

# Deviation of Hand Grip Strength from Normal Child before and after Two Different Techniques, of Hand Rehabilitation Therapy in Hemiplegic Children

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## ABSTRACT

**Background and Purpose:** Mirror mediated therapy and constraining induced movement therapy (CIMT) are two rehabilitation techniques that used for treatment of upper extremity for hemiplegic children. The purpose of this study was to detect the degree of deviation of hand grip strength from normal child before and after application of two different techniques of hand rehabilitation therapy in hemiplegic cerebral palsy children. **Subjects and Procedures:** Thirty children with hemiplegic cerebral palsy (CP) of both sexes ranged in age from 4 to 9 years participated in this study. Hand grip strength was measured in both groups before and after intervention and compared to its corresponding value of age matching normal children. Children in group (A) who were treated by mirror mediated therapy while children in group (B) received intervention with constraint induced movement therapy. Both groups received conventional physical therapy. **Result:** In children who received mirror therapy, the percent deviation of hand grip strength in girls measured pre-treatment was 65.09% and decreased after treatment to 39.33%, While in boys it was 70.30% and decreased to 47.46%, respectively but In group B, the percent deviation in hand grip strength in girls measured at pre-treatment was 62.60% and decreased after treatment to 48.47%, While in boys it was 71.82% and decreased to 58.88%, respectively. **Conclusion:** Both techniques (mirror therapy and constraining therapy) decreased deviation from normal children in hand grip strength but the mirror therapy has more significant effect than CIMT in hand grip strength in hemiplegic children.

**Keywords:** Hemiplegic cerebral palsy, Mirror therapy, Constraining induced therapy, Hand grip strength.

## **INTRODUCTION**

Cerebral palsy (CP) is a neuromuscular disorder caused by an injury to the fetal or infant brain that affects the development of movement and posture and causes activity limitations.(1)

Child with hemiplegic CP has delay in normal sequence of fine motor function, motor learning, problems in sensory awareness, lack of control in upper limb joints, muscle weakness in affected hand and problems in fine motor and gross motor developmental skills which lead to impaired hand functions.(2)

Dysfunction in children with hemiplegic CP result in failure of those children to use the involved upper extremity and they lean to perform all tasks with non- involved extremity (learned non-use), this phenomenon lead to additional impairments secondary to neural damage(3). The child try to do task by the affected hand but he can't due to physiological reaction of the nervous system during acute phase of an injury this repeated failure lead to LNU and this in turn lead to contraction of cortical representation of involved limb and prevented the use of affected upper limb.(4)

Mirror therapy is easy applied, in-expensive and non- invasive therapy which may be considered a promising adjunct to rehabilitation of children with hemiplegia. As for adult after stroke, modulation the dysfunctional cortex with mirror visual feed back could facilitate improvement of function and partly compensate the lack of experience of age appropriate sensorimotor stimuli that lead to improvement of development of upper extremity skills.(5)

Constraint induced movement therapy (CIMT) is a treatment for hemiplegia to improve motor functions in the affected upper limb. The unaffected limb is restrained while intensive motor training is provided to the affected arm. (6)

Constraint induced movement therapy increases the motor representation area of the more affected part, (7) more likely mechanism it reduces in activity of the local inhibitory interneurons thus unmasking preexisting excitatory connection. (8)

## **MATERIALS AND METHODS**

Thirty hemiplegic CP children (14 boys and 16 girls ) their age ranged from 5 to 9 years were

selected from outpatient clinic of Faculty of Physical Therapy, Cairo University with this inclusion criteria : Mild spasticity ranged from (1 to 1+) according to modified ashworth scale. IQ not less than 70, and they were able to use their both upper limbs and maintain balance while changing their position .

### **Exclusion criteria:**

Mental retardation, vision or hearing disorders and structural deformities of the affected upper limb.

### **Ethical consideration**

All children's parents provided written consent before starting the study. The local ethics committee approved from ethical committee of Faculty of Physical Therapy, Cairo University.

Materials and instrumentations for Evaluation

A Base line hydraulic hand held dynamometer (white plans, NY 10602, USA) was used for grip strength measurement.

It provides a simple adjustment for fine size position and permits maximal isometric grip force. The read-out of the dynamometer dial was

presented in pounds “from zero to two hundred bounds” or in kilograms.

Evaluation Procedures of hand grip strength

It was done before and after treatment for both groups A and B). Each child was asked to sit on a chair with back supported , trunk erected , hips and knees were flexed 90° with the feet fully supported on the ground in neutral position.

The elbow joint of the affected upper extremity was flexed 90°, the forearm was kept in mid position and supported on arm rest arm chair with the wrist joint in neutral position and free from the chair, Then the child was asked to hold the handle of the dynamometer and squeeze it by his/her maximum power as much as possible, then release. Three trials were allowed and the mean of the trials was calculated.

### **Materials and instrumentations for treatment**

Tools for group (A and B) :A table and sturdy chair, the table with 60 cm height and the sturdy chair without arm rests with 40cm seating surface height ,occupational therapy tools were used they included, multi sized balls, papers, marker, playing

cards, sponge ball, doughs, cups, toys, pegs pencils and pens

Tools for group (A): A vertical wooden stand mirror, with zero lag mirror formed of two wooden boards hinged together, one board (35X35cm) on which the mirror was stacked on its outer surface and the other board (35X40cm) which stabilize the mirror place in vertical position by a hook which attached between the mirror piece and the wooden piece (oblique board) from one side for stability and preventing the mirror from sliding.

Tools for (Group (B)

Arm sling: sling was fastened around the neck and covered the entire arm and hand of child.

Straps were attached to the sling to go around the child waist, to secure it to the child's trunk, this prevented the child from using this sound limb in activities .

### **Treatment procedures:**

Two distinct types of massed practice exercises that were central to CIMT and mirror therapy including (shaping + repetitive practice), this application is based on broken down of all activities into step-by-step tasks that could be worked individually

then chained together in progressive steps toward the targeted goal. Performance of movement embedded in play activities was repeated continuously for 15 to 20 minutes.

patients in both groups were treated by a conventional physical therapy program including:

Stretching of hamstring muscles for 30 seconds from supine position, quadriped exercise with weight bearing on both upper limbs for 30 seconds then child was asked to raise his/ her left upper arm and practice reaching, stooping and recovery, balance exercise , gait training for 10 minutes and ascend and descent stairs for 10 minutes.

B-treatment for group (A):

Children received mirror therapy from sitting on a back-rest chair with the feet flat on the floor with hips and knees were kept at 90° in front of a suitable height table that was at the waist level, The mirror placed in the sagittal plane, perpendicular right angle , child was asked to hide his/her affected hand behind the mirror and to put the unaffected hand in front of the mirror and seeing its reflection, then he/she was asked to perform the tasks with his/her unaffected hand while seeing

its reflection in the mirror ,Then the child was asked to move his affected limb in front of mirror and encouraged to move it as he/she could as possible (shaping to the affected side). Finally bimanual movement therapy was applied this active movement of both hand to encourage the "forced used of paretic hand. Children treated by mirror mediated therapy 3 times per week for 12 successive weeks each session lasted for 30 minutes.

Tasks used in mirror therapy:  
(shaping- technique )

Towering cups starting with three cups then five cups by digital grasp, roll dough and smash it (cylindrical grasp) first by soft consistency dough then hard consistency. Spatial shaping by asking the child to transfer cube, grasp different sized balls ,discs ,markers ,pegs and brushes. Moving keys in lock, turning playing cards .Some of tasks were done bimanually as the child moved his sound limb in front of mirror and his affected hand do the same of movement behind in mirror as could as possible .

Child was asked to turn playing cards with his/her non affected hand at the same time he/she did the same

movement with his/her affected hand behind mirror , squeezed a spongy ball with non affected hand, child transferred cup from place to another.

C-Constraining induced movement therapy group (Group B) : the children in the second group did the same tasks of the first group but the non affected limb of child was restrained by sling which was strapped to child's waist to prevent using the non-involved hand as assist. This technique made forced use of impaired upper limb.

He or she did all tasks with shaping for affected hand and all tasks were repeated for 15 to 20 minutes to increase motor learning. (Each task was repeated for 2 minutes).CIMT was applicated for 6 hours per day for 21 days then a period of 1 week rest was given and the application of CIMT was repeated twice again (session lasted for 30 minutes), all duration of CIMT is three months.

Statistical analysis

Results are expressed as mean  $\pm$  standard deviation or number (%). Comparison between categorical data [number (%)] was performed using Chi square test or Fisher exact test if cell count was less than (5).

Test of normality, Kolmogorov-Smirnov test, was used to measure the distribution of data. Accordingly in normally distributed data, comparison between variables in the two groups was performed unpaired t test. In normally distributed data, comparison between variables in the two groups was performed Mann Whitney test.

Percent deviation from normative data was performed using this equation:- [(normative data - study data)/ normative data] x 100 Statistical Package for Social Sciences (SPSS) computer program (version 20 windows) was used for data analysis. P value ≤ 0.05 was considered significant.

## RESULTS.

### A) Physical characteristics of the children in both groups:

Age and sex distribution in group A and B were represented in table (1)

**Table(1) Age and sex distribution between both groups.**

	Mirror (n= 15)	CIMT (n= 15)	t value	P value
Age (yrs.)	6.97 ± 1.27	7.08 ± 1.52	- 0.208	0.837 (NS)
Gender				
Girls	8 (53.3%)	8 (53.3%)	$\chi^2=$ 0.000	1.000 (NS)
Boys	7 (46.7%)	7 (46.7%)		

$\chi^2$ : Chi square test. NS : p> 0.05= not significant n: Number

The percentage of deviation in both groups was detected by comparing the normative values of grip strength that was gained from previous study of Egyptian population grip strength by detecting the

normative grip strength values of age matching boys and girls and the deviation of study groups from these values before and after application.<sup>(9)</sup>

Normative data was extracted from previous study (normative hand grip strength of healthy children at different school grades and its relation to anthropometric measures.<sup>(10)</sup>

The mean values of age in normal girls and boys were 7.52 and 9.38, respectively. In group A, the percent deviation in hand grip strength in girls measured at pre- and post-treatment were 65.09% and decreased to 39.33%, respectively. While in boys they were 70.30% and decreased to 47.46%, respectively as shown in Table 2.

In group B, the percent deviation in hand grip strength in girls measured at pre- and post-treatment were 62.60% and decreased to 48.47%, respectively. While in boys they were 71.82% and decreased to 58.88%, respectively as shown in Table 3 .

**Table 2:** Percent deviation of hand grip strength from normative data in girls measured at pre- and post-treatment in the two studied groups (n= 8).

	<b>HGS (mean ± SD)</b>	<b>HGS of normative (mean ± SD)</b>	<b>MD</b>	<b>Percent deviation from normative data</b>
<b>Mirror</b>				
<i>Pre</i>	2.62 ± 0.44	7.52 ± 3.72	4.90 ↓↓	65.09 ± 5.89 ↓↓ (53.46-73.40)
<i>Post</i>	4.56 ± 0.68	7.52 ± 3.72	2.96 ↓↓	39.33 ± 9.02 ↓↓ (20.21-46.81)
<b>Z &amp; p values</b>	-2.588 & 0.010 (S)			
<b>CIMT</b>				
<i>Pre</i>	2.81 ± 0.53	7.52 ± 3.72	4.71 ↓↓	62.60 ± 7.05 ↓↓ (53.46-73.40)
<i>Post</i>	3.88 ± 0.64	7.52 ± 3.72	3.64 ↓↓	48.47 ± 8.52 ↓↓ (33.51-60.11)
<b>Z &amp; p values</b>	-2.549 & 0.011 (S)			

SD: Standard deviation. Z value= Wilcoxon Signed Ranks test. S= p≤ 0.05= significant. HGS: (Hand Grip Strength). MD: Mean difference. n: Number of girls. CIMT : Constraint induced movement therapy.

**Table (3) :** Percent deviation of hand grip strength from normative data in boys measured at pre- and post-treatment in the two studied groups (n= 7).

	<b>HGS (mean ± SD)</b>	<b>HGS of normative (mean ± SD)</b>	<b>MD</b>	<b>Percent deviation from normative data</b>
<b>Mirror</b>				
<i>Pre</i>	2.79 ± 0.76	9.38 ± 4.62	6.59 ↓↓	70.30 ± 8.06 ↓↓ (62.69-78.68)
<i>Post</i>	4.93 ± 0.61	9.38 ± 4.62	4.45 ↓↓	47.46 ± 6.48 ↓↓ (41.36-57.36)
<b>Z &amp; p values</b>	-2.401 & 0.016 (S)			
<b>CIMT</b>				
<i>Pre</i>	2.64 ± 0.56	9.38 ± 4.62	6.74 ↓↓	71.82 ± 5.93 ↓↓ (62.69-78.68)
<i>Post</i>	3.86 ± 0.38	9.38 ± 4.62	5.52 ↓↓	58.88 ± 4.03 ↓↓ (52.03-62.69)
<b>Z &amp; p values</b>	-2.428 & 0.015 (S)			

SD: Standard deviation. Z value= Wilcoxon Signed Ranks test. S= p≤ 0.05= significant. HGS: (Hand Grip Strength). MD: Mean difference. n: Number of boys. CIMT : Constraint induced movement therapy.

## DISCUSSION

Hands are continuously used in everyday activities such as writing, eating, handling and manipulating objects, gripping and many other activities. Hand grip strength has been used as good indicator for the functional integrity of hand and helpful in prediction of the expected hand strength values of an individual.(11)

Choosing the children age agree with Gordon et al. (12) who reported that the child with age of six to nine years can assume hand grip with regular force either to grasp or lift the objects without making them slip through fingers as adult. They also have control on finger tip forces and grasp the pattern became completely matured. Stanely et al.(13) explained that in age of three, the child starts to recognize the mirror visual stimuli and by age of five the mirror visual system will be mature enough which make child able to focus on mirrored tasks and respond to them.

Selecting the study sample suffering from hemiplegic C.P with impairment of hand functional abilities agrees with Brown et al.(14) who reported that hemiplegia children with different degrees of spasticity suffer from variable degrees of hand dysfunction.

The result of current study showed increased percentage of deviation than normal in hand grip strength before intervention may be supported by Gormely (2) who explained that children with hemiplegia have some problems like muscle weakness and defect in motor control that interfere with motor functions and they have delay in acquisition of motor function such as gross and fine motor skills. Pre-treatment results may also agree with Duff (15) who reported that children with hemiplegic CP have inability to use their hands for reach, grasp and manipulate objects which affect many of activities of daily living as eating, dressing, and hand writing. Upper extremity function also plays an important role in gross motor skills as crawling, walking, recovering balance and protective reactions.

The current study showed that mirror therapy in addition to physical therapy rehabilitation program could significantly improve hand grip strength that supported by the opinion of Fadiga and Crighero (16) who reported that mirror neuron are bimodal visual motor neurons that are active during action observation or mental imagery it has been shown that passive observation of an action facilitate primary motor cortex this will lead to stimulation of muscle to

do action .This in turn lead to improve functional activity of paretic limb. According to the strategy of Dohle et al., (17) the child mentally pictured the affected hand movements 'motor imagery', during mirror therapy he/she watched the mirror image of the unaffected hand as if it was the affected one. According to Altschuler (18) mirror therapy activates the mirror neuron which found in front of temporal region and superior temporal gyrus which was fired when an individual either performs or observes a motor action which lead to bilateral premotor cortex activation and increased excitability primary motor cortex on the side of the affected limb.

(Decconinck et al., (19) also explained the impact of the visual stimulus [mirror visual feedback (MVF)] on the brain is thought to cause cortical reorganization, therefore enhancing motor recovery of the paretic limb. Decreasing the percetange of deviation of hand grip strength from normal of hand grip strength in patients treated by mirror therapy in the current study may be attributed to the visual illusion of mirror therapy which may enhance activity of the primary motor cortex and increasing the descending neural drive from the brain to the muscles .which may explained by the work of

Gygax et al., (20) who stated that the illusion of a functional paretic upper limb in mirror seemed to have an immediate effect on motor unit recruitment.

Decreasing percentage of deviation from normal in children treated with CIMT in the current study due to significant improvement in hand grip strength this agree with the study of Taub et al., (4) who recorded that improving hand function after CIMT is due to increasing cortical representation of the affected upper limb and increasing of neural imaging that result from repetitive practice. Liepert et al., (21) who used trans-magnetic stimulation to study six patient before and after 14 days of CIMT and observed neural recovery in the motor area adjacent to the damaged neural region. This in turn lead to improve neural plasticity in those patients. Tarrka et al., (22) agree with the result of current study in improvement hand function they used EEG as a method of evaluation of four hemiplegic subjects who received intervention with constraining therapy they found plastic changes after treatment and large activation in the motor cortex, premotor cortex and the motor cortex, premotor cortex and the primary motor area in both hemisphere that in turn lead to a significant increase of

affected hand functionally. The result of the current study in CIMT group comes in agreement of many authors (23,24) who reported that child with hemiplegia may have neural tissue that is underutilized, constraint induced movement therapy might be especially well suited for use with hemiplegic children because of great capacity for plasticity in the developing nervous system.

## CONCLUSION

Both techniques (mirror therapy and constraining induced therapy) have decreased deviation from normal children in hand grip strength but the mirror therapy was lesser in its value of deviation of hand grip strength from normal than CIMT as it has more significant improvement in hand grip strength than CIMT in hemiplegic children.

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