Research Paper: The Effect of Motor Training in Mirror Therapy on Gross Motor Skills of the Affected Hand in Children With Hemiplegia

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ABSTRACT

Objectives: Spastic hemiplegia cerebral palsy is the second type of cerebral palsy among premature infants, which affects the mobility of one side of the body by impairing the brain's ability to send nerve impulse to the muscles. The present research aims to examine the effect of motor training in mirror therapy on the gross motor skills in Spastic Hemiplegia Cerebral Palsy (SHCP) children.

Methods: This experimental study, 14 children with SHCP were selected using convenience sampling and randomly divided into two groups, i.e. mirror therapy or therapy group (7 children) and the control group or without mirror therapy (7 children). The gross motor skills for both groups was measured using Box and Block Test in the first session as pre-test. Later, the first group participated in motor training such as wheeling shoulder, adduction and abduction arm, throwing tennis balls into the basket, pushing a cylinder, rolling a tennis ball, rowing with elastic bands, etc. Both groups participated in 16 sessions of 30 minutes each. The control group completed the above program without a mirror. The post-test was conducted using the same procedure as the pre-test.

Results: Results showed that the gross manual dexterity significantly promoted from pre- to post-test in both groups ($P<0.05$), but comparisons showed that the therapy group outperformed the control group in gross motor skills of their affected hand ($P<0.05$).

Discussion: The finding of this study suggests that though motor training were beneficial for gross manual dexterity, mirror therapy had higher efficiency and efficacy. Therefore occupational therapists can benefit from this program in their remedial sessions for SHCP children.

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1. Introduction

Cerebral Palsy (CP) is a non-progressive and non-specific term that refers to a movement disorder caused during the brain development period in early childhood (i.e. in utero, at birth, infancy and childhood) [1]. Cerebral palsy is not a rare disorder; rather, it is the third common diagnosis after mental retardation and autism among the developmental disorders [2]. Surveillance Committee of Cerebral Palsy in Europe has reported the incidence rate of cerebral palsy to be 6 per 1,000 live births [3].

Based on the type of lesion, growth, and quality of movement patterns in children, the cerebral palsy is different. Spastic hemiplegia cerebral palsy (SHCP) is the second type of cerebral palsy among pre-mature infants and affects the hands and feet of one side of the body [4]. In patients with hemiplegia spastic, often hand is involved more than foot and difficulties in working hand is obvious in the first year of life [5]. Hand and upper limbs dysfunction causes problems in half of cerebral palsy children [6]. Spastic cerebral palsy children often suffer severe problems compared to children with other types of cerebral palsy. The therapeutic aim in most of these patients is learning simple hand activities [7].

Researchers used the two-class fine and gross motor skills for the classification of motor skills via differentiation based on the size of the muscle groups involved. Fine motor skills are the basis of daily life activities [8]. These skills are divided into two major parts of gross manual motor skills and fine finger motor skills. The only difference in these types is that the gross manual motor skills often involve manipulation of large objects controlled with arm and hand movements, whereas fine finger skills include manipulation of smaller objects controlled with hand and fingers [9]. Fine motor skills rehabilitation is a complex and highly specialized process with a wide range of activities [10].

At times, the hidden complexity in the rehabilitation processes pose as a barrier to proper education of their parents or caregivers and keep track of continuous treatment in other places except for medical centers. This, consequently, causes a low-impact and long treatment duration of the process [11]. Therefore, the use of easier and more accessible alternative methods to improve the cerebral palsy in children is necessary. Mirror therapy (mirror visual feedback), focusing on the movements of unaffected limbs, is one of the new methods introduced to improve the motor function of SHCP patients [12]. It was developed by Rogers Ramachandran and his colleagues as a treatment technique for eliminating the involuntary movements, pain, and paralysis in the affected limb [13].

They suggested that the visual illusion created by the mirrors of the healthy limb will trick the brain, and the patients would think that the affected limb has movement, which would, in turn, result in improving the motor function of the affected limb of the patients [13]. This therapy increases the excitability of the spinal cortex through its effects on the neurons of the affected limb without its involvement or causing any pain. Due to the action of mirror neurons, the brain tricks the patient to imagine that his both limbs are healthy. The brain cortex regeneration is hereafter initiated on receiving these new information [14].

It seems that the use of the procedure to follow-up and complete the rehabilitation programs is also possible by non-specialists with limited equipments and low cost. Therapeutic targets in cerebral palsy involve not only the full recovery or achieving the normal condition, but also increasing the efficiency in movement, enhancing the capabilities of the limb, and achieving a desirable motor condition along with its maintenance. This research aimed to examine the effect of motor training in mirror therapy on the gross motor skills in Spastic Hemiplegic Cerebral Palsy (SHCP) children.

2. Methods

Fourteen patients aged 6-12 years old with hemiplegic cerebral palsy referring to the Medical Center of Mohammad Kermanshahi Hospital, Kermanshah, Iran participated in this quasi-experimental study. The participants were randomly selected of which 7 patients were placed in the mirror therapy group (motor exercises in the mirror) and 7 patients in the control group (motor exercises without the mirror). Inclusion criteria for the study included a shaft control that allowed to sit without supervision, cognitive and verbal abilities (attention, working memory, and concentration), whereas the exclusion criteria included previous surgery or pain in the upper limbs, vision problems, epilepsy, heart, and respiratory problems.

The training program included 16 exercise sessions of 30-minutes each. After completing the consent and personal information questionnaire, the subjects were informed about the research process. Pre-test and post-test were conducted in the first and last sessions. To create a mirror illusion, a relaxed environment free from any other focus or disruptive devices was needed. During the 16 treatment sessions, the patient was placed on an arm-

Figure 1. Rotating the wheeling shoulder with non-affected hand in front of mirror

chair, and the affected limb was positioned on a height-adjustable table so that its position could be adjusted to the length of the patient's trunk and arm. The affected limb was situated in a safe and preferably comfortable position behind the mirror.

The non-affected limb was positioned in a similar position as the affected limb, which would result in facilitating the intensity of the mirror illusion. The dimension of the mirror was big enough to cover the entire affected limb in order to allow patients see all major movements in the mirror. In the preparation of the mirror box a triangular box was constructed using a Pythagorean theorem, and the mirror was placed on its right edge. Generally, the mirror was positioned in front of the patient's midline, so that the affected limb could be fully covered by the mirror and the reflection of the unaffected limb was completely visible. Therapist repeatedly reminded the focus on the movement of the unaffected limb in front of the mirror by patient, which helped to increase the mirror illusion.

The patient then completed the training program in a level ranging from simple to difficult during 16 sessions of treatment, which included rotating the device, wheeling shoulder, adduction and abduction of the arm, picking up tennis balls and dropping them in the basket, pushing the cylinder on the table, rolling a tennis and Hedgehog ball on the table, rowing with elastic bands, connecting the dots on the paper, snipping card-board, and etc with the non-affected limb in front of the mirror (Figure 1). For the control group, the use of mirrors during the intervention was eliminated, and the training program for the nonaffected limb was conducted without the mirror.

To investigate about any improvement in their functional ability, gross motor skills of affected hand patients before and after treatment were assessed using the Box and Block test. This test assessed the effect of upper limb rehabilitation [15]. This test required items like Stopwatch, Wooden boxes with partitions (Box: 8.5×25.4×53.7, partitions: 1×15.2×25.4 cm), and 150 pieces of woody cubes (2.5 cm). The test box consisted of a partition in the middle that was placed along the edge of a desk at a standard-height and 150 cubes. The 150 cubes were placed in the box and aligned with the affected hand of the patient [16].

Before the test, the therapist gave a chance to patient to perform the test for a period of 15 seconds, and then was asked to sit in the primary test situation. When testing began, the patient grasped cubes with the affected hand, one by one, and transported the cube from one side of the partition to the other, and released cubes into the opposite side box. Therapist calculated the number of cubes transported from one side to the other in a minute for scoring purpose. [16].

The reliability and validity of the test were shown by Kramvyl in 1976 (P=0.9 and r=0.91) [17]. In this study, informed consent was obtained from each patient participating in this project, and the descriptive statistics (such as mean and standard deviation) was used to report the subjects' scores in research variable. In order to evaluate the normality of the data, the Kolmogorov-Smirnov test was used. Later, the paired T-test was used to compare the data collected from both pre-test and post-test, and

Table 1. The value of gross motor skill of participants with affected hand

Groups	Pre-Test	Poost-Test	T	P
Therapy group, mean±SD	12.29±3.49	19.29±4.11	-7.77	<0.001
Control group, mean±SD	12.86±3.89	14.43±3.69	-22.68	<0.001
T	0.289	-2.33		
P	0.778	0.038		

independent T-test was employed to compare the pre-test with post-test in both groups. The analysis was conducted using the software SPSS version 19. In all cases, the significance level was P<0.05.

3. Results

The descriptive information related to gross motor skills is shown in Table 1. The results of paired T-test compared the mean affected hand gross motor skills of the patients as intra-group. There were significant differences in both groups during the post-test training compared to pre-test training (P<0.05). Furthermore, there was a significant difference between the two groups after test, i.e., the mean gross motor skill was higher for the therapy group than the control group (P<0.05). There was no significant difference in pre-test (before test) between the therapy group (1.643±0.5855) and control group (1.486±0.6149) (P>0.05). This difference is shown in Figure 2.

4. Discussion

This research investigated the effect of mirror therapy on improving the gross motor skills of affected hand in hemiplegic cerebral palsy children. The findings showed that both groups showed a significant progress during the evaluation process from pre-test to post-test. However, the therapy group had more progress in its gross motor skill compared to the control group, i.e. 19.29 (MT) versus 14.43 (NMT) after test.

Motor skills in children with SHCP on the affected side of the body are more vulnerable than the healthy side and they often tend to use that side more in their day-to-day activities. The current results suggested that mirror therapy had the mixed effect of using the affected hand in daily activities [9]. It can be, therefore, conclude that mirror therapy improves the gross motor skills of the affected side (or hand) of the body. These results are in line with the results of Jin Young et al. [18], and Shahanawaz et al. [19]. Therefore, it can be concluded that the intervention used (mirror therapy) in this study resulted in an increased use of the affected hand of the children with SHCP.

Several fundamental mechanisms accounted for the effect of mirror therapy on their motor skills have been identified. Altschuler [20] suggested that the mirror illusion created from the natural movement of the affected hand may be an alternative to reduce the proprioceptive information. For patients, paying attention to the mirror provides a perfect visual data input, which results in the reconstruction and rehabilitation of their premotor cerebral cortex via the connection developed between the visual input areas and premotor. The mirror therapy may also help in reversing the process of learning about not using the affected hand in daily activities.

The data obtained from the affected hand, before the onset of the treatment, may be attributed to the dependency of the child with hemiplegia on the unaffected hand for doing more Activities of Daily Living (ADL). This neglect of affected hand may increase upper limb weakness and reduce the muscle tension, which ultimately makes the patient feel there is a reduction in the amount of functional activity of the affected motor neurons [21]. The results of this study showed that mirror therapy training had a significant effect on improving gross motor skills.

The effect of mirror therapy on some of the indicators of motor abilities has not been supported by some studies, which led to the contradictory results. Adler et al. [22] concluded in his study that the bimanual movements of the mirrors result in a certain negative impact on the bimanual performance of cerebral palsy children.

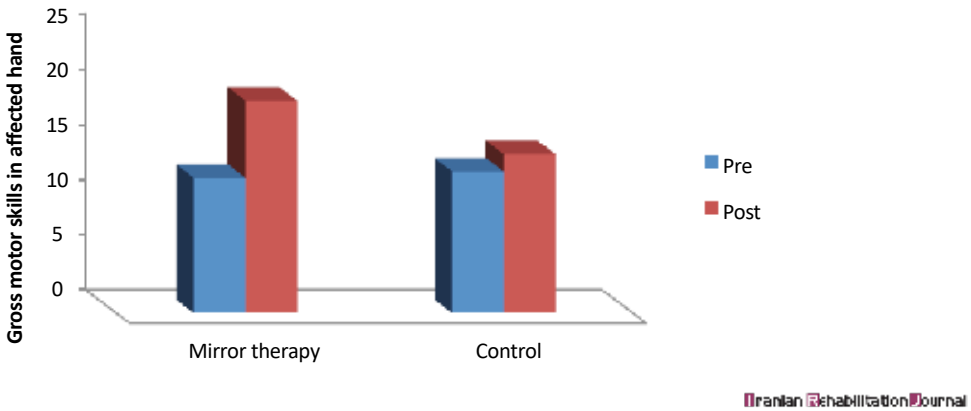

Figure 2. The comparison of pre-test and post-test of affected hand means gross motor skills between two groups

Probably the reason behind the rejection of the hypothesis was not taking the entry and exit criteria and the type of task or inappropriate intervention into account. In contrast, the majority of researches conducted with the purpose of restoring motor function achieved the result that mirror causes an increased stimulation of the primary motor cortex and the return of motor functions.

Several studies also reported that mirror therapy can improve the upper extremity motor function of the affected limb through increased activity of motor neurons and reduce the movement disorder to its minimum, which is in line with the results of our study [23-29]. Although improvement in motor function occurred during mirror therapy, there is still a tendency to continue improvement after stopping this procedure. It is possible that an isolated increase in primary motor cortex excitability would lead to sustainable recovery in performance after diverting the focus of the therapy on points like nervous mechanisms [30].

There is a possibility that visual illusions can stimulate the primary motor cortex, thereby the descending the neural pathway that links the brain to muscles [31]. A therapist can find the effect of mirror therapy after witnessing the patient sending motor order to right and left hands to create a symmetrical movement which allows the brain to feel that his affected hand is following his order [32].

5. Conclusions

The empirical results suggested that mirror therapy significantly improved the gross motor skills in hemiplegic cerebral palsy children. The important goals of usual rehabilitation methods are to increase the motor skills of the affected limb. However, mirror therapy has some important features, such as cost-effectiveness, painless, no need of advance equipment, and the ability to exercise without interference of the affected limb. It also enables a patient to do exercises with parental help. Therefore, it can be concluded that mirror therapy can be an alternative method to treat the motor disorders in cerebral palsy children. Additionally, the application of this procedure can be suggested in rehabilitation program centers and welfare agencies to increase the gross motor skills in the affected hand of the SHCP children.

As mentioned earlier, a triangular box was used to make the mirror box. Because of curiosity, some children pay attention to the affected hand movement behind the mirror and cannot focus on the unaffected hand movement in the front of the mirror. To solve this problem, a screen was installed for the entire camouflaged affected hand. It is, therefore, suggested that in future studies, the mirror box should be designed in a way that the affected hand of the patient is completely camouflaged inside the box and patient does not view the affected hand. As a result, the patient can concentrate more on doing practice with the unaffected hand. Future researchers are recommended to investigate the effect of mentioned exercise on other motor variables such as eye-hand coordination, and hand grip strength, etc.

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Conflict of Interest

The authors declared no conflicts of interest.

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