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The effect of task-based mirror therapy on upper limb functions and activities of daily living in patients with chronic cerebrovascular accident: A randomized control trial

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ABSTRACT

Background and Objective: Cerebro-Vascular Accident (CVA) is considered to be one of the main causes of acquired motor disability in adults. Different motor rehabilitation programs are being designed in order to improve motor difficulties of patients with CVA. In the current study we aimed to assess the effect of task-based mirror therapy on upper limb functions and activities of daily living in patients with CVA.

Materials and Methods: Twenty one patients with CVA were randomly divided into two groups of intervention (mirror therapy) (11 individuals) and control (10 individuals) and the both groups were receiving the usual rehabilitation protocol. The intervention group also received mirror therapy besides the usual program. Motor functions and activities of daily living were assessed via different tests (including: Box and Block test, Jebsen Taylor test, Minnesota manual dexterity test and Barthel scale) before and after the intervention course.

Results: The results showed that regarding the effect of task-based mirror therapy on different motor skills and activities of daily living, measured by mentioned tests, the main effect of time as well as the interaction effect of group × time was significant ($p<0.05$).

Conclusion: Generally, our findings in the present investigation suggest that mirror therapy has the potential to improve upper limb function and activities of daily living in patients with chronic CVA.

1. Introduction

Nearly half of the patients with cerebrovascular accident (CVA) die a year after their first stroke and from those who survive, about 85% suffer from hemiparesis and 55-75% from upper limbs paresis and thus experience difficulties in upper limb functions and daily activities. Consequently, CVA could negatively affect the independency level, daily-life engagement and quality of life of the survivors. CVA is considered to be one of the main causes of acquired disability in adults. One of the key goals of motor rehabilitation programs in patients with CVA is to maximize the upper limb functions. It is worth mentioning that motor improvement rehabilitation programs are supposed to be in line with the functional role of the limb in daily activities (1).

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In consonance with this and based on the current and supplementary therapies designed for CVA patients, Pomeroy et al introduced three principles in regard to paresis specific intervention techniques including: 1. Adding more exercises into the program in order to enhance muscular activity throughout the physical activities (Robot therapy and CIMT) 2. Priming techniques (stimulatory) which enhance motor system activity and (based on brain neuroplasticity) affect brain networks' reorganization (TMS and mirror therapy) 3. Task-based exercises (2).

Mirror therapy is one of the priming techniques which first invented by Ramachandran (3). In addition to patients with CVA, this technique has been also used in patients with complex regional pain syndrome (3), phantom limb pain (4, 5), musician's dystonia (6), spastic hemiplegia (7, 8), fibromyalgia (9), trigeminal neuralgia and brachial plexus injuries (10). The mirror therapy actively engages the patient in repetitive exercises and give him an immediate visual feedback about his accomplishment and hence motivates the patient to continue therapy program (11, 12). Moreover, the mirror therapy is a simple, inexpensive and patient-centered method and works based on central nervous system functions. This method focuses on healthy and unaffected limbs and makes the patients feel they still have intact limb after having it paralyzed (10, 13). The mirror in the mirror therapy is responsible for transferring the visual input resulting from unaffected limb movement into the brain. The basic neural mechanism of mirror therapy is mirror neuron system (MNS) which is a network containing mirror neurons in the frontal and parietal lobes. The multi-modal mirror neurons fire both when an individual acts as well as when the individual observes the same action accomplished by another. Moreover, the mirror neurons also fire when an individual receives a sensory input as well as when the individual observes another person receiving the same sensory input. Furthermore, the mirror neurons have the ability to counterbalance different visual inputs, proprioceptive inputs and motor commands. Consequently, the visual hallucination occurring in the mirror therapy as the result of MNS activity, may provide sensory inputs that have the ability to counterbalance cortical somatosensory network. There are evidences showing that the mirror therapy has a quick effect on restarting the motor units and consequently increase the reorganization and neuroplasticity of premotor cortex (10). On account of this, the mirror therapy is considered effective in paresis treatment in CVA patients (14, 15). In addition, numerous studies administrating mirror therapy in patients with CVA have reported increased grasp ability, range of motion, motor power and generally motor function improvement in their patients (16). Moreover, improvement in upper limb functions and increased self-care ability have also been reported in sub-acute patients treating with mirror therapy (17). The motion observation is one of the most appropriate feature of mirror therapy that let the clinicians use mirror therapy in motor rehabilitation of the patients who suffer from engaging in active rehabilitation programs (11, 12, 15). Furthermore, neuroimaging studies have shown that MNS exhibits significantly more activation in task-based and object-based activities in comparison to activities which have no task or object. Nevertheless, most of the studies administrating mirror therapy in patients with CVA have used simple limb exercises without any task. To our knowledge, there are two pilot and single-subject studies which have administered task-based mirror therapy and have confirmed the advantages of such tasks in patients with CVA (15, 18, 19).

Hence, in the current study all the training exercises were administered in the task format. We hypothesized that administrating training exercises in the format of a task could affect motor control more efficiently, would result in better outputs and consequently more exercise would be transferred into the real daily life.

2. Materials and Methods

2.1. Participants

The study consisted of a convenience sample of 21 patients with CVA from Shafa Yahyayian hospital in Tehran (12 males and 9 females, mean age: 57.25 years, mean time past from their stroke: 50 months). Fourteen patients had right-sided and seven patients had left-sided CVA. The participants were randomly divided into two groups of intervention (mirror therapy) (11 individuals) and control (10 individuals) and both groups were receiving the usual rehabilitation protocol in the occupational therapy center of the Shafa Yahyayian hospital. The intervention

group also received mirror therapy besides the usual program.

The inclusion criteria of the patients were as follows: 1. the diagnosis of CVA was supposed to be confirmed by a neurologist 2. The patients were supposed to experience their first stroke 3. The patients were supposed to score higher than 21 in MMSE test 4. The time past from their stroke was supposed to be at least six months 5. No history of other neurologic, orthopedic disorders and affected upper limb surgery according to medical files, patient/family report or experimenter's observation 6. Lack of hemi-neglect according to Star Cancelation test 7. No history of untreated visual disorders 8. No history of treatment by mirror therapy

Moreover, the exclusion criteria of the participants were as follows: 1. Lack of appropriate patient's cooperation throughout program's instruction and tasks 2. The occurrence of orthopedic disorders and additional CVA. The patients gave the informed consent prior to study program. All the programs were conducted according to the principles and ethics committee of Tehran University of Medical Sciences.

2.2. Experimental design

This was a clinical and single blind investigation. In the current investigation, the effect of task-based mirror therapy on upper limb functions, dexterity and independency in daily life activities were examined. Intervention protocol elements for the intervention group included doing functional tasks of mirror therapy one hour per session, three days a week for one month. Furthermore, the patient was supposed to do the same exercises at home one hour per session for four sessions per week. For this aim, the patient was given a training video clip showing and training the same functional tasks and exercises that he was required to do in the clinic. The home program was controlled and assessed via the timetables given to the patients and their family. In this study, the task-based mirror therapy sessions were set in a quiet room. The patient was sit facing toward a table, on a comfortable chair with backrest, with legs leaned on the ground. In the table, a rectangular platform measuring 40×40 cm was used, where a mirror was put in the sagittal plane in line with the sagittal plane of the patient's body. The patient's normal and unaffected hand was placed in front of the mirror while the affected hand was placed on the other side of the mirror in a box limiting the patient's sight of his affected hand (both hands' distance from the mirror was the same). The patients were required to just look at the mirror and concentrate on it. In the first five minutes, the patients were oriented to watch the reflection of their normal hand on the mirror during different exercises. Then in the next 10 minutes, the patients were required to perform exercises bilaterally with both hands while still concentrating on their normal hand's movements in the mirror. Then the patients were instructed to perform 15 functional tasks only with their normal hand while concentrating on their normal hand's movements in the mirror and imagining that their affected hand is performing the tasks. The functional tasks were different upper limb activities including reaching, grasping and releasing.

2.3. Assessment

The patients were assessed one day before and one day after intervention period. There was only one experimenter who was totally blind and unaware in regard to the specific intervention program in each group. Upper limb functions, dexterity and independency in daily life activities were examined in the both assessment sessions.

2.4. Tools

Box and Block test

This test was used to measure the gross manual dexterity of the patients. The test consists of a box with a divider in the middle of the box. Blocks are placed at one side of the divider. The patient is seated facing toward the box and is asked to move as many blocks as possible from one side to the other in 60 seconds. The number of displaced blocks is the measure of the gross manual dexterity. Test-retest reliability of the box and block test has been reported 0.89-0.97 in patients with CVA (20).

2.5. Jebsen Taylor test

Hand functions commonly used in every-day activities were measured by Jebsen taylor test. This test consists of seven subsets representing a spectrum of hand fine motor functions. In the current study, we administered four subsets of the test including: 1. Picking up small common

objects (e.g. two paper clips, two bottle caps and two coins) 2. Moving heavy objects 3. Moving light objects 4. Stacking checkers. A good validity and reliability has been reported for this test (21).

2.6. Minnesota manual dexterity test

Dexterity was assessed by Minnesota manual dexterity test. This test consists of five time-related subsets which measures hand dexterity by means of spinning or putting 60 small round blocks by one or both hands. In the current study, we used the putting subset of this test. A good validity and reliability has also been reported for this test (22).

2.7. Barthel scale

The Barthel scale or Barthel ADL index is a scale for measuring performance in activities of daily living. Barthel scale has different versions. One of the them is a revised version of the scale which was designed by Shah et al in Australia in 1989 and is called modified Shah Barthel scale. The key difference between the modified Shah Barthel scale and the main version, lies in their scoring method. In the modified version, more attention has been paid to details, the scoring style is finer and more objective and detailed explanation are considered for each questions. Thus, it seems that the modified version is a more appropriate tool for evaluating the effectiveness of intervention and care programs (23). This scale is filled by the patient himself. The validity and reliability of Farsi version of the Barthel scale has been reported 0.99 and 0.98, respectively (24).

2.8. Statistical analysis

Shapiro-Wilk test was used to assess the normality of the quantitative data. The main and interaction effects of the group variable (patient and control) and time (before and after intervention program) were evaluated by a two-way analysis of variance/ANOVA (intra-subject and inter-subject) in order to evaluate the scores in tests of upper limb functions, dexterity and independency in activities of daily living. All statistical analysis was performed by SPSS (version 23). The level of significance alpha was considered 0.05.

3. Results

A total of 21 patients with CVA participated in the current investigation which randomly divided into two groups. The intervention group consisted of 11 patients; the mean time past from their stroke: 47 months (± 24.55), in the range of 14-48 months. Moreover, the control group consisted of 10 patients; the mean time past from their stroke: 50.45 months (± 32.31), in the range of 12-96. Table 1 shows the mean, SD and range of upper limb functions, dexterity and independency in daily life activities' scores in both groups before and after the intervention period.

3.1. The effect of task-based mirror therapy on upper limb functions

The results showed that regarding the effect of task-based mirror therapy on gross motor skills measured by Box and Block test, the main effect of time as well as the interaction effect of group × time was significant ($p<0.05$) (Table 2). As figure 1A shows the significant effect of task-based mirror therapy on the gross motor skills was only observed in the intervention group and this effect was not significant in the control group. Furthermore, our results represented that the main effect of time (before and after mirror therapy) was significant in all the subsets of Jebsen Taylor test ($p<0.05$). In addition, the interaction effect of group × time was only significant in the subset of "picking up small common objects" ($p<0.05$) (Table 2). Moreover, the results of multiple comparisons indicated that the duration of performing all the subsets of Jebsen Taylor test had been decreased in the intervention group in comparison to the control group (Figures 1B, C, D, and E).

3.2. The effect of task-based mirror therapy on dexterity

Our findings showed that regarding the effect of task-based mirror therapy on dexterity, the main effect of time as well as the interaction effect of group × time was significant ($p<0.05$) (Table 2).As figure 1F shows, the significant increase in dexterity score after the intervention program in comparison to pre-intervention time, was only observed in intervention group and this change did not reach statistical significance in the control group.

Table 1. Mean (standard deviation) and range of upper extremity, dexterity and activity of daily living score in mirror therapy and control group in chronic stroke patients (n=21)

Variable		Mirror therapy group				Control group			
		Before treatment		After treatment		Before treatment		After treatment	
		Mean (standard deviation)	Range	Mean (standard deviation)	Range	Mean (standad deviation)	Range	Mean (standard deviation)	Range
Upper extremity function	Box and Block Test (number in 60 seconds)	30.90 (11.70)	6-50	36.09 (12.08)	9-56	31.4 (12.58)	8-49	32.2 (11.79)	9-48
	Picking up small common objects (seconds)	27.09 (14.47)	13.5-55	22.9 (12.37)	12.5-46	20.95 (11.59)	6-40	20.05 (11.83)	6-42
	Moving heavy objects (second)	13.27 (3.69)	8-19	11.72 (3.31)	6-17	13.55 (5.1)	8-25	13.35 (5.43)	5-24
	Moving light objects (second)	13.13 (4.69)	7-25	11.77 (4.07)	6-22	13.85 (5.36)	8-25	13.1 (5.33)	7-23
	Stacking checkerrs (second)	14 (7.056)	6-30	12.54 (5.65)	8-26	16.25 (7.67)	7-30	15.35 (6.9)	7-27
Dexterity	Minesoa Manual Dexterity (number in 30 seconds)	12.54 (4.92)	2-18	15.45 (5.69)	3-23	15.9 (4.78)	4-20	16.2 (4.77)	4-21
Activity of Daily Living	Barthel index (no unit)	93.18 (9.02)	70-100	97.27 (5.17)	85-100	95 (4.71)	85-100	95.5 (4.97)	85-100

Table 2. Results of main and interaction effect of group(control and mirror therapy) and time(before and after treatment) for upper extremity function, dexterity and activity of daily living scores in chronic stroke patients n=21

vaiable				Degree of freedom	Mean squares	F size	significancy	Effect size
Upper Extremity Function	Box and Block Test (number in 60 seconds)	Main effect	Group	1	30.27	0.105	0.749	0.006
			Time	1	93.71	44.94	0.000	0.703
		Interation effect	Group × Time	1	50.28	24.11	0.000	0.559
	Picking up small common objects (seconds)	Main effect	Group	1	212.14	0.667	0.424	0.034
			Time	1	67.63	22.73	0.000	0.545
		Interation effect	Group × Time	1	28.2	9.48	0.006	0.333
	Moving heavy objects (second)	Main effect	Group	1	9.45	0.24	0.624	0.013
			Time	1	7.97	7.16	0.015	0.274
		Interation effect	Group × Time	1	4.74	4.25	0.053	0.183
	Moving light objects (second)	Main effect	Group	1	10.9	0.23	0.634	0.012
			Time	1	11.7	12.12	0.002	0.390
		Interation effect	Group × Time	1	0.98	1.02	0.325	0.051
	Stacking checkerrs (second)	Main effect	Group	1	66.72	0.72	0.406	0.037
			Time	1	14.43	9.19	0.007	0.326
		Interation effect	Group × Time	1	0.78	0.5	0.488	0.026
Dexterity	Minesoa Manual Dexterity (number in 30 seconds)	Main effect	Group	1	44.02	0.87	0.362	0.044
			Time	1	26.97	27.69	0.000	0.593
		Interation effect	Group × Time	1	17.82	18.3	0.000	0.491
Activity of Daily Living	Barthel index (no unit)	Main effect	Group	1	1.094	0.006	0.938	0.000
			Time	1	0.001	7.993	0.011	0.296
		Interation effect	Group × Time	1	0.001	5.128	0.035	0.213

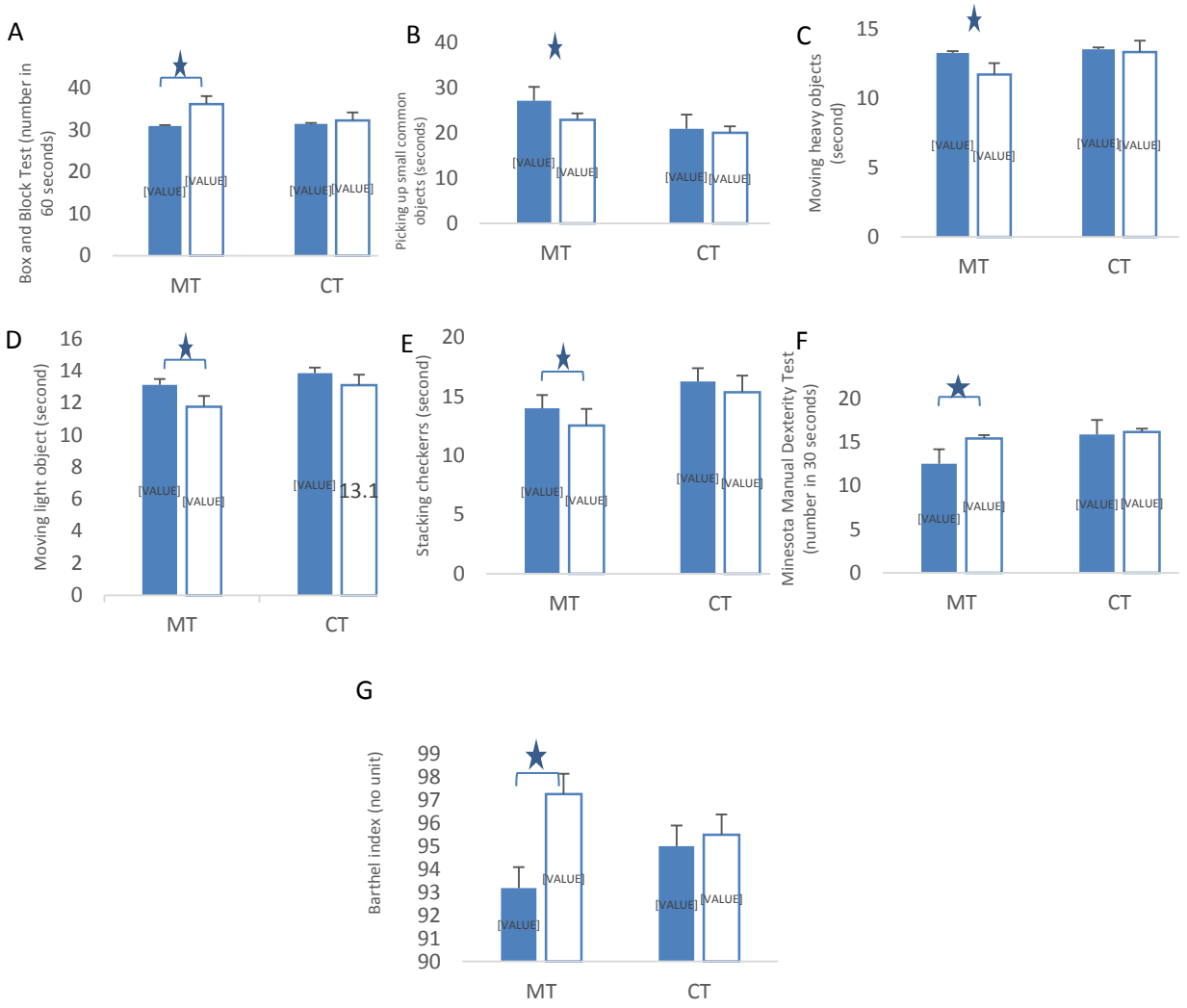

Fig. 1. Result of multiple comparison from upper extremity function, dexterity and activity of daily living (*:p<o.o5 , blue color is for pretest and with color is for post test)

3.3. The effect of task-based mirror therapy on activities of daily living

The results showed that regarding the effect of task-based mirror therapy on the activities of daily living, the main effect of time as well as the interaction effect of group× time was significant ($p<0.05$). As figure 1G depicts, the significant increase in the ADL's score after the intervention program in comparison to pre-intervention time, was only observed in the intervention group and this change did not reach statistical significance in the control group.

4. Discussion

4.1. The effect of mirror therapy on upper limb functions

The aim of the current investigation was to evaluate the effectiveness of task-based mirror therapy on upper limb functions, dexterity and activities of daily living in patients with chronic CVA. The results represented that duration of picking up small common objects as well as duration of moving heavy and light objects prominently decreased after task-based mirror therapy in the intervention group while no prominent change was observed in the mentioned tasks in the control group. In other words, duration of picking up small common objects in

all the members of the intervention group was decreased averagely by 4 seconds while this duration was decreased averagely by 0.8 second in only 70% of the patients in the control group. Moreover, duration of moving heavy objects was decreased averagely by 1.54 seconds in 81.81% of the patients in the intervention group while this duration was decreased by 0.25 seconds in only 40% of the patients in the control group. In addition, duration of moving light objects as well as duration of Stacking checkers were decreased averagely by 1.4 and 1.5 seconds, respectively, in 72.72% of the patients in the intervention group while these durations were decreased averagely by 0.65 and 0.9 seconds in 50 and 60 percent of the patients in the control group, respectively. Furthermore, the results of the current study indicated that the number of transferred blocks was increased averagely by 5.8 numbers per second in all the patients of the intervention group after intervention period. While this rate was increased averagely by 0.8 number in only 70 percent of patients in the control group. Moreover, the results showed that the number of block sput per time in the Minnesota test was increased averagely by 2.9 numbers in all of the 11 patients in the intervention group after the intervention period. While, this rate was increased averagely by 0.3 number in only 50% of the patients in the control group. The result of the current study is in line with the result of a single-subject study done by Rim et al (2014)(25). Rim et al administrating both simple and task-based mirror therapy on four patients with chronic CVA reported that upper limb functions measured with BBT, cube carry test, card turning test and Fugl-Meyer test improved following the intervention course. However, the reached results remained stable only after task-based mirror therapy in the 6 month follow-up examination (25).

Furthermore, Kamal Naryan et al (2013) examined 13 patients with chronic CVA and showed prominent improvement in FMA (WH) scores following task-based mirror therapy (26). Moreover, Michelsen et al (2014) assessed the effect of visual hallucination (mirror therapy) on reaching performance in patients with chronic CVA. The authors reported that visual hallucination could reduce duration of reaching performance and positively affect motor learning (27). The reduction in the duration of reaching performance in the Mlchelsen's study supports our results of Jebsen Taylor scores' improvement in the intervention group. Furthermore, Wu et al (2013) reported that mirror therapy positively affect distal part of upper limb's motor performance in patients with chronic CVA. The authors showed a 3.7% increase in Fugl-Meyer scores measuring upper limb functions. Furthermore, the results of kinematic analysis in the intervention group indicated that reaction time and the coordination between shoulder and elbow joints of the affected limb improved prominently after the intervention period (28). Thimie et al (2012) in a review investigation assessed the effect of mirror therapy on improvement of motor functions, activities of daily living, pain and hemi-neglect in patients with CVA. Their results showed that mirror therapy has a considerable effect on motor functions (16). However, it is worthy mention that the effect of mirror therapy on motor function is impacted by different mirror therapy methods. Youzar et al (2008) also reported that Brunnstrom scale scores of hand and upper limb improved significantly in comparison to control group and this finding remained stable after a 6 month follow-up. Moreover, hand motor functions measured by FIM improved prominently in comparison to the control group (17).

In a clinical investigation, Michelsen et al (1999) administrating mirror therapy at patients' home, reported that Fugl-Meyer scores improved significantly in the mirror therapy group in comparison to control group and this result remained stable after a 6 month follow-up (29).

The present study aiming to assess the effect of task-based mirror therapy on hand's functions of patients with chronic CVA was based on motor imitation and imagination principles as well as virtual world usage (30-32). Moreover, in the current study the patients were required to perform the tasks by their healthy limb, to look at the healthy hand movement's reflection on the mirror, to imagine that their affected limb is performing the tasks and to try imitating the performed tasks in the real world. In other words, the patients could not look at their affected hand's movement during mirror therapy tasks' performance. Given together, one can argue that mirror therapy is based on mirror neuron system functions. Thus, in this method, there are both mental simulation of a motor task with a motor

kinesthetic feeling, and a visual imagination of the motor task (33-35). Hence, activation of brain's motor imitation areas in the affected side following the observation of the healthy hand's movement in the mirror, is one of the neural mechanisms involved in motor function improvement following mirror therapy. There are evidences showing that activation of motor imitation areas plays an important role in the motor learning. For example, studies represented that inferior frontal gyrus (IFG) and inferior parietal lobule (IPL) controlling sensory information related to motor functions and imitation, are linked to mirror neuron system activities and are activated by means of motor observation (36, 37). These areas are activated before motor learning occurrence and stop to work by motor execution (38). Another possible involved mechanism for the hand function improvement is the brain imagination of affected limb motor performance following observation of healthy hand's movement in the mirror. In line with this, several studies have suggested that tasks that are designed on the basis of theory of mind (TOM) and cause the mental imagination of the task, are in a close relationship with the execution of the similar functions or tasks (39-41). For example, previous studies have shown that rehabilitation programs that are on the basis of motor imagination of the tasks, could improve motor quality, enhance speed and kinematic in patients with neurological conditions (42),. Furthermore, according to James 's theory, motor imagination is some kind of remote effect meaning that when someone thinks about an action, environmental sensations' pictures as well as proprioception substitute action's idea. Moreover, the effect of mirror therapy on motor function is justified by Prinz's theory explaining that stimulus and response in a cognitive system are defined as an event. Thereafter, both stimulus and response are coded in a measurable and proportionate model defined as action concept. In regard to action concept, whenever the stimulus code is activated, the appropriate response code is also activated automatically (43). Therefore, it seems that the imagination of affected-side's movement occurring in the brain in the mirror therapy, may provide an appropriate interaction between stimulus and response. Consequently, the repetitive performance of mirror therapy tasks could provide improvement in our patients with CVA (44).

Thus, given together, we can discuss that the motor imitation and imagination in the mirror therapy might improve motor functions in patients with CVA through two neural mechanisms. First, action observation activates motor systems which play role in motor execution. Second, throughout the imitation of a new motor model, the mirror neuron system is activated as the action observation starts till the execution of the new action. Regarding the motor learning and improvement resulting from mirror therapy, one of the models is the biological model explaining that the affected neural networks are positively affected and improved directly by means of mirror therapy tasks and exercises. Another model is the educational model which explains that the achieved inhibition through learning (as the effect of mirror therapy), indirectly takes the responsibility of function performance in the normal brain networks and areas (44). Both models might take place following mirror therapy in patients with CVA. However, as the patients in the current study suffer from a chronic condition, there is a strong possibility that the learned functions in the patients in this study had been based on the educational model and through the indirect mechanism.

4.2. The effect of mirror therapy on activities of daily living

Our results showed that the Bartel scale scores were averagely increased by 4.09 in 63.63% of the patients in the intervention group following mirror therapy while, the Bartel scores were averagely increased by 0.5 in only 10% of the patients in the control group.

The final results indicated that task-based mirror therapy applied on the upper limb, could improve activities of daily living in patients with chronic CVA. This finding is supported by the previous evidences showing that the upper limbs play an important role in performing activities of daily living (45). In a systematic review study, Mei Toh (2013) reported that there are inconsistent findings about the effect of mirror therapy on the activities of daily living in different studies (46). One of the possible explanations for the inconsistent findings is that there are different study designs and heterogeneous samples (different levels of CVA) in different studies. In line with our finding,

Radajeweksa et al (2013) declared that there is considerable improvement in self-care scores measured by activities of daily living assessments in the intervention group following mirror therapy (47). Moreover, Lee et al (2012) showed that the percentage of enhancement in the self-care ability of the patients with CVA had been 21% (48). Furthermore, Youzar et al (2008) represented a prominent improvement in the self-care ability in the intervention group in comparison to control group following mirror therapy and this improvement remained stable after a 6 month follow-up (17). In contrast to our finding, Wu et al (2013) showed that mirror therapy had no effect on activities of daily living measured by MAL test either immediately after the intervention or in the 6-month follow-up examination (28). This difference between Wu's and our finding might be justified by the different assessment tools in the studies. Moreover, Dohel et al (2008) also reported that the ability to do activities of daily living did not differ between their intervention and control group following mirror therapy (49).

4.3. Limitations

The current study has several limitations. First, our study sample was small both in the intervention and control group. Second, we did not administer neuroimaging techniques in order to evaluate brain reorganization of neural networks following mirror therapy. Undoubtedly, using and administrating neuroimaging techniques shed more light on the mechanisms involved in the effect of mirror therapy on motor function improvement. Thus, it is suggested to future studies to add neuroimaging techniques into their tools battery.

Conclusion

Generally, our findings in the present investigation suggest that mirror therapy has the potential to improve upper limb function and activities of daily living in patients with chronic CVA. Therefore, mirror therapy can be recommended as a beneficial therapeutic technique in the rehabilitation program of patients with CVA.

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