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RESEARCH ARTICLE

EFFECT OF MIRROR THERAPY ON COMPLEX REGIONAL PAIN SYNDROME POST WRIST BURN

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ABSTRACT

Purpose of the study: To investigate the effect of mirror therapy on Complex Regional Pain Syndrome (CRPS) post wrist burn. **Methods:** Thirty patients were randomly divided into two equal groups; Group A (study group) and Group B (control group). Group (A) received conventional hand progressive exercise program (active, and active resisted hand exercises)in addition, the same exercises were done by the sound hand in front of mirror for 15 min in the first 2 weeks and 30 min in the last 2 weeks. Group (B) received only conventional hand progressive exercise program. The total duration of treatment was four weeks (30 min, 3 sessions per week). Methods of assessment included visual analogue scale (VAS) to assess pain and hand held dynamometer to assess hand grip and pinch, pretreatment and post treatment (after four weeks). **Results:** The results showed a significant improvement in VAS and hand grip as the percentage of improvement of VAS in groups A and B was 58.65% and 33.9% respectively, while in hand grip strength was 39.55% and 16.36% respectively. However, there was a significant improvement in VAS and hand grip in group A compared to group B (P=0.001), also we reported a significance increase in pinch strength as the percentage of improvement in groups A and B was 75.16% and 33.56% respectively with more significant improvement in group A compared to group B (P=0.0001). **Conclusion:** From the finding of the current study we concluded that mirror therapy exercise program is an effective, safe, relatively inexpensive, simple and available modality in decreasing pain and improving function level.

INTRODUCTION

Burn injury represents a significant problem worldwide. More than 1 million burn injuries occur annually in the United States. Although most of these burn injuries are minor, approximately 40,000 to 60,000 burn patients require admission to a hospital or major burn center for appropriate treatment every year (Keck, 2009). Complex regional pain syndrome (CRPS) is debilitating condition, characterized by pain in limb, in association with sensory, vasomotor, sudomotor, motor and dystrophic changes. It commonly arises after injury to that limb. Pain is typically the symptom of CRPS, but is often associated with limb dysfunction and psychological distress. Patients frequently report neglect – like symptoms or a feeling that the limb is aliens (Ferttloh, 2006)

Complex regional pain syndrome, formerly known as reflex sympathetic dystrophy, often is triggered by a minor or major trauma—fractures account for about 60% of cases. Surgery is the next most common precipitating event at 20%. Other etiologies include injections, venipuncture, infections, burns, Cerebrovascular accidents, or myocardial infarctions (Borchers, 2014). Studies on the effect of Mirror therapy (MT) on the upper extremities have demonstrated improvements in R.O.M, speed and accuracy of movement; increased grip strength; and improvements in motor function (Stevens, 2003).

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Mirror visual feedback (MVF) is a phenomenon where movement of one limb is perceived as movement of the other limb, it has the capacity to alleviate phantom limb pain or promote motor recovery (Deconinck, 2005). The investigators found that mirror visual feedback (MVF) was helpful for pain reduction in the early stage of CRPS and for stiffness in the intermediate stage; no changes were seen with late stage CRPS (McCabe, 2008). Mirror therapy suggests that visual illusion may enhance activity in primary motor cortex, then increasing the descending neural drive from the brain to muscles, viewing the illusion of functional of practice upper limb in a mirror seemed to have an immediate effect on motor unit recruitment (Michielsen, 2011). Mirror therapy is a neuro rehabilitation technique designed to remodulate cortical mechanisms of pain and has proved successful in phantom pain and Complex Regional Pain Syndrome Type 1(CRPSt1) (McCabe, 2003). The concept behind this "visual input" modality is that it helps patients re-educate, or re-introduce to their altered higher processing neural networkings, a normal relationship between a physical movement and the sensory feedback it provides (Altman, 2011). Motor imagery works by using imagined hand postures and movements. Asking patients to conceptualize a pain-free, functional movement pattern triggers in their brains the same way actual physical movements do (Priganc, 2011). Complex regional pain syndrome (CRPS) patients are suffering from pain that makes them take a lot of medical treatments which have serious adverse effect on the long run, also pain will lead to decrease function level of the affected

limb leading to psychological effects on patients, mirror therapy is new and safe modality in treatment of CRPS and can be helpful in decrease pain and improve function level. so this study was conducted to evaluate the efficacy of mirror therapy on CRPS post wrist burn.

MATERIAL AND METHODS

Subjects: Thirty patients with Complex regional pain syndrome (CRPS) post wrist burn participated in this study these patients were selected from the outpatient clinics of faculty of physical therapy, Cairo university and Kasr EL Anni medical school. The patients were included if they met the following criteria (1) Patients of both sexes with age ranged from 20 to 40 years old. (2) Patients with 2nd degree burn. (3) Patients with only one wrist burn.(4) patients with CRPSt1, while the exclusion criteria included (1) Patients with hand deformities (2) Diabetic patients. (3) Visual impairments. (4) Poor general health. (5) Patients with open wound at or near treatment site.

Study design: This study was a single blinded randomized controlled trial and was approved by the ethical committees of the faculty of physical therapy (Cairo University. Egypt). Every patient was given an informed consent before starting the study. All participants were informed about the nature and the effect of the treatment and measurement devices. The patients were also instructed to report any side effects during the treatment sessions. Patients were assigned randomly to either group A or group B. Group A (n=15) included (11 males , 4 females) while Group B included (10 males , 5 females). The random assignment into two equal groups in number by rolling of a dice by an independent person. Group A when the dice revealed an even number and Group B when the dice revealed an odd number. All patients underwent complete history taking including the name, age, sex , occupation and address in addition , they were asked about any trauma ,surgery and any neurological or orthopedic deficits. Detailed analysis of the present complex regional pain syndrome included pain intensity and hand muscle strength. Medical history included drugs used and current illness. Physical examination included weight, height and BMI.

Methods of assessment

Visual analogue scale (VAS): It is a scale used for pain assessment, horizontal line 100mm in length, anchored by word descriptors at each end. The patient was asked to mark on the line the point they feel represents their perception of their current state. The VAS score is determined by measuring in millimetres from the left hand end of the line to the point that the patient marks. Assessment was done pre and post treatment (after 4 weeks).

Hand held dynamometer: Hand held dynamometer (Base line pneumatic bulb made in U.S.A.) was used to evaluate the hand function (hand grip and pinch strength). The patients performed the test while sitting comfortably with shoulder adduction, neutrally rotated Forearm, elbow flexed to 90 degrees, forearm and wrist in neutral position. The patient was instructed to preform maximal contraction. The test was repeated 3 times with 30 sec relaxation period in-between and the average value of 3 tests was taken for the analysis. Assessment was done pretreatment and post treatment (after 4 weeks).

Treatment procedures

Group A (study group): patients received 4 weeks of conventional hand progressive exercise program for the affected hand (for 30 min, 3 sessions per week). The selected exercise included wrist flexion, extension, fingers flexion, extension, abduction and adduction exercise, thumb Opposition, Squeezing a ball by full hand, squeezing a ball by thumb and index, catch pins, in addition, the previous exercises were done by the sound hand in front of mirror (Mirror box consists of a 2 x 2 foot mirror vertically propped up sagittally in the middle of a rectangular box. The top and front sides of the box are removed) for 15 min in the first 2 weeks and 30 min in the last 2 weeks.

Group B (control group): patients received only conventional hand progressive exercise program for the affected hand (for 30 min, 3 sessions per week for 4 weeks).

Statistical procedures: Descriptive statistics and t-test were conducted for comparison of the mean age between both groups. t-test was conducted for comparison of VAS , hand grip and pinch between groups at pre and post measurements, ANOVA with repeated measures was conducted for comparison between pre and post measurements of mean values of VAS, hand grip and pinch in each group. The level of significance for all statistical tests was set at $p<0.05$. All statistical measures were performed through the Statistical Package for Social Sciences (SPSS) Version 19 for windows.

RESULTS

Subjects demographic data: The means ± SD age of group A and B were 30.93 ± 5.17 and 32.46 ± 5.24 respectively. There was no significant difference between both groups in the mean age values ($p = 0.42$).

Mean values of VAS pre-treatment and post-treatment of Group A and B: The means ± SD VAS of group A and Bpretreatment were 7.73 ± 1.33 and 7.46 ± 1.4 respectively, while post treatment were 3.2 ± 0.94 and 4.93 ± 1.48 respectively. The mean difference between pre and post treatment in group A and B was 4.53 and 2.53 respectively; while the percent of change was 58.6% and 33.91% respectively. There was a significant decrease in the VAS of group A and B post treatment compared with pretreatment ($p = 0.0001$).

Comparison of mean values of VAS pre-treatment and post-treatment between Group (A and B): There was no significant difference in the VAS between group A and B pretreatment ($p = 0.59$). However, the mean difference between both groups post treatment was -1.73. There was a significant decrease in the VAS of group A compared with that of group B post treatment ($p = 0.001$) as demonstrated in Table (1).

Mean values of Hand grip pre-treatment and post-treatment of Group A and B: The mean ± SD hand grip strength of group A and B pretreatment was 4.93 ± 1.17 lb and 4.46 ± 1.28 lb respectively; while post treatment was 6.88 ± 1.28 lb and 5.19 ± 1.09 lb respectively. The mean difference between pre and post treatment in group A and B was -1.95 lb and -0.73 lb respectively, while the percent of change was 39.55% and 16.36% respectively. There was a significant

increase in the hand grip strength of group A and B post treatment compared with pretreatment (p = 0.0001).

Comparison of mean values of Hand grip pre-treatment and post-treatment between Group (A and B): There was no significant difference in the hand grip strength between group A and B pretreatment (p = 0.3). The mean difference between both groups post treatment was 1.69. There was a significant increase in the hand grip strength of group A compared with that of group B post treatment.(p = 0.001) as demonstrated in *Table* (2).

Mean values of Pinch pre-treatment and post-treatment of Group A and B: The mean ± SD pinch strength pretreatment of group A and B was 2.98 ± 0.46 lb and2.92 ± 0.73 lb respectively, while post treatment was 5.22 ± 0.96 lb and 3.9 ± 0.71 lb respectively, The mean difference between pre and post treatment in group A and B was -2.24 lb and -0.98 lb respectively, while the percent of change was 75.16% and 33.56% respectively. There was a significant increase in the pinch strength of group A and B post treatment compared with pre treatment (p = 0.0001).

Table 1. T test for comparison between pre and post treatment mean values of VAS of group A and B

		VAS	MD	t- value	p-value	Sig
		$\overline{X}$ ± SD				
Pre-treatment	Group A	7.73 ± 1.33	0.27	0.53	0.59	NS
	Group B	7.46 ± 1.4				
Post-treatment	Group A	3.2 ± 0.94	-1.73	-3.81	0.001	S
	Group B	4.93 ± 1.48				

$\overline{X}$: MeanMD: Mean differencep value: Probability value
SD : Standard deviationt value : Unpaired t valueS : Significant

Table 2. T test for comparison between pre and post treatment mean values of hand grip strength of group A and B

		Hand grip strength (lb)	MD	t- value	p-value	Sig
		$\overline{X}$ ± SD				
Pre-treatment	Group A	4.93 ± 1.17	0.47	1.05	0.3	NS
	Group B	4.46 ± 1.28				
Post-treatment	Group A	6.88 ± 1.28	1.69	3.88	0.001	S
	Group B	5.19 ± 1.09				

$\overline{X}$: MeanMD: Mean differencep value: Probability value
SD : Standard deviationt value : Unpaired t valueNS : Non significant

Table 3. T test for comparison between pre and post treatment mean values of pinch strength of group A and B

		Pinch strength (lb)	MD	t- value	p-value	Sig
		$\overline{X}$ ± SD				
Pre-treatment	Group A	2.98 ± 0.46	0.06	0.27	0.78	NS
	Group B	2.92 ± 0.73				
Post-treatment	Group A	5.22 ± 0.96	1.32	4.23	0.0001	S
	Group B	3.9 ± 0.71				

$\overline{X}$: Mean MD: Mean differencep value: Probability value
SD : Standard deviationt value : Unpaired t value S : Significant

Fig. 1. Flexing & extending the fingers with non-affected hand in front of mirror

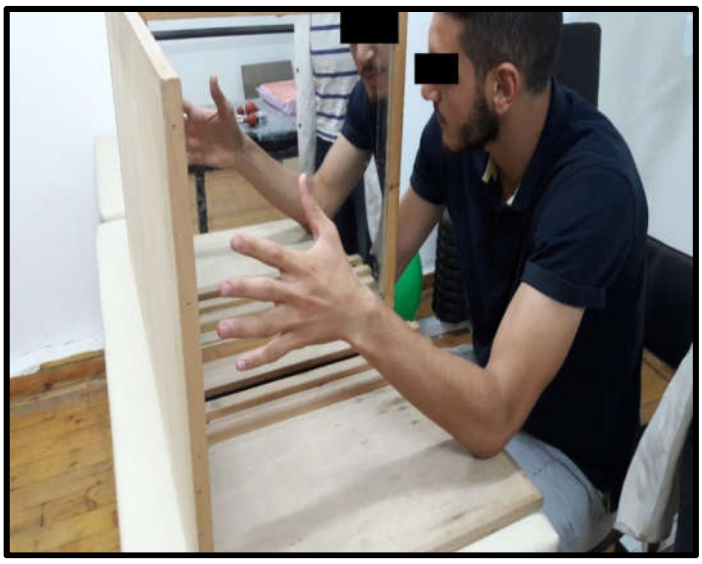

Fig. 2. Fingers abduction & adduction with non-affected hand in front of mirror

Comparison of mean values of pinch pre-treatment and post-treatment between Group (A and B): There was no significant difference in the pinch strength between group A and B pre treatment (p = 0.78). The mean difference between both groups post treatment was 1.32. There was a significant increase in the pinch strength of group A compared with that of group B post treatment (p = 0.0001) as demonstrated in *Table* (3).

DISCUSSION

Complex Regional Pain Syndrome occurring after traumatic injury, and rarely after surgical procedures. Numerous studies have documented the development of Complex Regional Pain Syndrome following distal upper extremity procedures such as carpal tunnel release, Dupuytren's contracture release, and amputation. CRPS has also been described following minor trauma resulting in fractures, burns, and venipuncture. A positive outcome to CRPS is favored when patients are treated early and from a multi-modality approach. Limited research is currently available for guiding appropriate therapy, and unfortunately while modest improvement can be achieved in some cases, significant disability frequently results (Johnson, 2008). The results of this study revealed that there was a significant improvement in mirror group more than control group in VAS score and also in both hand grip and pinch strength (P value < 0.01). Our study results come in agree with several studies applied by Yun & Kim.,(2019), Boesch *et al* (2016), Thieme *et al*., (2016), Park *et al*., (2015), Rostami *et al*., (2013), Wand *et al*. (2012), Cacchio *et al*., (2009), Chan *et al*. (2007) and Mosley (2006).

Yun and Kim, (2019) stated that there was a significant difference in pain and hand function in each group (pre-intervention vs post-intervention). A significant decrease in painwas observed in both experimental and control groups. After comparing the 2 groups it showed a significant reduction (by 23.70%, P=.04) in pain within the experimental group than the control group. Thus, a synergic effect between the conventional physical therapy and MT might have been induced, leading to greater pain reduction effect in the experimental group. Also no significant difference in muscle elasticity between groups was observed. Therefore, we suggest that patients with mutilating injuries who received MT along with conventional physical therapy showed significant improvements in hand function and pain reduction. After 4 weeks of MT, significant improvements in hand function and decrease in pain were observed for the experimental group. These results supported the primary hypothesis that mirror therapy would have positive effects on function recovery in patients with mutilating injuries (Yun, 2019). Boesch *et al* (2016) have shown that phantom limb and complex regional pain syndrome are significantly reduced (standardized mean difference =–1.11; 95% CI: –0.56 to –1.66; P<.0001) in meta-analysis of 2 randomized controlled trials (RCTS) on the effect of 4week-long mirror therapy,(13) also Thieme *et al*., (2016) published a systematic review with a meta-analysis of data from eight RCTs (224 participants), including five additional RCTs to the previous review. Conditions included complex regional pain syndrome, phantom limb pain and pain after stroke. Results indicated that mirror therapy reduced pain in the affected limb (standardized mean difference = -1.00; 95%CI -1.77 to -0.24; p=0.01) when compared with covered mirror, direct view of limbs, no treatment and repetitive transcranial magnetic stimulation (Thieme, 2016).

Park *et al*., (2015) concluded that mirror therapy showed positive effects on upper-extremity function and activities of daily living in chronic stroke patients. Differences in upper-extremity function after intervention in the mirror group were compared with those in the control group treated with sham therapy. The mirror group showed significantly greater differences compared to the control group, with improvements in paretic upper-extremity functions (p < 0.05) (Park, 2015). Rostami *et al*.,(2013) have suggested that patients with orthopedic disorders of hand show better improvement in hand function than the control group, including significant improvements for total active motion and disability of the arm, shoulder and hand (DASH) in the MT group that received traditional physical therapy at same time (Rostami, 2013). Wand *et al*. (2012) has applied a RCTs on the efficacy of mirror therapy for back pain, they placed one large mobile mirror in front of the participant and one mirror behind the participant so that there was a clear view of the reflection of their back. They found that pain intensity was reduced immediately post exercise compared with no reflection control during repeated lumbar movements (mean difference = 9.3 mm; 95%CI 2.8-15.7; p=0.007; 25 participants). The duration of low back pain elicited was also shown to be significantly reduced in the mirror condition (mean difference = 49.9 s; 95%CI 19.3-80.6; p=0.003) (Wand, 2012).

Cacchio *et al*., (2009) conducted a study to compare the effectiveness of mirror therapy on CRPSt1 of upper limb in patients with acute stroke. The primary end points were a reduction in the VAS score of pain at rest, on movement, and brush-induced tactile allodynia. The secondary end points were improvement in motor function as assessed by the Wolf Motor Function Test and Motor Activity Log. The mean scores of both the primary and secondary end points significantly improved in the mirror group (P < .001). The result indicates that mirror therapy effectively reduces pain and enhances upper limb motor function in stroke patients with upper limb with CRPSt1 (Cacchio, 2009). Chan *et al*. (2007) reported that all six patients in the MVF intervention group had a significant reduction in pain after 4 weeks of therapy (15 minutes/day), compared with the covered-mirror group and mental visualization of a moving phantom, (19) also Mosley (2006) tested The motor imagery program (MIP) on a broader group of patients with CRPS (who were more typical of patients seen in routine clinical practice) and a cohort of patients with phantom limb pain. A pre- and post-treatment reduction in pain was recorded for the motor imagery group (mean 23.4 mm, range 16.2–30.4 mm on a 100-mm visual analogue scale), compared with the control group (mean 10.5 mm, range 1.9–19.2 mm).

It is unclear whether these figures are clinically significant, but this is a promising advance considering that these two conditions are frequently intrac *Table* to therapy. In this study, we reported a significant improvement in VAS, hand grip and pinch strength of group A compared with that of group B (P value < 0.01). However, the study was limited by the small sample size, psychological state of the patient during the period of treatment, individual differences in patients and their response to the treatment. Future studies are needed to include larger sample size are providing better statistical analysis. Future studies with larger scar size should be applied. Future research should focus more on comparison among detailed regime of intervention application using a larger sample size.

Conclusion

From the previous discussion of these results and according to reports of researches in the field related to the present study, it could be concluded that application of Mirror therapy exercise program on CRPS patient can decrease pain , increase hand grip and pinch strength , leading to decrease the physical, psychological and financial complications for these patients . The results of the current study would introduce an effective and safe modality that can help physical therapists, physicians and clinicians in their dealing with CRPS patients who suffer from severe pain and loss of hand function to overcome this problem and improve the quality of life.

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