EFFECT OF MODIFIED CONSTRAINT INDUCED MOVEMENT THERAPY ON HAND FUNCTION OF HEMIPLEGIC CEREBRAL PALSY

Pranali Thakkar
Sigma Institute of Physiotherapy, Bakrol, Vadodara, Gujarat, India.

ABSTRACT

Introduction: From the last few years constraint induced movement therapy (CIMT), as an intervention, has received a great deal of attention for children with Hemiplegic cerebral palsy (CP). To date, evidence on this treatment has been very poor and limited so additional research required. For various reasons, traditional form of therapy was neither considered feasible nor do child and family friendly for that we had use a modified form of CIMT

Objective: To determine the effectiveness of modified CIMT on hand function of hemiplegic CP children characterized by re-straining the unaffected hand with short glove up to wrist.

Methodology: 10 children (age: 2 to 8 years) from pediatric physiotherapy clinics from Vadodara and Ahmedabad with hemiplegic CP were included in the study. Modified constraint was applied to unaffected hand. The intervention was given for 3 hrs/day including 30 minutes of therapy time and home program which could split into different sessions of no less than 30 minutes duration for consecutive 4 weeks. Pre and Post outcome measure by using QUEST (Quality of upper extremity skill test) and PMAL (pediatric motor activity log) were taken.

Result: Significant difference between Pre and Post values of all components of PMAL and QUEST (P < 0.05) showing the effectiveness of mCIMT in improving hand function and in ADL activities.

Conclusion: mCIMT yields statistically as well as clinically significant improvements in both motor function and functional use of the affected upper extremity in children between the ages of 2 and 8 years with hemiplegic CP.

Key Words: Hemiplegic CP, Modified CIMT, Hand function

INTRODUCTION

Hemiplegia accounts for 35% (1 in 1300) of the children with CP and upper limb (UL) involvement is usually more pronounced than the lower limb.1 If hemiplegic stroke occurs in-utero, or any time between birth and two years of age, it is considered hemiplegic CP.

The most common cause of hemiplegic CP is a CVA (Cerebro vascular accidents) commonly known as a stroke. Children with hemiplegia have unilateral involvement of upper and lower extremities opposite to the side of cerebral injury, often characterized as muscle weakness and spasticity.2 These factors may decrease movement efficiency3, especially in the use of the upper extremity, which can also limit performance in functional activities at home and school.2,4 They often learn to perform many tasks exclusively with their non-involve extremity. This results in failure to use the involved extremity (i.e. developmental disuse). The impairment of the hand is often the result of damage to the motor cortex and cortico spinal pathways responsible for the fine motor control of the fingers and hand.4

Constraint induced movement therapy (CIMT) is a relatively new intervention derived from the basic sciences. In 1995, however, it was suggested that a promising new therapy for adults with hemiparesis consequent to stroke, known as Constraint-Induced Movement therapy.6,9

The CIMT protocol stems directly from basic research with monkeys.6,10 CIMT has been adopted as a method of teaching a child to use his/ her affected upper limb through use of a restraint on the non-affected limb and massed practice of movements of the affected limb.11

Corresponding Author:
Pranali Thakkar, Sigma Institute of Physiotherapy, Bakrol, Vadodara, Gujarat, India, E-mail: dr.pranalithakkar27@gmail.com

Received: 27.05.2014 Revised: 25.06.2014 Accepted: 21.07.2014
The elements of CIMT are:

1) Constraint of the unaffected arm to encourage the use of the affected hand,
2) Practice of the affected arm and
3) Use of intensive techniques to train the affected arm.\textsuperscript{12}

A Cochrane review concluded that there was emerging evidence supporting CIMT for children with hemiplegia.\textsuperscript{13}

Therapy accompanied in CIMT is constraint given for 6 hours per day. For various reasons, traditional form of therapy was neither considered feasible nor do child and family friendly for that we had use a modified form of CIMT

A number of variations are used in mCIMT. Modified CIMT (mCIMT) involve the application of a restraint with less than three hours per day\textsuperscript{11} and Type of constraint use can be different

Modification of this approach for children with CP has followed, but until recently efficacy was limited to case reports and small prospective studies.\textsuperscript{4,13-15}

Need for this study was to overcome these methodological problems and design a trial that can give evidence on modified CIMT (Modified constraint) effect.

This study presents the methodological choice (with less duration and short comfortable glove to the unaffected side for 3hrs per day) and to see the effectiveness of Modified CIMT (as a restraint glove combined with an intensive rehabilitation and home program) on hand function of hemiplegic CP children.

**MATERIAL AND METHODS**

**Ethical approval:** Study was approved by Ethical committee of Sumandeep Vidyapeeth University and From pediatric physiotherapy centers of Vadodara and Ahmedabad, from where Participants met with inclusion criteria for the study was found and approval letters were taken from that physiotherapy centers. Permission for outcome measure scale (QUEST and PMAL) was taken by e-mail from author.

**Research Design:** Single group pretest posttest design.

**Source of data:** Pediatric Physiotherapy clinics of Vadodara and Ahmedabad

**Sampling method:** Convenient sampling

**Sample size:** 10 Patients

**Inclusion Criteria**

- Participants with diagnosis of spastic hemiplegic cerebral palsy as diagnosed and reported in the medical history by a Physician
- Age between 2 to 8 years
- Active movement of the shoulder, elbow, wrist, digits and thumb of the affected upper limb, such that the: child is able to reach forward to an elevated position In front with mid-range shoulder flexion\textsuperscript{10,17}
- Ability to extend wrist $>20^\circ$ and fingers at the meta carphalangeal joints $>10^\circ$ from full flexion\textsuperscript{10,17}
- Able to attend the tasks and follow simple commands
- Muscle tone (i.e. 1-2, modified Ashworth scale)
- Parents who are willing to commit for an intensive therapy program and agree to cease all other upper limb therapeutic interventions for the 4 weeks period of the trial.

**Exclusion Criteria**

- Known case of seizure and on anti–epileptic drugs
- Visual problems interfering with treatment
- Any surgery on the paretic hand within past 1 year
- Botulinum toxin therapy in the upper extremity within the past 6 month

**Sample Recruitment**

**Targeted Population:** Hemiplegic CP

**Accessible Population:** Physiotherapy clinics of Vadodara and Ahmedabad

Subjects Met with inclusion criteria from 4 clinics

N = 11

Drop out N=1 (due to uncomfortable with glove parents wants to discontinue)

Total Sample size

N =10

**Procedure**

Parents and Children (who were understandable) were explained about the study. Informed consent were obtained from parents prior to study.

Modified Constraint Induced Movement Therapy (mCIMT):
Subjects participated in the study were provided to wear a fairly comfortable glove by Principal Investigator, as a modified restraint up to wrist is used which covers fingers, thumb and hand to avoid hand function of unaffected side. The subjects can however use the hand for support or for breaking a fall. (Figure: 1)

The intervention was given for 3 hours/day including therapy time and home program which they can split into different sessions of no less than 30 minutes duration for consecutive 4 weeks (week days). 3 hours was decided according to children play time when maximum use of hand was needed.

According to assessment, treatment plan based on unimanual activities were given.

Treatment protocol

- Reach out activities (forward, Lateral and backward reach-figure:3-5)
- Grasping and releasing activities (using different size of cubes and different shape things e.g. Pencil, eraser, toys, glass etc.)
- Fine motor movements (figure:7-10)
- Protective function exercise
- Resisted exe. For improving strength
- Hand weight bearing exercise (forward, lateral, backward)
- Functional ADL and play activities (figure : 6)
- Goal oriented activities

Activities were facilitated by using simple verbal commands, encouragement, toys, demonstration and assistance was given when needed.

Family members and / care givers were explained to undertake an intensive home program for 3 hours per day. Families were provided with specific goals after each session.

Logbook (Work diary) - was given to primary care giver for collecting details of child activity during that 3 hour time period.

Outcome measure
The motor outcome was measured by using,

PMAL (Pediatric motor activity scale) 18, 19(How often and how well) and

QUEST (Quality of Upper Extremity Skill Test) 20(dissociated movement, grasp, protective extension, and weight bearing)

Prior to treatment and after 4 week of treatment

Materials used in the study

- Restraint (a glove) (Figure: 1)
- Different Toys (figure : 2)

Statistical Analysis:
Data analysis was done by using SPSS 17 for windows, for both outcome measures PMAL and QUEST by statisti-
Thakkar et al.: Effect of modified constraint induced movement therapy on hand function of hemiplegic cerebral palsy

Mean difference scores and Standard deviation for each variable were done. Wilcoxon signed rank test (as qualitative data) was used for data analysis. A significance level of 0.05 was set for all data analysis.

**RESULT**

Children in the study were aged between 2 to 8 years (the mean age was 5.25 years). There were of (60%) boys and (40%) girls, and equal numbers with the left or right arm affected. (Table 1, 2&3)(Graph 1&2)

Result of PMAL in which p value (p<0.05) showing significant difference between Pre and post value of amount of use, quality of use and average score showing in (Table: 4, Graph: 3)

Result of QUEST in which p value (p<0.05) showing significance difference between pre and post values for dissociated movements, grasp, protective extension and weight-bearing but mean difference less in protective extension and weight bearing showing in (Table: 5, Graph: 4)
DISCUSSION

This study was planned to see the effectiveness of Modified CIMT that is on hand function of hemiplegic CP children. In the QUEST there was significant improvement seen in overall 4 domains but less improvement in weight bearing and protective Extension. Results from this study are consistent with other studies in showing a significant improvement in upper limb function after mCIMT in children.13,14,21 In this study most families did

Table 1: Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2</td>
<td>8</td>
<td>5.25</td>
<td>±1.82</td>
</tr>
</tbody>
</table>

Table 2: Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>60%</td>
<td>40%</td>
</tr>
</tbody>
</table>

Table 3: Affected side

<table>
<thead>
<tr>
<th>Variable</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affected side</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 4: Mean, SD and p-value for PMAL score

<table>
<thead>
<tr>
<th>PMAL</th>
<th>Pre</th>
<th>Post</th>
<th>p-value</th>
<th>z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>How Often</td>
<td>1.36</td>
<td>± 0.83</td>
<td>1.77</td>
<td>± 0.88</td>
</tr>
<tr>
<td>How Well</td>
<td>1.56</td>
<td>± 0.91</td>
<td>1.83</td>
<td>± 0.95</td>
</tr>
<tr>
<td>Average</td>
<td>1.46</td>
<td>± 0.86</td>
<td>1.80</td>
<td>± 0.91</td>
</tr>
</tbody>
</table>

Graph 1: Gender

Graph 2: Affected side

Graph 3: Mean differences between Pre and Post values Of How Often, How well and average Score

Graph 4: Mean differences between Pre and Post values For Dissociated movement, Grasp, Weight bearing, Protective Extension and Total scor

Figure 10: Fine motor activity -4
not find it easy to complete even modified CIMT. Some children disliked wearing the glove and some have complaint of uneasiness due to close glove.

Studies in adults following stroke have provided evidence of adaptation in the brain following CIMT.\textsuperscript{22, 23} Since the potential for central nervous system plasticity in young children is increased relative to adults,\textsuperscript{24-26} it is postulated that this approach might prove to be especially effective in children.\textsuperscript{27} In one study found that bilateral cortical activation was increased following mCIMT including higher levels of activity in the contralateral sensorimotor cortex. This suggests that with mCIMT, cortical reorganization occurs as new pathways between the damaged and healthy cortical hemisphere are made and control of the affected UE moves towards coming from the contralateral (lesion) hemisphere rather than solely from the ipsilateral hemisphere.\textsuperscript{27} Secondly, The motor learning literature suggests that CIMT employs massed practice to increase the tendency of patients to use their more impaired limb, and thereby induces a use-dependent functional reorganization of brain structures.\textsuperscript{28}

Taub’s study involved restraining children in casts for 24 hours per day for 1 month, with and without structured practice. Our study, as well as Eliasson’s, succeeded in being ‘child friendly’ by reducing the number of hours that children were restrained while still improving motor performance in the involved hand and embedding practice in play activities with intensive rehabilitation programme.\textsuperscript{8} Although in one study they have concluded that Improvement in hand function is not captured by any one measure. The effectiveness of this intervention is promising but may be dependent on the age, severity of the impairment, cognitive abilities and behavior.\textsuperscript{29} Clinically Overall, this intervention improve in hand function of involved upper extremity in a selected group of children with hemiplegic CP. In this study no side effects of restraint was found.

**Limitation of the study**
- Small sample size
- No comparison with control group so can’t comment on that modified CIMT is more better than the conventional therapy
- No Long term follow up

**Further recommendation**
- Long-term follow-up for amount of time required for stable performance following this type of training
- Multiple intervention episodes of Pediatric mCIMT with a larger sample of children with Hemiplegic CP and to see whether functional changes relate to cortical reorganization and, if so whether changes vary as a function of age

**CONCLUSION**

In conclusion, the planning and implementation of this multisite study on the efficacy of modified CIMT in hemiplegic CP children shows that interventions are safe, effective and worthwhile. Modified constraint induced movement therapy yields clinically as well as statistically significant improvements in both motor function and functional use of the affected upper extremity in children between the ages of 2 and 8 years with hemiplegic cerebral palsy. In this study we found that modified CIMT is a feasible and tolerable intervention for children with hemiplegic CP children. The results obtained seem particularly important for the current rehabilitation practice for hemiplegic CP with modified CIMT.

**ACKNOWLEDGEMENT**

Author would like to express sincere gratitude to Dr. A. Jagatheesan, Dr. Mandar, Dr. Lata A. Parmar, Dr. Pallavi Barochiya, Dr. Savji A. Nakum, Dr. Piyusha, Dr. Diwakar, Mansi Parikh, Rupal Shah, Shivam, Nirali, Mitali for their direct and indirect contribution in the work.

Author acknowledges the immense help received from the scholars whose articles are cited and included in ref-

**Table 5: Mean, SD and p-value for QUEST score**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre Mean</th>
<th>Pre SD</th>
<th>Post Mean</th>
<th>Post SD</th>
<th>P value</th>
<th>z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissociated Movement</td>
<td>75.00</td>
<td>±9.83</td>
<td>82.65</td>
<td>±8.93</td>
<td>0.005</td>
<td>-2.807</td>
</tr>
<tr>
<td>Grasp</td>
<td>54.27</td>
<td>±17.58</td>
<td>62.21</td>
<td>±19.34</td>
<td>0.008</td>
<td>-2.668</td>
</tr>
<tr>
<td>Weight Bearing</td>
<td>73.27</td>
<td>14.83</td>
<td>79.07</td>
<td>±11.23</td>
<td>0.027</td>
<td>-2.207</td>
</tr>
<tr>
<td>Protective Extension</td>
<td>36.92</td>
<td>±10.46</td>
<td>44.16</td>
<td>±10.83</td>
<td>0.026</td>
<td>-2.226</td>
</tr>
<tr>
<td>Total</td>
<td>59.86</td>
<td>±10.84</td>
<td>67.01</td>
<td>±10.12</td>
<td>0.005</td>
<td>-2.803</td>
</tr>
</tbody>
</table>
ferences of this manuscript. She is also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

ABBREVIATION

CP : Cerebral Palsy
CIMT : Constraint Induced Movement Therapy
mCIMT : modified Constraint Induced Movement Therapy
UE : Upper Extremity
QUEST : Quality of Upper Extremity Skill Test
PMAL : Pediatric Motor Activity Log scale
CVA : Cerebrovascular accident
HO : How Often
HW : How Well

REFERENCES

27. Sutcliffe TL, Gaetz WC, Logan WJ, Cheyne DO, Fehlings DL: Cortical reorganization after modified constraint-induced
