (4.8-6.3)	3.7 (2.1-5.3)	
p1	0.974	0.097	
Range of motion – wrist flexion (degree)			
EMFT	32.6 (25.9-39.3)	51.3 (48.1-54.5)	0.513
p-EMFT	33.1 (26.7-39.1)	45.6 (39.6-51.8)	
p1	0.816	0.061	
Range of motion – wrist extension (degree)			
EMFT	20.1 (17.4-22.6)	38.4 (30.4-40.3)	0.347
p-EMFT	19.5 (16.8-22.2)	32.9 (30.1-35.8)	
p1	0.791	0.051	
Fingertip-to-distal palmar crease distance (cm)			
EMFT	2.8 (1.9-3.7)	1.2 (1.0-1.4)	0.218
p-EMFT	3.0 (1.8-4.2)	1.8 (1.1-2.6)	
p1	0.713	0.113	
Circumference of the hand (cm)			
EMFT	46.2 (37.4-55.0)	36.7 (30.1-43.3)	0.173
p-EMFT	45.6 (40.9-50.3)	39.6 (34.3-45.1)	
p1	0.806	0.207	
Tampa Scale of Kinesiophobia (17-68)			
EMFT	41.8 (37.5-46.3)	21.1 (16.6-25.5)	<0.001
p-EMFT	39.2 (35.9-42.5)	33.6(29.4-37.8)	
p1	0.671	<0.001	
Q-DASH (0-100)			
EMFT	86.5 (81.4-91.6)	76.2 (70.4-82.1)	0.735
p-EMFT	83.6 (79.6-87.6)	78.2 (72.7-83.7)	
p1	0.315	0.314	
Grip strength (kg)			
EMFT	6.5 (5.1-8.0)	12.0 (9.6-14.4)	0.067
p-EMFT	6.0 (4.8-7.3)	8.5 (7.1-9.8)	
p1	0.149	0.057	

CI = 95% confidence interval. EMFT = electromagnetic field therapy. p-EMFT = placebo electromagnetic field therapy. Q-DASH = Quick-Disabilities of the Arm, Shoulder and Hand. p1 = independent sample t test, p2 = repeated measures ANOVA.

Edema is a common feature in acute CRPS-1.[6,30] Previous studies reported that physiotherapy protocols for CRPS-1 prevented edema in hands.[6,7,28] Regarding edema, Moseley et al. applied 6-week-long graded motor imagery (GMI) program to patients with CRPS-1 and reported reduction in edema of the affected hand.[31] It is possible to fail to determine any improvement in edema if there is baseline edema or atrophic muscles in hand or forearm which then lead to hypertrophy. In addition, it has been reported that magnetic field treatment induces inflammation, resulting in increased microcirculation leading to increases in vessel permeability.[32,33] In this study, similarly, it is thought that EMFT application increases vessel permeability and has a greater effect on edema.

Kinesiophobia has been identified as a potential predictor of chronic disability in CRPS-1.[34] In a study conducted by DeJong et al., patients with CRPS-1 were divided into two groups; one of which underwent graded exposure therapy and the other was given an education including pain coping model. They reported that TSK scores of graded exposure therapy group were found to be significantly lower than those of education group.[34] To

Table 3. Pair wise comparisons of groups at baseline and after treatment.

	Baseline mean Mean±SD	After treatment Mean±SD	p	ES (CI)
Pain (Visual analog scale, cm)				
EMFT	5.4±1.7	2.1±0.7	<0.001	1.9
p-EMFT	5.5±2.6	3.7±1.6	0.004	0.7
Range of motion – wrist flexion (degree)				
EMFT	32.6±10. 8	51.3±11.4	<0.001	1.6
p-EMFT	33.1±11.7	45.6±12.1	<0.001	1
Range of motion – wrist extension (degree)				
EMFT	20.1±11.4	38.4±13.7	<0.001	1.5
p-EMFT	19.5±12.1	32.9±11.8	<0.001	1.1
Fingertip-to-distal palmar crease distance (cm)				
EMFT	2.8±1.1	1.2±0.9	<0.001	1.4
p-EMFT	3.0±1.3	1.8±0.4	<0.001	0.9
Circumference of the hand (cm)				
EMFT	46.2±10.6	36.7±8.9	<0.001	0.9
p-EMFT	45.6±8.7	39.6±5.2	0.006	0.7
Tampa Scale of Kinesiophobia (17-68)				
EMFT	41.4±12.7	21.8±4.1	<0.001	1.6
p-EMFT	39.1±13.2	33.6±7.3	0.057	0.4
Q-DASH (0-100)				
EMFT	86.5±10.1	76.2±10.6	<0.001	1
p-EMFT	83.6±9.3	78.2±8.2	0.011	0.7
Grip strength (kg)				
EMFT	6.5±3.6	12.0±4.1	<0.001	1.9
p-EMFT	6.0±1.9	8.5±2.6	<0.001	1.3

ES: Effect size. 95% CI: 95% confidence interval. EMFT: Electromagnetic field therapy. p-EMFT: Placebo electromagnetic field therapy.
Q-DASH = Quick-Disabilities of the Arm, Shoulder and Hand.

investigate the effects of PEPT in CRPS-1, van de Meent et al. designed a multiple single-case study and reported that TSK scores decreased throughout the treatment and continued to decrease with an overall rate of 18% over the 12-month follow-up period.[34] To the best of our knowledge, there were no studies examining the effects of EMFT on kinesiophobia in patients with CRPS-1. In this study, comparing pre- and post-treatment TSK scores of the two groups revealed that while significant changes were recorded in the EMFT group, no significant changes were found in the p-EMFT group. The reduction of kinesiophobia by EMFT application is thought to be related to the effects of EMTF on pain, inflammation and bone formation.[8,9] According to this; the values obtained after treatment in the EMFT group is thought to be an important parameter in coping with kinesiophobia in individuals with CRPS-1.

Functional restoration of the affected hand is one of the important goal of CRPS-1 treatment.[35] Two studies applied PEPT and compared the results to conventional physiotherapy in individuals with CRPS-1. In these studies, they found significant improvement in Q-DASH scores.[12,36] Furthermore, Atalay et al. carried out a study to explore the effectiveness of Prednisolone in complex regional pain syndrome; they evaluated the functional ability with Q-DASH and reported that Q-DASH scores decreased considerably at the end of treatment.[37] Although the present study and above mentioned studies did not use the same methods in the treatment of CRPS-1, results of the current study were in accordance with their findings. In addition, EMFT program yielded more pronounced improvements than p-EMFT program in terms of Q-DASH scores.

Devrimsel et al. conducted a study to compare the effects of neuromuscular electrical stimulation and whirlpool bath in

patients with CRPS-1. According to the results of this study, significant improvements in grip strength were found in both groups.[38] However, they found that grip strength increased in whirlpool bath group more significantly. According to the literature, grip strength largely improved in the studies which applied different techniques for treatment of CRPS-1.[12,36,39] In the present study, it was found that EMFT was effective in treatment of grip strength in CRPS-1, based on the findings that there were significantly greater improvements in grip strength.

Limitations

Absence of laboratory parameters regarding healing processes of CRPS-1 can be mentioned as the first limitation of the present study. It is recommended that further studies should investigate biochemical markers of bone formation (bone alkaline phosphatase, osteocalcinin and procollagen 1) and bone destruction (pyridinoline, deoxypyridinoline and hydroxyproline). Secondly, long-term effects of the interventions on patients were not evaluated in this study. In their study on the incidence of CRPS, de Mos et al. have shown that females between 61 and 70 years of age were more affected.[40]The third limitation of the present study is that the population of our study is incompatible with the incidence group described by de Mos et al.[40] However, this study, which shows the mean age and gender distributions of patients who applied to our hospital during the period of our study, agrees with many studies on CRPS in Turkey.[7,15,38] In addition, comparing cost of equipment and training for aspects of EMFT with other effective treatment methods of CRPS such as GMI and PEPT reveals the disadvantage of the EMFT device, which is more expensive than devices used in other methods. However, while short-term training is sufficient for EMFT, some long-term training is required to implement PEPT and GMI methods. This can be considered as an advantage of EMFT.

Conclusion

The results of this study showed that in patients with CRPS-1 physical therapy along with EMFT had positive effects on pain, ROM, grip strength, hand functional abilities and kinesophobia.

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REFERENCES

1. Sohn H-S, Lee D-H, Lee K-J, et al. Impaired Empathic Abilities among Patients with Complex Regional Pain Syndrome (Type I). Psychiatry Investig. 2016;13:34-42.
2. Daly AE, Bialocerkowski AE. Does evidence support physiotherapy management of adult Complex Regional Pain Syndrome Type One? A systematic review. Eur J Pain. 2009;13:339-353.
3. Harden RN, Oaklander AL, Burton AW, et al. Complex regional pain syndrome: practical diagnostic and treatment guidelines. Pain Med. 2013;14:180-229.
4. Lukovic TZ, Ristic B, Jovanovic Z, et al. Complex regional pain syndrome type I in the upper extremity-how efficient physical therapy and rehabilitation are. Med Glas (Zenica). 2012;9:334-340.
5. Cossins L, Okell R, Cameron H, et al. Treatment of complex regional pain syndrome in adults: a systematic review of randomized controlled trials published from June 2000 to February 2012. Eur J Pain. 2013;17:158-173.
6. Oerlemans HM, Oostendorp RA, de Boo T, et al. Adjuvant physical therapy versus occupational therapy in patients with reflex sympathetic dystrophy/complex regional pain syndrome type I. Arch Phys Med Rehabil. 2000;81:49-56.
7. Durmus A, Cakmak A, Disci R, et al. The efficiency of electromagnetic field treatment in Complex Regional Pain Syndrome Type I. Disabil Rehabil. 2004;26:537-545.
8. Sert C, Mustafa D, Düz MZ, et al. The preventive effect on bone loss of 50-Hz, 1-mT electromagnetic field in ovariectomized rats. J Bone Miner Metab. 2002;20:345-349.
9. Pilla AA. Low-intensity electromagnetic and mechanical modulation of bone growth and repair: are they equivalent? J Orthop Sci. 2002;7:420-428.
10. Harden RN, Bruehl S, Stanton-Hicks M, et al. Proposed new diagnostic criteria for complex regional pain syndrome. Pain Med. 2007;8:326-331.

11. Doig GS, Simpson F. Randomization and allocation concealment: a practical guide for researchers. J Crit Care. 2005;20:187-191.
12. van de Meent H, Oerlemans M, Bruggeman A, et al. Safety of "pain exposure" physical therapy in patients with complex regional pain syndrome type 1. Pain. 2011;152:1431-1438.
13. McCabe C, Haigh R, Ring E, et al. A controlled pilot study of the utility of mirror visual feedback in the treatment of complex regional pain syndrome (type 1). Rheumatology. 2003;42:97-101.
14. LaStayo PC, Wheeler DL. Reliability of passive wrist flexion and extension goniometric measurements: a multicenter study. Phys Ther. 1994;74:162-173.
15. Askin A, Savas S, Koyuncuoglu HR, et al. Low dose high frequency ultrasound therapy for stellate ganglion blockade in complex regional pain syndrome type I: a randomised placebo controlled trial. Int J Clin Exp Med. 2014;7:5603-5611.
16. Leard JS, Breglio L, Fraga L, et al. Reliability and concurrent validity of the figure-of-eight method of measuring hand size in patients with hand pathology. J Orthop Sports Phys Ther. 2004;34:335-340.
17. Pellecchia GL. Figure-of-eight method of measuring hand size:: reliability and concurrent validity. J Hand Ther. 2003;16:300-304.
18. Maihafer GC, Llewellyn MA, Pillar WJ, et al. A comparison of the figure-of-eight method and water volumetry in measurement of hand and wrist size.J Hand Ther. 2003;16:305-310.
19. Miller RP, Kori SH, Todd DD. The Tampa Scale: a Measure of Kinesophobia. Clin J Pain. 1991;7:51.
20. Yılmaz T, Yakut Y, Uygur F. Turkish version of the Tampa Scale for Kinesiophobia and its test-retest reliability. Physiother Rehabil. 2011;22:44-49.
21. Duger T, Yakut E, Oksuz C, et al. Reliability and validity of the Turkish version of the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire. Physiother Rehabil. 2006;17:99-107.
22. Hudak PL, Amadio PC, Bombardier C, et al. Development of an upper extremity outcome measure: the DASH (Disabilities of the Arm, Shoulder, and Hand). Am J Ind Med. 1996;29:602-608.
23. Mathiowetz V, Weber K, Volland G, et al. Reliability and validity of grip and pinch strength evaluations. J Hand Surg Br. 1984;9:222-226.
24. Altman D. Practical statistics for medical research. 1st ed. Chapman & Hall: London; 1991.
25. de Vet HC, Terwee CB, Bouter LM. Current challenges in clinimetrics. J Clin Epidemiol. 2003;56:1137-1141.
26. Correll GE, Maleki J, Gracely EJ, et al. Subanesthetic ketamine infusion therapy: a retrospective analysis of a novel therapeutic approach to complex regional pain syndrome. Pain Med. 2004;5:263-275.
27. Ghai B, Dureja GP. Complex regional pain syndrome: a review. J Postgrad Med. 2004;50:300-307.
28. Bilgili A, Çakır T, Doğan ŞK, et al. The effectiveness of transcutaneous electrical nerve stimulation inthe management of patients with complex regional pain syndrome: A randomized, double-blinded, placebo-controlled prospective study. J Back Musculoskelet Rehabil. 2016;29:661-671.
29. Pleger B, Tegenthoff M, Ragert P, et al. Sensorimotor returning in complex regional pain syndrome parallels pain reduction. Ann Neurol. 2005;57:425-429.
30. Singh G, Willen SN, Boswell MV, et al. The value of interdisciplinary pain management in complex regional pain syndrome type I: a prospective outcome study. Pain Physician. 2004;7:203-210.
31. Moseley GL. Graded motor imagery for pathologic pain A randomized controlled trial. Neurology. 2006;67:2129-2134.
32. Morris CE, Skalak TC. Acute exposure to a moderate strength static magnetic field reduces edema formation in rats. Am J Physiol Heart Circ Physiol. 2008;294:H50-H57.
33. Rumbaut RE, Mirkovic D. Magnetic therapy for edema in inflammation: a physiological assessment. Am J Physiol Heart Circ Physiol. 2008;294:H19-H20.
34. de Jong JR, Vlaeyen JW, Onghena P, et al. Reduction of pain-related fear in complex regional pain syndrome type I: the application of graded exposure in vivo. Pain. 2005;116:264-275.
35. Zyluk A. The sequelae of reflex sympathetic dystrophy. J Hand Surg Br. 2001;26:151-154.
36. Barnhoorn KJ, van de Meent H, van Dongen RT, et al. Pain exposure physical therapy (PEPT) compared to conventional treatment in complex regional pain syndrome type 1: a randomised controlled trial. BMJ Open. 2015;5:e008283.
37. Atalay NS, Ercidogan O, Akkaya N, et al. Prednisolone in complex regional pain syndrome. Pain Physician. 2014;17:179-185.
38. Devrimsel G, Turkyilmaz AK, Yildirim M, et al. The effects of whirlpool bath and neuromuscular electrical stimulation on complex regional pain syndrome. J Phys Ther Sci. 2015;27:27-30.

39. Lagueux E, Charest J, Lefrancois-Caron E, et al. Modified graded motor imagery for complex regional pain syndrome type 1 of the upper extremity in the acute phase: a patient series. Int J Rehabil Res. 2012;35:138-145.

40. de Mos M, De Bruijn A, Huygen F, et al. The incidence of complex regional pain syndrome: a population-based study. Pain. 2007;129:12-20.