

The Magical Pouch Program: A case study of Modified Constraint Induced Movement therapy with Bimanual Training on a child with unilateral spastic cerebral palsy

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Abstract

Objective: The purpose of the case study is to assess the effectiveness of play based family centered modified constraint induced movement therapy (mCIMT) with bimanual training (BiT) on the child's participation in meaningful occupations.

Method: 4 year old girl with unilateral spastic cerebral palsy had 8 weeks of mCIMT-BiT intervention for 60mins twice a week. The Canadian Occupational Performance Measure, Beery Developmental Test of Visual Motor Integration, Bruininks-Oseretsky Test of Motor Proficiency and Hand Awareness scale were used to assess outcomes.

Results: The quantitative outcome measures did not show any significant changes in the scores. Though COPM showed significant increase in performance measure of predecided occupations. The mother reported improvements in the quality of movements of the affected hand along with amount of use and willingness to use the hand. She also reported reduction in prompts to use the affected hand by 60%.

Conclusion: Positive changes were seen on the measures which provided family centered information on functional change as it was meaningful for both the child and the family. Thus concluding a positive trend favoring play based, family centered mCIMT- BiT model of service delivery. Future references for more sensitive quantitative outcome measure and intensity of intervention is discussed.

Introduction

Constraint Induced movement therapy (CIMT) as a treatment approach designed for adults with hemiparesis mainly due to stroke and children with hemiplegic cerebral palsy. CIMT involves constraint of the less-involved upper extremity and repetitive massed practice of the upper extremity skills of the impaired arm.¹ In a systematic review conducted by Novak.L et al for state of evidence of interventions for children with cerebral palsy, constraint induced movement therapy was considered as a green light 'do it' intervention with substantial supporting evidence.² The Cochrane review to evaluate the effectiveness of CIMT concludes a positive trend favoring the use of the intervention in children with hemiplegia but on experimental basis.³ In recent years CIMT has been proposed as treatment for adults with hemiparesis due to stroke and children with unilateral spastic cerebral palsy. It aims to improve the use of the affected arm and hand in qualitative and quantitative aspects.

Children with unilateral spastic cerebral palsy face many challenges to participate in age appropriate occupations like play, dressing self etc. They use their affected hand with reduced frequency as well as with lower quality when compared to the unaffected hand.^{4,5} In cerebral palsy there is marked contraction in the size of the cortical representation of the more affected arm. As a child tries to use the affected arm, the movement is effortful and disorganized. This usually leads to failure in use of the affected hand leading to vicious spiral downwards that result in learned non-use of the affected extremity which is normally permanent leading to developmental disregard.⁶(fig 1) Developmental disregard evolves from the sensorimotor disorder as the affected arm does not receive sufficient practice and experience throughout childhood.⁶ (Fig 1)

However learned non-use can be reversed by application of CIMT which increases the size of cortical representation of the affected arm through intensive training and restraint of the unaffected arm.⁷ The experience of correctly using the hand leads to both reversal of the behavioural aspects of the suppression of the affected arm use and to reward the limb's use in even simple tasks like stabilization of an object.^{8,9} (Fig 2)

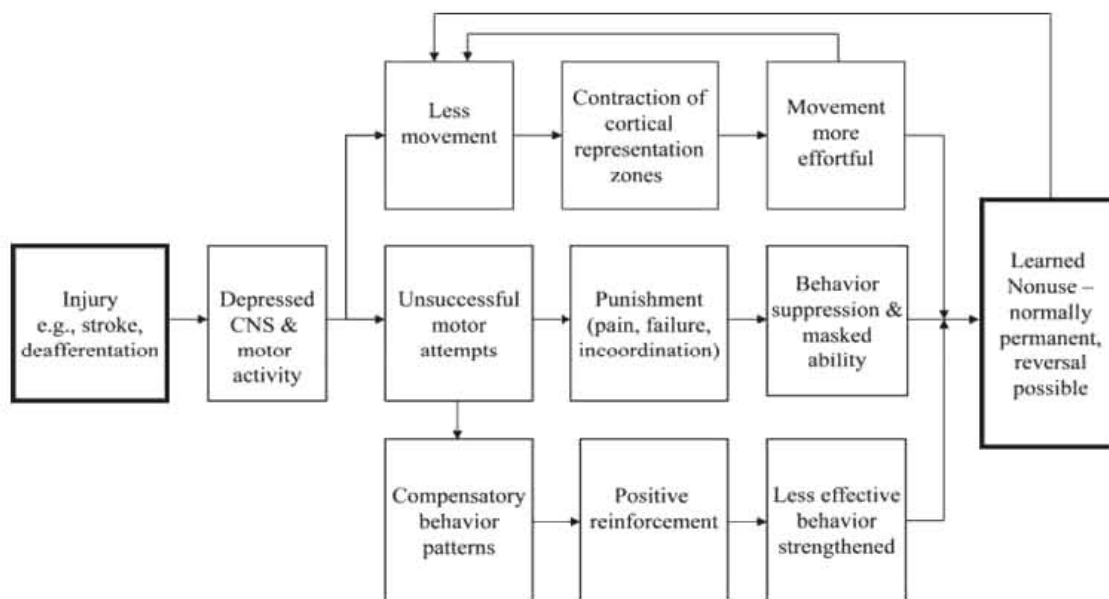


Fig 1: Explaining the pathway for development of learned non-use of the impaired arm.

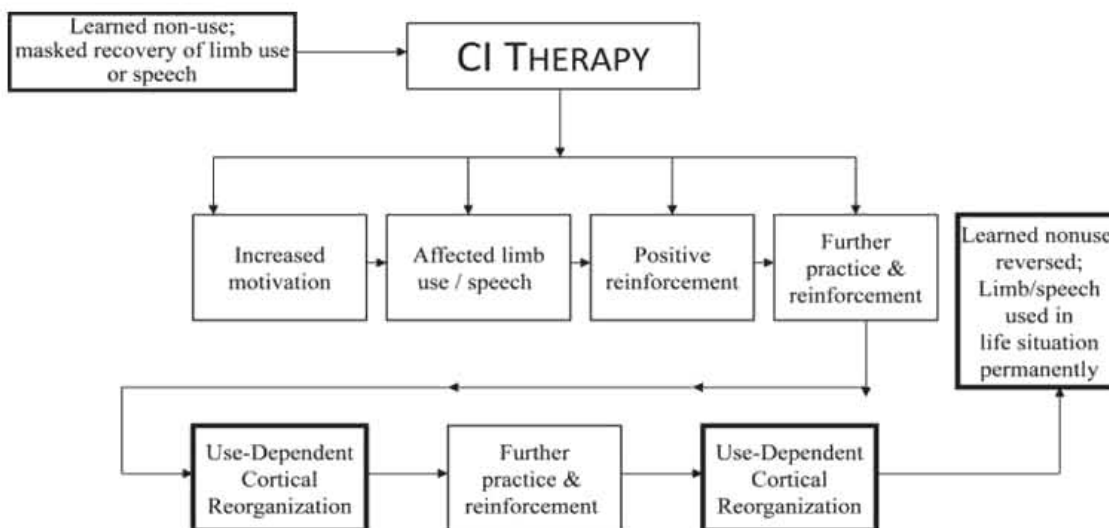


Fig 2: Explaining the effect of CIMT on reversing the learned non use of the impaired arm.

Streling.C et al in a study assessed the structural neuroplastic changes in ten children who received 3 weeks of CIMT. The MRI scans showed significant increase in gray matter volume of the sensory-motor cortex contra-lateral to the more affected arm which correlated to the motor improvements recorded post the intervention.¹⁰ In an another study, Juenger et al 2007 reported that even a short period of 12 days CIMT can induce changes of cortical activation in congenital hemiparesis. In their sample, increases in fMRI activation were consistently observed in the primary sensory-motor cortex of the affected hemisphere. Thus they concluded that the potential for neuromodulation is preserved in the affected hemisphere after early brain lesions.¹¹

The Magical Pouch program:

Edward Taub's original protocol for CIMT is highly intensive which consisted of targeted restraint of the less impaired arm during 90% of the waking hours over a period of three weeks.¹² Existing literature on protocols for CIMT for children have varied time period for the constraints.^{13,14,16} Kindergarten students spend up to 46% of their day by completing fine motor activities, of which 42% are paper-and-pencil tasks.¹⁵ Thus a protocol which demands 6 hours or more of constraint of the non-affected hand will restrict child's participation in various occupations leading to frustration and possibilities to reject the constraint. The magical pouch protocol developed by us differs from the

conventional protocol in several ways, typically in terms of the reduction in the hours per day of wearing the constraint accompanied by an increase in the number of treatment days. Furthermore the program also involved use of modification of home environment (e.g. visual cues) and embedding the therapy within the context of theme based play and family centered.

Models of intervention:

a. *Modified Constraint Induced Movement Therapy combined with Bilateral Therapy (mCIMT-BiT):*

The mCIMT-BiT intervention was derived from the pirate group intervention protocol which is a child friendly therapy with a combination of uni-manual and bi-manual massed practice.¹⁶ The three elements from Taub's CIMT protocol¹² were modified to create this eight week program. These main elements include the following:

1. Leaving the child no option but to use the impaired upper extremity during the CIMT sessions as the non affected extremity is incapacitated in a magical pouch. And also by continuously eliciting and prompting the child to use the affected arm and hand.
2. Repetitive, task specific training and shaping of the movements of the impaired upper extremity in unimanual and bimanual tasks, with frequency and duration of training sessions modified to one hour per day, two days a week.
3. A "transfer package" was designed to transfer the gains made during the training in the sessions to the child's home environment through discussions with the caregiver, individualized home program and intensive contact with the caregivers.

b. *Play:*

Play has always been a part of the pediatric occupational therapist's repertoire. It forms a method of intervention with children using spontaneous or organized activity that provides enjoyment, entertainment, amusement or diversion. Multiple researchers have shown how play based approach is the most effective approach for delivering services to children with developmental disabilities. Couch K, examined how pediatric occupational therapists use play in intervention. The findings indicated that 91% of the 202 therapists who participated in the study rated play as very important and 95% of them said play was primarily used to elicit motor, sensory, or psychosocial outcomes.¹⁷

c. *Empowering families:*

An innovative approach to planning, delivering and evaluating health care to children is grounded in mutually beneficial collaborations between health care professionals and families. Studies have shown that intervention provided taking into account the needs and goals of families have a greater impact. This approach is a systematic way of creating partnership with families that treats them with dignity and respect, places an emphasis on strengths rather than deficits,

and honors their values and choices.¹⁸ It provides greater family satisfaction, strong family beliefs of self efficacy, and greater family perception of helpfulness from supports and services provided. This has competency-enhancing consequences.¹⁹

Purpose:

The purpose of the study is to explore the changes due to the play based family centered mCIMT-BiT protocol (the magical pouch program) on the child's functioning. We also wanted to explore the effect of reduction in the intensity and frequency of training from the original protocol.

Methodology

Participant:

Sneha (fictive name) is a 4 years old girl diagnosed with spastic cerebral palsy with left sided hemiplegia. She has been receiving early intervention services since 6 months of her life. In recent time Mrs. Jain (Sneha's mother) has been concerned about her inability to use the left hand effectively and difficulty in performing occupations which need bilateral hand use. Hence during her regular follow up assessment with a developmental pediatrician at Ummeed Child Development Center, the pediatrician referred her to occupational therapy services for constraint induced movement therapy for improving her left hand use. To participate in the study, we used the inclusion criteria from previous pediatric reference study requiring the participant to have a minimum of 20 degrees of active wrist extension and 10 degrees of active finger extension in the hemiplegic hand. Exclusion criteria were other neurologic impairments and orthopedic surgery or neuro-pharmacologic interventions such as botulinum toxin in the past 6 months. Sensory testing revealed intact sensations to light touch and stereognosis of common objects.

Study Design: We used a single system study method: A1 (Baseline) à B (Intervention) à A2 (Post intervention). The outcome measures were administered at baseline and post intervention.

Intervention:

The magical pouch program was conducted over a period of eight weeks, 2 hours a day, twice a week. The target movements and graded constraints for each week were adapted from previous studies.^{13,14,16} The protocol involved 6 weeks of constraint of the non-affected hand along with the functionally impaired upper limb being facilitated to be used through graded activities. The last two weeks involved use of bimanual, task specific training to integrate the new skills in daily living activities. The protocol was administered by two occupational therapist on an outpatient basis at Ummeed Child Development Center. The family signed an informed consent form to participate in the study.

The magical pouch (fig 1) is a commercially available adjustable pediatric arm pouch sling which is strapped to the child's trunk and is sewn shut except the proximal end to avoid the use of the hand as an assist. Fastening the sling to the trunk prevents any bimanual assist or any cheat that can occur. The therapist



Fig:1 Sneha wearing the magical pouch

thought of this name to help Sneha accept the pouch as a 'fun activity'. We encouraged Sneha to pretend to make her hand disappear when she would wear and that she would acquire magical powers in her affected hand. Repetitive task practice and shaping of the movements of the impaired upper extremity were performed in activities with targeted movements and graded constraints during both the CIMT and BIT. Feedback and instructions were given about performance as well as about the result of execution of the task to enhance generalization of qualitatively good movement patterns to other activities and settings. As "transfer package", the therapist and mother discussed and list all the activities to be performed at home with the affected hand. During the course of the BIT visual cues like small hand prints, which were stuck on the door knobs, cupboard handles, dustbin etc were used in therapy room and at home to provide a cue for bilateral use of the hand. Reward system: Each time Sneha would successfully use both her hands in a bimanual tasks, she would get a small colorful hand sticker as a reward on the affected arm.

The parent along with the therapist used the Canadian Occupational Performance Measure to determine the goals for the BIT during the start of the mCIMT protocol. Sneha's mother had the following COPM goals:

COPM 1: She should be able to stabilize the book/paper with the left hand while writing or erasing.

COPM 2: She should be able to use both her hands while playing with legos and links.

COPM 3: She should be able to pull her pants or any lower extremity dress with both her hands equally.

Outcome measures:

To document the changes due to the intervention, outcome

measures were selected to assess the effect at the level of body functions, activities and participation of the ICF model.

Active and passive range of motion (aROM & pROM), The Beery Developmental test of Visual Motor Integration (VMI) 5th Edition and Hand awareness scale was assessed for the body functions. Activity measures were the Bruininks-Oseretsky Test of Motor proficiency 2nd edition. Participation measures were the COPM Performance (COPM-P) and Satisfaction (COPM-S) scores. A qualitative interview of the mother's observation of the child's functional changes (hand use, quality of movements, prompt dependency, and activity level) was also conducted.

Data Analysis:

The collected data from the various outcome measures was analyzed by comparing the mean scores between pre and post data sets. The scores were also visually analyzed by plotting graphs using Microsoft Excel.

Results

The following tables and graphs show the results of the outcome measures at the level of the body function, activity and participation at baseline (week 0) and post-treatment (week 9).

There was no change noted in the passive range of motion of the affected extremity though gains of an average of 20 degrees were documented in active ranges of the joints.

By the end of the intervention, Sneha could stabilize the book while writing/ erasing. She could use her left hand effectively while playing with links and Lego blocks. While wearing her pants she could now hold the pants and pull them from the mid thigh level.

After the intervention, her mother and we observed that her hand movements were quicker. She was using the hand in a

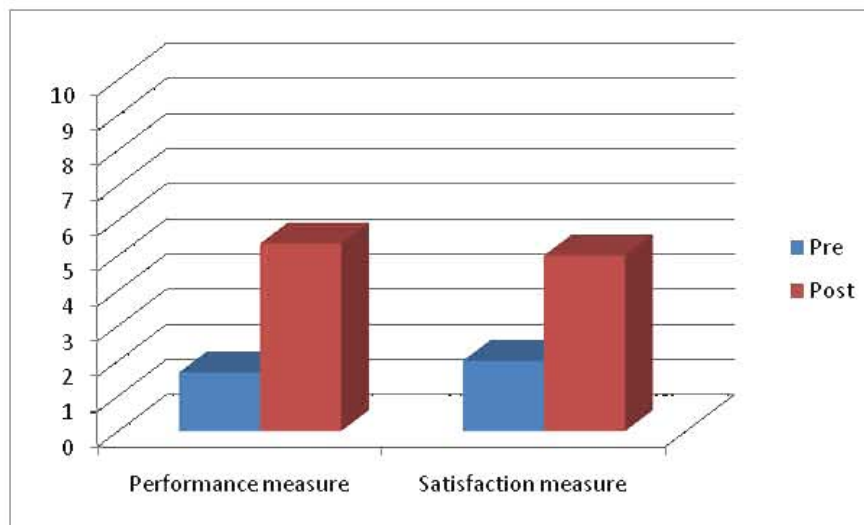
Table 1
Pre-Post Scores of The Beery Developmental Test of Visual Motor Integration test

	Visual Motor Integration		Visual Perception		Motor Coordination	
	Pre	Post	Pre	Post	Pre	Post
Mean Scores	11	13	15	17	11	13

Table 2
Pre-Post Scores The Bruininks - Oseretsky Test of Motor Proficiency – Second Edition

Areas	Fine Motor Integration		Fine Motor Precision		Manual Dexterity	
	Pre	Post	Pre	Post	Pre	Post
Mean Scores	6	6	14	15	2	4

Fig 3: Changes in the performance and satisfaction of the parent informed goals on the COPM



typical movement pattern without much deviation into atypical patterns. She also shows better grasping, release and thumb opening. Post intervention she used the left hand more effectively while performing bilateral task like transferring coins on the BOT-2 as an assisting hand. We also noted decrease in the spasticity post the intervention in her wrist flexors.

During the post intervention interview, the mother reported decrease in the need of prompts by 60 % for use of the left hand. She also reported that the movements of the left hand 'look more coordinated'. She also reported 'being more confident and creative' while administering the protocol at home.

Discussion

This case study provides indications that the magical pouch program may be a useful intervention for children with hemiparesis. Post intervention gains were mainly made in use of hand more spontaneously in daily living tasks, better participation in age appropriate occupations and reduction in the need for verbal prompts from the caregivers. We also observed generalization of the motor skills learnt during the training period in the day to day tasks.

The play based approach helped to reduce the resistance pediatric

therapists and parents often face in encouraging the child to deviate from an earlier acquired motor patterns and the resistance children tend to show to accepting a constrain .An important aspect in this context is that a child is more likely to learn and retain information when it is intrinsically motivated. Intrinsic motivation refers to active involvement, showing good temper, maintaining tasks that involve various difficulties and barriers, repeating actions and activities and being interested and involved in the process of the task more than in the product.²⁰ Sneha's mother was one of the most important factors towards the gains. Her active participation in the process of planning the protocol and implementing it in the home environment supports the need for empowering families with the skills.

The most prominent outcome of this study was the increase in occupational participation and satisfaction in the COPM which was mainly due to the use of a family centered approach. Any problem related to child's ability to self care has the most impact on the family's occupations. E.g. Her inability to hold the cutlery during dinner time disturbs the family during dinner as she needs extra help. Hence a family centric approach targets the prime needs of the families and thus the increase in their levels of satisfaction.

Neural plasticity and physiological maturation of the nervous system always has a major role in any therapeutic intervention and especially in young children.²¹ Hence while examining the gains made during the intervention the same should be considered as the contributing factors.

We observed generalization of the skills acquired during the intervention to her day to day tasks, and the same was reported by her mother. However we observed that Sneha still occasionally needed verbal prompts to use the affected hand in certain challenging tasks e.g. wearing the back pack for the school, opening her tiffin box etc. We felt that this behavior could be because of presence of developmental disregard. Hence we considered a second phase of the intervention consisting of booster mCIMT sessions.

The scores of the standard outcome measures used to assess the body functions and activity level were incoherent with the findings of the occupational participation measure. The standard assessment tools do not provide direct measures of affected extremity motor function in the real world. Traditional instruments in physical rehabilitation focus on measuring strength, flexibility, and coordination in the clinic or laboratory setting. The relationship between the performance on these instruments and activity in the life situation has not been rigorously tested.²² We also do not exclude the possibility of a bias due to application of a new intervention and; a parent's expectations and anxieties about their child's progress. Thus use of more sensitive assessment tools assessing unilateral functions should be considered to monitor the progress.

Factors supporting the intensity and the frequency of the intervention of the magical pouch program are;

- the positive gains the child achieved,
- family's increased perception of their efficacy to administer

the protocol and,

- Less demand on resources and time of the caregiver and the professional.

Scope for future studies: Administering the program in a group will be more effective in a developing country like ours with limited resources, availability of professional and poor organizational policies. A group approach will also have positive effects of children coming together for therapy, including healthy competition between peers (motivation) and behaviour modeling.²¹ Future studies should elaborate on the intensity of the program and generalization of the skills using rigorous study designs and sensitive outcome measures.

Limitations:

The single system study design lacks the evidence to ascertain the positive changes are because of the occupational therapy intervention or the maturational process, which is due to the lack of a control group. The single case study is also not conclusive due to its descriptive statistics which is inherent to the design. Lack of reliable and standardized assessment tool for unilateral functions and activity participation.

Conclusion

This study explored a play based family centered approach while using the modified constraint induced movement therapy along with bilateral therapy. The study also documents the changes in child's participation in occupations like play and self care possibly due to the intervention, which sets a ground work for further research and more than anything for further occupational therapy evidence based practice.

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