

Case Report

Can constraint induced movement therapy improve In-Hand Manipulation skills: a single subject design

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This study describes a single subject design (ABA) that shows the effective use of constraint induced movement therapy in improvement of quality and performance of in-hand manipulation skills for a 10 year old boy and a 9 years old girl with hemiplegic cerebral palsy, as Dickerson (2007) showed it in arm movement and function.

Objective: To determine the effectiveness of CIMT by the use of C-statistic analysis and visual analysis. The first step was to design a child friendly group activity and home based intervention program through occupation. The possible effectiveness of CIMT was evaluated by daily measurements and video recording of 6 sub skills of in-hand manipulation according to Pont category (2009) in defined activity.

Practice Implication: For making the treatment more cost effective, families can produce a simple clinical setting at home and participate in their child treatment plan actively.

Conclusion: A client center intervention will facilitate the use and quality of fingers and hand motion. Also a group activity can motivate participants to participate more and better.

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Introduction

One of the causes of child disability is cerebral palsy with the prevalence of 1 in 500 births. Of these, 35% of children are diagnosed with hemiplegia and usually have more limitation in their upper extremities than lower extremities. Following these disabilities, particularly upper limb disability, performance and participation in the areas of self-care, home and school are reduced. (1) Traditional therapies for patients with Cerebral Palsy especially hemiplegia mainly focused on the affected side awareness, training individuals to use the affected side in activities with the intact side, preparing the individual for performance with increased trunk control, weight shifting and stabilizing proximal parts of the limbs and the use of neurodevelopment techniques although research shows they have short-term and sometimes minor effects. Therefore, innovative and effective methods are required to be used. (2-4)

Many patients use compensatory techniques rather than the upper extremity use. This compensatory technique can lead to learned non-use and limitation in progression of the function of the affected limb. Constraint induced movement therapy is an innovative approach to the hemiplegia, facilitating the upper limb movement, and research shows that it can be a successful method in adults and children (5-8) Theoretically, constraint induced movement therapy can overcome the acquired non-use in the affected side in patients with hemiplegia and activate neuroplasticity for more effective patterns. It is assumed that constraint induced movement therapy neutralizes incompatible changes in the brain function that is the result of central nervous system damage, with a force towards the cortical reorganization in the used side. These results in plasticity changes related to improvement in the brain function after damage. Studies of brain before, during and after constraint induced movement

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therapy show documents of plasticity and cortical reorganization. (8, 10)

Although previous studies have primarily shown the effect of constraint induced movement therapy on adults with stroke but many studies on children also indicate the impact of these methods of therapy. Charles and colleagues in 2007 showed that there were effective changes in 3 children with cerebral palsy during 14 consecutive days of therapy programs for 6 hours per day in limb functions including dexterity, coordination and sensory discrimination.(11) In another study on a 15 month child it was shown that substantial changes have occurred in power, control and use of the affected side following the use of constraint induced movement therapy method and then the effect of this method has lasted for 1.5 years after the intervention.(12) Another study has shown that after using constraint induced movement therapy techniques, there was a dramatic progression in bringing both hands together on the midline of the body, supination and pronation of the forearm, taking objects with hands, transferring of a cube between arms, using the index finger in games, eating food with fingers, using spoon to eat, taking, dropping and manipulating small objects in games and daily living activities. (13-15) In a study by Dickerson and Brown an intervention period of 21 consecutive days (six hour program a day at home) was done, helping to improve performance of the hand to reach the objects, the use of the affected arm, active range of motion, opening hand, pushing power and taking objects and the simultaneous use of both hands. (5) On the other hand, occupational therapists know that in hand manipulation skills are one of the important components of fine motor skills. It is strongly related to hand writing and self care skills. (16) From the Pont and colleagues point of view, in hand manipulation skills different components are included based on their new division in 2009. These components include finger to palm transfer, palm to finger transfer, simple shift, complex shift, simple rotation and complex rotation. (16-17)

Considering the great importance of in hand manipulation skills in the everyday life of individuals and also considering that the major articles about constraint induced movement therapy mentioned indirectly the impact of this approach on improving in hand manipulation skills, we decided to study the impact of using constraint induced movement therapy on in hand manipulation skills of children

specifically. Also, this study combines individual and group interventions and also clinical and home interventions. This aspect is important because there were few studies in literature review based on combination interventions. According to the study condition, it was not possible to find our special study patients and using this special method was very difficult in large number of cases. So a single subject research study method was used.

Method

A single subject design is a study from the case series studies that has been designed for three phases (pre-intervention (base line), intervention and post intervention (follow up)). At the beginning of the study, we informed our participants' families about our study and offered answers to their questions and ensured parental consent to confidential information and gave them written home programs.

Child no1(Shahab) was a boy about 10 years and two months with a diagnosis of mild cerebral palsy (right hemiplegia), ready to attend the fifth grade with very good educational background, full gestational age, without the medical or other psychiatric diagnosis. He had just received occupational therapy programs about seven months before the study, two times a week. During the study period, he had no deformation in any joints and only had problems in fine motor skills and manual dexterity. He received number 1 based on modified Ashworth scale. He had very high motivation to participate in this new method of therapy programs.

Child No. 2 (Negin) was a 9 year and 5 month girl diagnosed by brain hemorrhage at age 4. She had continuously participated in rehabilitation programs especially occupational therapy since age 4. Although learning disability was not confirmed, her school records indicated that there were problems with reading skills. She used the affected side less than the other side in activities of daily living and had moderate performance in bilateral activities. Based on modified Ashworth scale, she received number 2. She was heavily dependent on her mother and showed less motivation to participate in treatment plan. Both families were from middle socioeconomic class in Shiraz city.

Two removable splints made of polypropylene made of the material formed at temperatures above 200 ° C (high temperature materials) for both the children's right upper extremity were used to limit the movement of the intact side. These splints were

immobilized from the above part of the elbow to fingertips. Elbow was positioned in 90 with neutral wrist, palmar abduction thumb and 4 other fingers in semi-flexion. (5, 14, 19)

Since there was no standard test to evaluate the performance of hand skills, we used the newest category system for assessment of performance and quality of in hand manipulation skill. This test includes six sections for quality and performance of finger to palm transfer, palm to finger transfer, simple shift, complex shift, simple rotation and complex rotation. The quality of each subscale was scored from 0 to 4 and performance including frequency, rate and duration. Frequency is the amount of repetition in a certain behavior. Rate includes the amount of certain behavior in a specific timeframe and duration is the time range in which a behavior is happening. Considering the test design, frequency of the finger to palm transfer, frequency of the palm to finger transfer, rate of simple shift, rate of complex shift, duration of simple rotation, rate of complex rotation were assessed. Finally, each child received scores in 12 cases based on performance and quality of movements (for the test (see Appendix). It was camera recorded to ensure data integrity during the evaluation.

A) Pre-intervention phase

During the first day until the eighth, both children took part in a separate assessment sessions from 10 to 15 minutes, in a certain time of day.

B) Intervention phase

The intact limb was limited by splint in most of the awaking time during the ninth to thirtieth day. But children had permission to remove the splint in the time of shower, sleep and a very short period of rest during the day. During the 21 days of intervention, we processed the assessment for both children in a certain time of day and then both children participated in a group of occupational therapy jointly for 30 minutes every session in a clinic. Parallel and cooperative groups were used with the aim to strengthen hand skills, especially in hand manipulation skills through behavioral perspectives (shaping method). Occupational therapists worked on different skills such as reaching, grasping, carrying, releasing and in hand manipulation skills. Note that the test items were not included in the therapy plan during all sessions. Group activities included the use of common forms of pulp making, painting

pictures, and making different shapes with small star shaped legos and playing with marbles and other items. Program activities at home included various self-help, play and recreational activities and organized activities requested by occupational therapists for 6 hours a day.

Due to three weekends of 21 consecutive, 18 days of treatment evaluation was done in the occupational therapy clinic.

C) Post intervention phase (follow up)

After the end of the intervention, both splints were delivered to therapists. After a week away from intervention phase, children were re-evaluated from day 31-38th of the study. Assessment was exactly done like the pre-intervention phase. To review changes in the quality and performance skills within the in hand manipulation skills during different phases, C statistics (a method of analyzing time series used in small sets of data) were used. The purpose of this statistical method is to study those changes in data over time statistically. At first, the process changes of pre-intervention phase were studied and if it was not significant, the data in two stages including pre -intervention and intervention phases were combined and the data of this series were re-processed. If there were significant differences, it indicates the effectiveness of the treatment. C statistics is calculated through eight stages step by step using computer. Following the process step by combining pre-intervention, intervention data and follow up, it can also be explained about the stability and maintenance of interventions related to pre-intervention and intervention phases.

Performance of the left hand and fingers was recorded for 6 sub skills of In-hand manipulation, using frequency, rate and duration. Frequency is the number of occurrences of a repeating event per unit time, rate is the frequency relative to a time unit, and duration is the period of time during which something continues. The sub skills that we defined as behavior include:

- 1) Frequency of transferring a coin from finger to palm.
- 2) Frequency of transferring a coin from palm to finger.
- 3) Rate of bead to string.
- 4) Rate of walking on the pencil by finger.
- 5) Rate of rotating a pen between fingers 0-360°.
- 6) Duration of opening the battle cap.

For each behavior, we designed a quality rating scale to record the quality of performance according to 0-4 scores system. Score 4 showed the highest quality and score 0 showed the lowest quality (see the appendix for description of behaviors and quality rating scale).

Each behavior was observed and recorded during pre CIMT (A), CIMT intervention (B), and 1 week follow-up period (A). During the evaluation, the unaffected hand was restrained by splint in pre- and intervention phase and by the therapist in post-intervention because of removing the splint in that phase. Also, it is noteworthy that we used video recording for accurate scoring and adjusted the scores recorded by researchers and the scores recorded after video tape observation, making the measurement more accurate. Line graph was used for visual analysis of variations, trend and slope in

each graph for each behavior during each phase of the study. Mean and standard deviation were used to summarize the quality rating. In addition, C-statistics, a method of time series analysis that can be used on small data sets to evaluate the effects of treatment interventions, was used to determine statistically significant changes over time.

Result

All the scores of each behavior were stable during the first 8 days of pre- intervention phase for 2 children .Here, the results are reported for each child separately:

Child number 1:

At first, pay attention to Table 1, revealing details about significance level of variable changes.

Table 1. z-scores of varuable related to in-hand manipulation skills

IHM sub items	A	B	C	D	E	F	G	H	I	J	K	L
B	1.39	1.39	1.39	1.39	1.39	1.39	0	0	0	1.39	0	0
T	0.08	0.48	2.21	3.2	4.27	3.5	3.87	3.24	0	2.74	2.73	1.61
F	0	2.16	1.99	0.81	0	0.31	1.39	1.39	0	0	0	2.14
BT	0.06	1.22	2.77	4.43	5.16	4.45	4.6	4.36	0	3.79	4.2	3.15
FT	0.26	0.51	2.58	3.51	5.06	4.34	4.07	3.94	0	3.83	3.4	3.67
FB	3.52	2.5	2.57	3.66	3.74	3.45	0.28	3.98	0	3.08	3.73	3.89

(Z-score > 1.68) is significant the underline scores in the table.

A: quality of finger to palm transfer. B: frequency of finger to palm transfer. C: quality of palm to finger transfer. D: frequency of palm to finger transfer. E: quality of simple shift. F: rate of simple shift. G: quality of complex shift. H: rate of complex shift. I: quality of simple rotation. J: duration of simple rotation. K: quality of complex rotation. L: rate of complex rotation.

B: baseline. T: intervention phase. F: follow up phase. BT: combination baseline & intervention. FT: combination follow up & intervention. FB: combination follow up & baseline.

During the intervention phase, performance rating of transfer, shift and rotation increased significantly except for the frequency of finger to palm transfer and rate of complex rotation. The changes showed more use of the affected fingers and hand in this phase. In the follow up period, there was a fluctuation in the trend of improvement as shown in t Figure1. The frequency of finger to palm transition decreased but the trend was up to the baseline time but the rate of complex shift was increased during this period. It probably showed the longitudinal effect of treatment in this option. The other variables of performance had a steady trend in this phase of the research. (See Figure 1, 2)

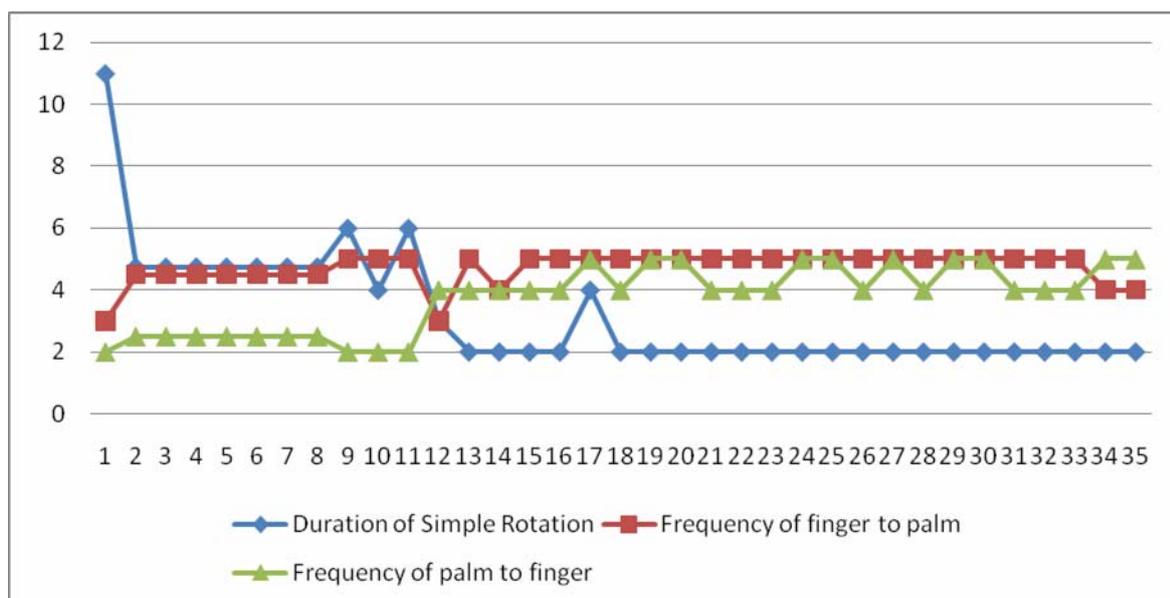


Figure1. Frequency of duration of simple rotation, frequency of palm to finger transfer, frequency of finger to palm transfer

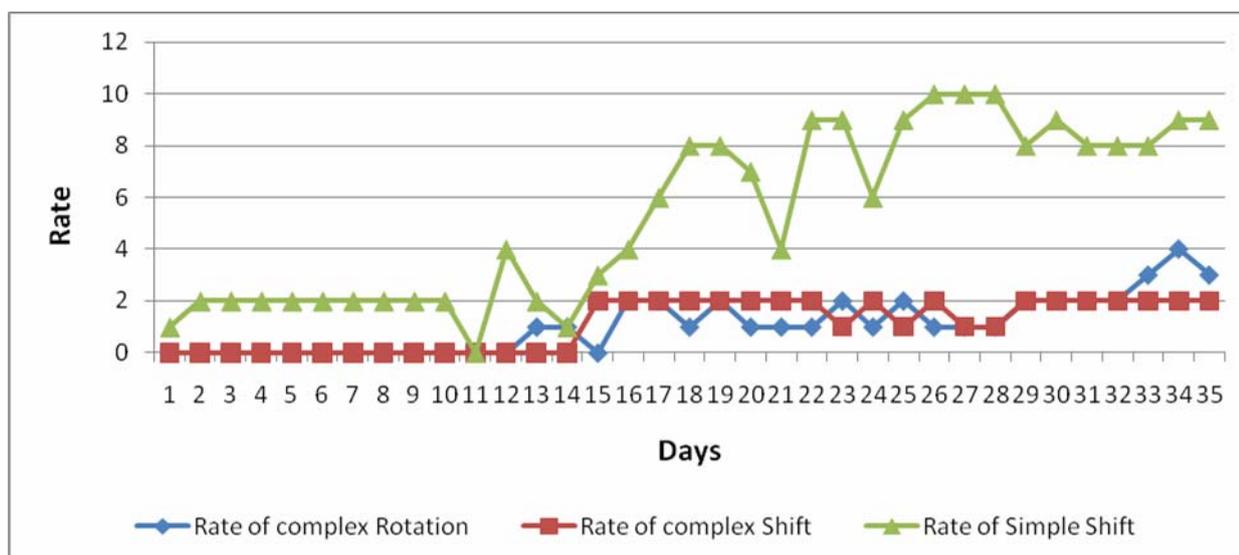


Figure2. Trend of changes in the rate of complex rotation, rate of complex shift, rate of simple shift (Shahab)

Table 2 shows the mean score across phases for performance of transfer, shift and rotation. You can see an overall improvement in the use of fingers and hand in the treatment and post-treatment phase.

During the follow-up phase, changes in the score of duration of simple shift, frequency of palm to finger

transfer, and rate of complex shift remained steady but the frequency of finger to palm transfer and rate of simple shift back to baseline as seen in Figure 2 only the rate of complex rotation get to higher score

Table 2. Mean score of performance of sub skills in 3 phases in the 2 children

Sub skills	Mean (Negin)			Mean (Shahab)		
	baseline	intervention	Follow up	baseline	intervention	Follow up
Frequency of Finger to palm transfer	3.25	3.8	4.6	4.3	4.8	4.7
Frequency of Palm to finger transfer	4	4.1	4	2.4	4	4.5

Sub skills	Mean (Negin)			Mean (Shahab)		
	baseline	intervention	Follow up	baseline	intervention	Follow up
Rate of Simple shift	0	1.2	3	1.8	5.4	8.6
Rate of Complex shift	0	0	0	0	1.2	1.8
Duration of Simple rotation	7.5	4.3	3.25	5.5	2.6	2
Rate of Complex rotation	0	0	0	0	1	2.3

Table 3. Mean score of the quality of subskills performance in 3 phases in the 2 children

Sub skills	Mean (Negin)			Mean (Shahab)		
	baseline	intervention	Follow up	baseline	intervention	Follow up
Quality of Finger to palm transfer	1.58	1.75	2	3.9	3.9	4
Quality of Palm to finger transfer	1	1.6	2	1.9	2.2	2.2
Quality of Simple shift	1.07	1.4	2	1.7	2.6	3
Quality of Complex shift	1	1.3	2	3	3.1	3
Quality of Simple rotation	1.8	1.8	2	3	3	3
Quality of Complex rotation	1.2	1.3	2	2	2.7	3

Variable related to quality rating

Quality rating increased from base line to follow up phase for all behaviors (Table3). The quality of opening the battle cap remained steady during all phases. Although the quality of palm to finger transfer decreased during the follow up phase, it remained above the baseline. A marked improvement was shown in the quality of simple shift since Shahab could move his ulnar and radial fingers as a coordinated unit. Progression in the quality of complex rotation was considerable; He could rotate his fingers consequently in metacarpal joints in the intervention phase, so he could rotate a pen between fingers in 0-270. The quality of walking fingers on the pen showed improvement in the last session of the intervention phase, but this

trend remained at the level of baseline level in the follow up phase.

Child 2:

At first, pay attention to Table 4 for more details about the significance level of the variable changes. The trend that were shown in Figures 3 and 4 indicated a fixed trend of data in the base line phase, but in the intervention phase data related to the duration of simple rotation improved significantly and the time spent for this task decreased. The other variables had no significant improvement. Comparison of the baseline and treatment phases revealed the effect of treatment in the performance of simple shift and simple rotation.

Table 4. Z-scores of variables related to in-hand manipulation skills

IHM sub items	A	B	C	D	E	F	G	H	I	J	K	L
B	1.39	1.39	0	0	1.39	1.39	0	0	1.39	1.39	1.39	0
T	.26	.24	1.85	.48	.93	1.07	2.34	0	0	1.8	.51	0
F	0	1.51	0	0	0	.81	0	0	0	.65	0	0
BT	1.96	.16	3.03	.44	1.76	2.49	2.99	0	.33	3.03	.61	0
FT	.21	.25	2.48	.53	2.41	3.28	3.61	0	0	2.03	2	0
FB	2.69	2.62	3.73	0	3.74	3.87	3.73	0	1.99	3.02	3.73	0

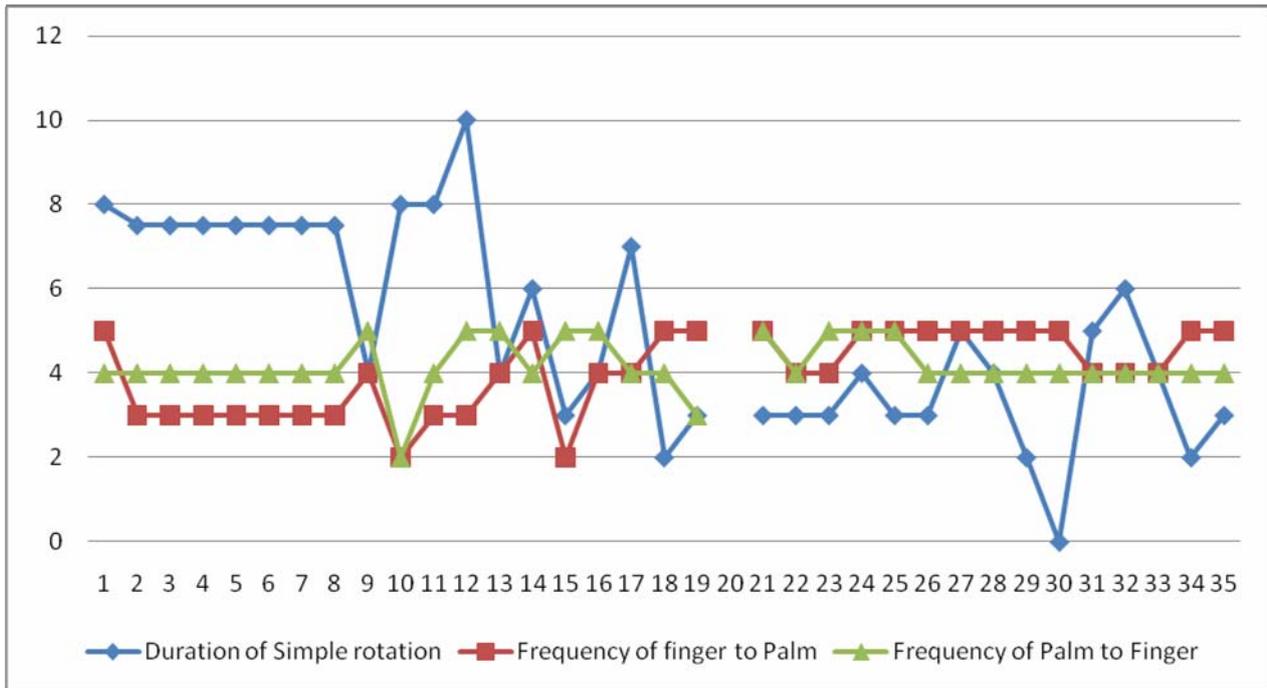


Figure 3. The tend of changes in frequency of duration of simple rotation, frequency of palm to finger transfer, frequency of finger to palm transfer (Negin)

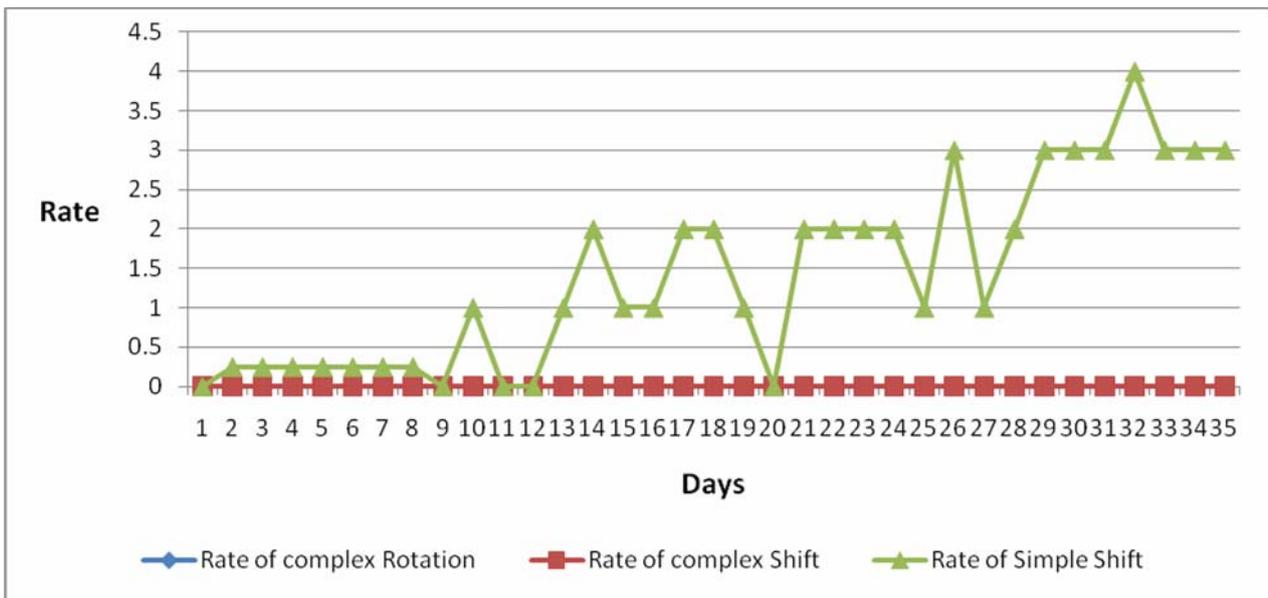


Figure 4. The trend of changes in rate of complex rotation, rate of complex shift ,rate of simple shift (Negin)

The results of both intervention and follow up phases showed the continuous trend of improvement in these 2 variables. Generally data of follow up phase in comparison with base line data indicated the effectiveness of treatment in performance of simple rotation, simple shift and finger to palm transition .Also the mean scores of performance are shown in Table 2

Quality rating

As you see in the Table 3, there was a steady trend in the base line data. This trend improved significantly in the treatment phase for all variables except the simple shift and finger to palm transfer. In the follow up phase, only data related to finger to palm transfer changed up to the intervention level and other variables showed a steady trend

Comparison the follow up phase with base line phase indicated the effect of treatment on the quality of in hand manipulation in this child. The pattern of these changes is shown in Tables 2 and 3.

During the intervention phase, performance rating of transfer, shift and rotation increased significantly except for frequency of finger to palm transfer and rate of complex rotation. Changes showed more use of the affected fingers and hand in this phase. In the follow up period, there was a fluctuation in the trend of improvement. As shown in Figure 1, the frequency of finger to palm transition decreased but the trend was up to the baseline time, but the rate of complex shift was increased during this period, probably showing the longitudinal effect of treatment in this option. The other variables of performance had a steady trend in this phase of research.

Discussion

Child 1(Shahab) had much improvement in performance and quality of in hand manipulation; he even showed improvement in 9 items of 12 items of the test. More impact of treatment was related to the rate of task completion. The quality and performance of transfer skills in the baseline phase was appropriate. This trend remained steady during the intervention and follow up phases; otherwise, Shahab was able to transfer a coin from palm to finger and finger to palm well, but he couldn't open the battle cap in a coordinate way. During the intervention, his duration of opening the battle cap decreased and it received from 11 second to 2 second and he could do it faster. But he couldn't open the cape by continuous coordinate movement of the thumb and other 4 fingers; Sometimes he used extension and ulnar deviation of the wrist to complete the skills. Shift skills improvement continued during post-intervention phase.

Shahab string the beads more accurately and coordinately during and after the treatment. Also duration of string the beads and walking on the pen increased in the intervention and post-intervention phases. So, the effect of CIMT remained after the intervention. On the other hand, the quality of task performance remained steady and there was no improvement in the thumb function in this task. As Dickerson & Brown stated for learning a movement it is necessary for a person to get involved in the task actively. The CIMT method by active engagement of the patient could affect the learning of new tasks in the two children.

The pattern of changes was different in child 2b (Negin): Ashworth scale and performance and quality rating for Negin led severe levels of dysfunction. Her treatment for was more effective in the quality of in hand manipulation skills (finger to palm and palm to finger transfer, simple and complex shift). As there was a considerable improvement in the rate of simple shift and duration of simple rotation

The constancy of the effect of treatment in Shahab was more than Negin. Since at first Shahab had more deficit than Negin, so the treatment had more effect, as Dickerson & Brown (2007) and Tab et al (2003) had shown it. They mentioned that the positive effect of CIMT is related to the degree of the first deficit; definitely, the result in the clients with lower first deficit is more than those with more deficits. (5,14)

Generally, the result showed that children can learn a new movement in the research period but doing an existing movement more coordinately with dexterity is so difficult and needs more exercise and longer time.

It seems that motivation would be another reason for more improvement in Shahab. Motivation is the function of limbic system and research has shown the effect of limbic system on the motor system. Combination of CIMT with a fun and peer-group organized program in a 2 week camping increases the motivation of children for participation in the program, leading to more effectiveness 2009. (20)

Because the 2 participants made a group so community relationship, modeling, reciprocal reinforcement, competition and cooperation induced a successful treatment. Everyone wanted to be better than the others, so they tried hard. Also in the assessment sessions in which every child was evaluated lonely without any other participant, the child had lower levels of effort. It was so surprising. Their family confirmed it as well.

By the use of some activity like painting, making block building and any kind of structured game, the 2 children cooperated in group activity and so it made the treatment more effective, as Eliasson and Gordon showed

Appendix: Assessment of in hand manipulation skills

Finger to palm transition

Objective: lifting coins with finger tips from table and moving them to bring into the palm.

Style of Performance: 5 coins (100 Rials) are placed about 5 cm apart from each other on the table. Once a verbal command is given that includes, please lift coins one by one with fingertips and move your fingers to bring it into your palm of hand and remove on the table and then let go on until the last coin. Number of coins taken to palm and quality of performance are considered.

4 - Bend fingers and lift coin with fingertips and move it to bring into the palm.

3- Bend fingers and lift coin with the help of palm and move it to bring into the palm with fingertips.

2- Bend fingers and lift coin with the help of palm, but can not move coin into the palm with fingertips.

1- Cannot lift coin with the help of palm and fingers

0 - does not attempt

Palm to finger transition

Objective: moving coins from palm of hand to fingertips and remove into bag.

Style of performance: 5 coins (100 Rials) are placed about 5 cm apart from each other on the table. Once a verbal command is given includes that please move the coin that is placed in your palm to your fingertips with movement of your fingers and let remove into bag and go on until the last coin. Number of coins taken from palm to fingertips and removing them into bag and quality of performance are considered.

4- Move coin with the movement of fingers from palm to fingertips and remove it into bag.

3- Move coin with the movement of fingers from palm to middle of finger and remove it into bag.

2-move fingers but can not move coin to middle of finger but remove it into bag.

1- Just open his hand and remove into bag.

0 - does not attempt

Simple shift

Objective: guide string placed between the thumb and other 4 fingers (with the integrated movement of 4 fingers with thumb as a unit) into the cube shaped bead.

Style Of performance: number of cube shaped beads with average size is placed of about 5 cm apart from each other on the table (they are placed in the form that the hole of bead is in front of child's face). Time is considered 2 minutes (120 seconds). Children must guide string that is placed between the thumb and 4 other fingers (with the integrated movement of 4 fingers with thumb as a unit) into the cube shaped bead. Once a verbal command is given

that includes please string number of beads that can in 2 minutes and you do not need to guide the bead until the end of string. Number of beads that is stringed in 2 minutes and quality of performance are considered.

4 - Thumb is moving as an integrated unit with other four fingers and can string beads.

3- Move thumb and index fingers together and fix other three fingers and keeps constant attempt to string beads.

2- Move thumb and index fingers together with not enough coordination and fix other three fingers and keep constant and attempt to string beads.

1- Only press string between the thumb and index fingers and do not move two fingers.

0- does not attempt

Complex Shift

Objective: pencil is placed from the marked place (near the end of it), between the thumb and index finger. Children lead pencil from end marked place to begin marked place (near pencil tip) with coordination and interaction between the two motor units as an integrated units (thumb and index finger as one motor unit and other 3 fingers as another motor unit).

Style Of performance: time is considered as 1 minute (60 seconds). Children must move fingers from the end of the pencil (as marked) to tip of pencil (as marked). To raise awareness of how children can run a task, order of performance is shown just once. Then, once a verbal command is given that includes please lead the pencil from end marked place to beginning marked place with the movement of your finger and then put your pencil on the table and again repeat the task in 1 minute. Number of doing task and quality of performance are considered.

4- Children can lead the pencil from the end part to first part with coordination and interaction between the two integrated motor units (thumb and index finger as one motor unit and other 3 fingers as another motor unit).

3- Thumb and index finger are moved as one motor unit and other three fingers are fixed, But linear transition occurs with no coordination.

2- Thumb and index finger are moved as one motor unit and other three fingers are fixed, but no linear transition occurs.

1- led Pencil with the palm of hand and keep the pencil with palmar grasp.

0- does not attempt

Simple Rotation

Objective: opening the door of jam with interaction and coordination between the two motor units (thumb as one motor unit and other four fingers as another motor unit).

style Of performance: a jar of jam with door is placed in front of children. Jam jar is kept by the therapist. a verbal command is given includes that please open the door of jam with movement of your fingers and hold it up. Time to open the door of jam and the quality of performance are considered.

4-can open door of jam with thumb movement as one motor unit and the other four fingers as another motor unit, in a very good interaction and coordination and constant movement.

3-can open door of jam with Thumb as one motor unit and the other four fingers as another motor unit with not enough interaction and coordination and constant movement.

2-put hand on the door of jam and use finger movement with the help of wrist movement.

1- just use wrist movement

0- does not attempt

Complex Rotation

Objective: can rotate pen (taken from middle) for 180 degrees with separate and individual finger movements.

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Style Of performance: To increase awareness of how children can do task, therapist shows how to do the task once. Then a pen with the door is placed (from the middle) between thumb and index fingers of children. Once a verbal command is given includes that please rotate the pen for 180 degrees that its door places upward and continue rotation. Then repeat the task for 30 seconds. Number of pen rotation for 180 degrees in 30 seconds and quality of performance is considered.

4- Can rotate pen (taken from middle) with separate and individual finger movements for 180-360 degrees.

3- Can rotate pen (taken from middle) with separate and individual finger movements for 90-180 degrees.

2-keep pen with palmar grasp and try to rotate it with movement of fingers.

1-keep pencil with palmar grasp and try to rotate it with the movement of wrist.

0- does not attempt

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