Original Article

Comparison of combination of CIMT and BIM training with CIMT alone on fine Motor Skills of children with Hemiplegic Cerebral Palsy

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Objectives: This study aimed to compare the combination of CIMT and BIM training with CIMT in Fine Motor Skills of Children with Hemiplegic cerebral palsy.

Method: 24 children with hemiplegic cerebral palsy aged between 60 and 120 months participated in this RCT study. They were randomly assigned into CIMT and BIM training (n=12, four males, eight females; mean age±standard deviation =93.58±14.24) and CIMT alone (n=12, six males, six females; mean age±standard deviation = 94.00±18.97) groups. The children in the CIMT and BIM group were received a combination of CIMT and bi-manual training in addition to current occupational therapy. Each session was started with restraint on non-involved upper extremity and practicing with the involved upper extremity for three hours. This was followed with bi-manual training for another three hours. The children in CIMT group received CIMT. Each session was started with restraint on non-involved upper extremity and practicing with the involved upper extremity for six hours. This process lasted for 10 out of 12 consecutive days for both groups. Fine motor skills, upper limb function and muscle tone were assessed using Bruininks-Oseretsky Test of Motor Proficiency, Jebsen-Taylor Test of Hand Function and Modified Ashworth Scale respectively.

Results: Fine motor skills and upper limb function of these children in CIMT and HABIT and CIMT alone groups had significantly improved ($P<0.05$). However, these changes were not significantly different between the two groups before and after intervention ($P>0.05$).

Discussion: Results showed that these two treatment approaches improved fine motor skills in the hemiplegic children with cerebral palsy. None of the interventions are better than the other one. Therefore, it is suggested to use a combination of CIMT and BIM training instead of CIMT alone in order to make the tasks more attractive and easier for the children.

KeyWord: cerebral palsy, hemiplegic, constraint induced movement therapy, bimanual training, rehabilitation.

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Introduction

Cerebral palsy describes as a group of permanent disorders of movement and posture that is caused by non-progressive disturbances that occurs in the developing brain with the incidence of2-2.5per 1000live births in industrialized countries Hemiplegia have accounted for over a third of this estimate (1). Since the integrity of the motor cortex and the cortical-spinal cord for accurate gripe and fine control of hand and fingers are damaged and skilled movements of the fingers and hands do not grow naturally, often they are unwilling to use the affected limb that is called developmental disused (2).

Unilateral defects in children include increased muscle tone, decreased strength, endurance and range of motion, impaired proprioception and touch sense. These defects lead to problems in grip, reach and manipulation of objects (3). Also, bilateral coordination is affected in these children. In other words, doing activities that require both hands is difficult for them (4). Despite having acceptable capacity in affected limb, these children are usually

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performing tasks with their unaffected limb by using compensatory strategies (5). These strategies are strengthened over time making rehabilitation of the affected arm and hand of these children more difficult (1). Defects of upper limb function will lead to problems in all activities such as self-care, school and leisure and/or play activities (6).

Constraints Induced Movement Therapy (CIMT) and Bimanual Intensive Training (BIM training) are well known approaches provided opportunities for children with hemiplegic to practice and so may improve their motor function (7). CIMT is an innovative approach in the treatment of hemiplegia. It is based on two principles: constraints of unaffected limb and at the same time, intensive practice with affected limb. It has been well established that this method is effective therapy for children and adult with hemiplegia (8). BIM training is also complementary for upper limb treatment. It aims to improve bilateral coordination with the usage of structured training with in the functional activities and bimanual games (4). CIMT and BIM training have recently drawn a great deal of attention. Charles et al (1) investigated the impact of CIMT based on the interest of the children with hemiplegia six hours daily for ten consecutive days. The results indicated an improvement in functional movement and skill of upper limb in the treatment group. However, they did not report any changes in strength and muscle tone. Gordon et al examined the influence of BIM training on children with hemiplegia six hours daily, for ten consecutive days (5).The results indicate the effectiveness of the intervention on the functioning and coordination of the upper limb (5). Brandao et al investigated the impact of adapted version of CIMT on children with hemiplegic (9).In this case, the unaffected upper limb was limited to ten hours a day and affected limb was trained intensively for three hours a day. This process was continued until two weeks. During third week the children were given training of bilateral function. Results indicated that this approach improves the performance of activities of daily living (9). Aarts et al examined the impact of modified CIMT on children with hemiplegic (10). In this study, during six weeks, children were received modified CIMT and then they were received two weeks bilateral training. Results showed that this approach improves the spontaneous use of the affected limb (10).

Starting practice with affected limb can lead to improvements in bilateral coordination. However, the principles of motor learning focused on the importance of task-specific training to maximize learning. Therefore, improvements in bilateral coordination would be greater by practicing the skills directly (4). In one hand, CIMT may improve the function of the affected limb; on the other hand, it has several challenges. The most important challenge is ignoring deficit in bilateral coordination in addition to unilateral defects. Bilateral coordination deficit is due to damage known areas of bilateral cooperation, including the supplementary motor area and the parietal lobe. Thus, functional independence in activities increasingly requires the coordinated use of both hands (1).

Considering these issues that using CIMT is aggressive for children and bimanual activities are ignored in this approach. In addition using BIM needs therapist constantly reminds child to use their upper limbs and then cause tiredness for therapist. Regarding this issue, to benefit from the advantages of both approaches, this study intended to use the combination of CIMT and BIM, which had not been done before, to determine the impact of combining the two approaches on the function of affected limb and bilateral coordination.

Methods

This study was a randomized controlled trial. The participants included children between five and ten years old with hemiplegic cerebral palsy (diagnosed by a neurologist).Criteria for inclusion criteria consisted of 1) ability to extend the wrist at least 20 degree and fingers at least 10 degrees of maximum meta carpophalansial joint flexion; 2)at least a 50 percent difference between affected and unaffected limb in the Jobson–Taylor test of motor function having; and 3) have normal intelligence quotient (IQ above 75 scores on the Raven nonverbal test). Exclusion criteria consisted of 1) any resistive seizure to treatment; 2) visual problems that may interfere with the intervention or assessment process; 3) severe muscle spasticity (i.e., grade three and four according to Modified Ashworth scale; 4)treatment with botulinum toxin in upper limb muscle structure during the last six months; 5) previous orthopedic surgery in the affected upper limb; and 6) balance problems when wearing constraints. The parent's written consent was gained prior to the testing and intervention process. This study approved by the Ethics Committee at the University of Social Welfare and Rehabilitation Sciences (USWR).

Sixty four children were screened initially according to their age, diagnosis and medical history from the four occupational therapy clinics of the USWR . Of these, 40 were excluded for the following reasons:22 children due to lack of interest for this study, remote distances, and having a travel plan for the summer, nine children due to severe impairment of the upper limb, five children due to cognitive problems, and four children due to misdiagnosis. 24 children met inclusion criteria and had willing to participate in this study. These children were randomly divided into CIMT and BIM, and CIMT groups. It should be noted that the assessment process was performed by an occupational therapist that was blind to the children's group assignment. Figure 1 shows the progress of the clinical trial.

Treatment Methods - The subjects in the CIMT and BIM group received a combination of CIMT and BIM. At first unaffected upper limb was limited with wearing a sling for three hours. During this time, children completed some tasks with their affected limb. Then, the sling was removed and children completed some tasks with both hands for further three hours. This process was continued for ten days(week days) during two consecutive weeks. In the CIMT group unaffected limb was limited with wearing a sling for six hours and children completed tasks with their affected limb. In all therapy sessions, shaping techniques and repetitive task training were used (7). In order to promote social interaction and providing an appropriate environment for children, the intervention was conducted in groups of four children under the supervision of a trained occupational therapist.

Instruments - In this research three instruments were used to measure results including Jobson–Taylor test of hand function (11), Bruininks-Oseretsky Test of Motor Proficiency (12) and Modified Ashworth scale (13).

Jobson–Taylor test of hand function

To evaluate the unilateral performance of the affected limb, the Jobson–Taylor test of motor function was used. This test has been used primarily in adults. It has also been used with children with eliminating the writing activity and by reducing the maximum time of performance into two minutes to ease frustration (11).

Bruininks-Oseretsky Test of Motor Proficiency

In this study, six items of bilateral coordination, upper limb coordination, and upper limb dexterity and speed subscales of Bruininks-Oseretsky Test of Motor Proficiency was used. These items include: drawing lines and crosses simultaneously, bouncing a ball and catching it with both hands ,catching a tossed ball with both hands, placing coins in two boxes with both hands, sorting shape cards with both hands, and string beads with both hands (12).

Modified Ashworth scale - The Modified Ashworth scale was used to assess muscle tone. Also, a questionnaire was used to collect information on demographic data and medical history (13).

Statistical analysis - Data were analyzed using SPSS software version 16.According to the normality of data distribution, mean comparisons and the mean scores of the dependent variable comparisons were performed using independent t-test and paired t-test respectively.

Results

Twenty four children participated in this study. The CIMT and BIM group consisted of our boys and eight girls and CIMT alone group consisted of six boys and six girls. The mean age in the CIMT and BIM and CIMT groups were 93.58 and 94 months respectively. Independent t-test and paired t-test were used to compare the results with a normal distribution in the two groups before and after intervention. There were no significant differences between the two groups before the intervention Table (1).

Table 1. Compare means with a normal distribution in the two groups before and after intervention

Item	Group	Mean	Sd	Sig
Bruininks-Oseretsky test	CIMT&HABIT	4.58	3.05	1.0
	CIMT	4.58	3.72	
Jobson-Taylor test	CIMT&HABIT	263.91	162.31	0.743
	CIMT	288.41	197.35	
Wrist flexor tone	CIMT&HABIT	1.45	0.49	0.717
	CIMT	1.37	0.60	
Elbow flexor tone	CIMT&HABIT	1.45	0.33	0.210
	CIMT	1.70	0.58	
Shoulder flexor tone	CIMT&HABIT	1.25	0.33	0.832
	CIMT	1.29	0.58	

After the intervention, Bruin inks test score significantly changed from4.58to10 and Jobson–Taylor test score significantly changed from 263. 91 to 146 in CIMT and BIM group. The results of the test also show the effects of the intervention. But there were no significant differences in flexor tone of wrist elbow and shoulder after intervention Table (2).

Table 2. Comparing means in intervention group before and after intervention

Item		Mean	Sd	Sig
Bruininks-Oseretsky test	before intervention	4.58	3.05	0.001 <
	After intervention	10.0	3.64	
Jobson-Taylor test	before intervention	263.91	162.31	0.001 <
	After intervention	146.0	80.23	
wrist flexor tone	before intervention	1.45	0.46	0.082
	After intervention	1.33	0.38	
Elbow flexor tone	before intervention	1.45	0.33	0.166
	After intervention	1.54	0.33	
shoulder flexor tone	before intervention	1.25	0.32	0.220
	After intervention	1.08	0.55	

After the intervention, Bruininks test score significantly changed from 4.58to6.75 and Jobson–Taylor test score significantly changed from 288.41to245.75 in CIMT group. The statistical analysis also demonstrates significant changes. But there were no significant differences in flexor tone of wrist elbow and shoulder after intervention Table (3).

Table 3. comparing means in control group before and after intervention

Item		Mean	Sd	Sig
Bruininks-Oseretsky test	before intervention	4.58	3.72	0.005
	after intervention	6.75	5.49	
Jobson – Taylor test	before intervention	288.41	197.32	0.010
	after intervention	245.75	187.9	
Wrist flexor tone	before intervention	1.37	0.60	0.515
	after intervention	1.25	0.54	
Elbow flexor tone	before intervention	1.70	0.58	0.701
	after intervention	1.62	0.74	
Shoulder flexor tone	before intervention	1.29	0.58	0.074
	after intervention	0.83	0.83	

After the intervention, CIMT and BIM and CIMT groups were not significantly different from each other. It shows that none of the treatment is superior to another Table (4).

Table 4. comparing means in the two groups after intervention

Item		mean	sd	sig
Bruininks-Oseretsky test	CIMT&HABIT	10.0	3.64	1.0
	CIMT	6.75	5.49	
Jobson-Taylor test	CIMT&HABIT	146.0	80.23	0.743
	CIMT	245.75	187.7	
wrist flexor tone	CIMT&HABIT	1.45	0.49	0.717
	CIMT	1.37	0.60	
Elbow flexor tone	CIMT&HABIT	1.45	0.33	0.210
	CIMT	1.70	0.58	
shoulder flexor tone	CIMT&HABIT	1.25	0.33	0.832
	CIMT	1.29	0.58	

Discussion

Intervention effect on upper limb muscle tone - The results of the Modified Ashworth scale did not demonstrate the efficacy of therapeutic interventions on upper limb muscle tone. The results are in agreement with those of Abootalebi et al (2010) and Charles et al (2006) (14,15). This may be due to the nature of the scale that for measuring muscle tensile strength re lies on subjective judgment of the testers. Therefore, this did not show any significant effects during this period of intervention. However, the fine motor subscale of Jobson–Taylor test of motor function results showed the effectiveness of the interventions. This may also be illustrated by the issue that changes in motor function and performance are not associated with muscle tone and improvement in performance can occur without changes in tone.

Intervention effect on upper limb motor function - Significant reduction in the time of doing Jobson-Taylor test tasks was seen after the intervention in both groups. It shows the impact of the intervention on unilateral upper limb function. However, there were no significant difference between treatment and control groups and none of the treatment is superior to another. Overall, the results of the Jobson-Taylor test showed the efficacy of the rapeutic interventions on motor function. Our results support those of Charles et al's study (15). However, the results are in disagreement with those of Brandao et al's study (9), in that, they found no significant differences in the mean of Jobson–Taylor test score. This may be related to the duration of training. While, the time of the practice was six hours a day in our study, it was three hours a day in Brandao et al's study (9).

Intervention effect on fine motor skills- According to bilateral function domain of Bruininks -Oseretsky Test of Motor Proficiency there was significant difference in both treatment and control groups after receiving treatment. However, there was no significant difference between treatment and control groups and none of the treatment is superior to another. Our results support those of Charles et al(2006), Gordon et al (2007) and Aarts et al with this difference that in their studies with unaffected limb was limited with wearing a sling for six hours and children did tasks with their affected limb (1).

In our study, doing activities and tasks with both hands may improve bilateral coordination that is affected in children with hemiplegia. During bilateral activities, unaffected upper limb may provide a model for affected limb. In Gordon's study(5),children did tasks with both hands for 6 hours. They stated that, although BIM training is potentially less invasive, it is often caused problems for therapists regularly asking children to use both hands together. Hemiplegic children have significantly adapted themselves to the use of the unaffected upper limb to perform tasks which their peers perform with both hands, even if the task is performed with more difficulty and less performance. In CIMT approach, restriction of the unaffected limb forced them to use the affected limb with the problem that task should be unilateral. In BIM training approach, tasks for teaching specific coordination skills must be done with both hands. The most frequently, spatial and temporal in spatial were observed in the use of both hands together. Most children have a natural tendency to use compensatory strategies. Although the therapist can simply remind children to use the affected limb, this strategy is not effective when the child is exhausted. Therefore, the therapist must spend a lot of attention in selecting activities and organizing environment. Generally recognizing rules before the operation and recalling them sometimes can be more effective. The therapist should take these laws and environment as a kind of new restrictions. In this study, we used the combination of CIMT and BIM training, so the pressure was distributed between the child and the therapist and tiredness of them was reduced. In other words, the advantages of both approaches were used.

We suggest that future studies should examine the lasting impact of the intervention in the longer period of time. Due to the limited time in our study the impact of long-term follow-up of the intervention results was not possible. Our results suggest that the combination of CIMT and BIM training improves fine motor skills of the upper limb of hemiplegic children. There is no difference between using CIMT alone or combination with BIM. However, it is clinically suggested to use a combination of both interventions for children with CP. This may improve the level of the child’s acceptance and reduce pressures of both therapists and children.

Smith et al. showed that children with ETPKU have specific cognitive deficits in executive function skills in school age. These skills were examined in 2 groups (19 children with PKU and 19 age-, sex-, and IQ-matched controls). Five tasks were given to children; three for measuring executive, or frontal-lobe functions (problem-solving, working memory, and verbal fluency) and two as control measures (verbal memory and spatial perception). Children with PKU performed more poorly on two tasks (the problem-solving and verbal memory tasks). The results suggested that cognitive impairments associated with PKU persist into the school-age years. In addition, cognitive performance in children with PKU was corrected to the phenylalanine (phe) levels negatively at the time of testing; the high-phe group performed consistently more poorly than low-phe group on four of the six measures of the problem-solving task and on the verbal memory task (18). Other evidence also suggested that short-term elevations in blood Phe levels caused by diet holidays, in well-controlled PKU patients can result impairment of mental function (as measured by IQ). Therefore, the concept of the lower the Phe levels the better should change to the concept of stable and low blood Phe levels for a lifetime (19).

Conclusion

The result of this study indicates the importance of laying emphasis on early detection and continuous dietary control in ETPKU individuals with a focus on stabilizing the phe level. Also, it is recommended that developmental follow-up be conducted on all ETPKU infants and if needed, early developmental interventions be done. We hope that this study's findings will set off further studies in the field of developmental assessment and early intervention of ETPKU patients in Iran.

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