

## Effect of Modified Constraint Induced Movement Therapy on Hand Function in Paediatric Stroke-A Narrative Review

Pranali Saurabh Thakkar

### ABSTRACT

**BACKGROUND OF THE STUDY:** Cerebral Palsy (CP) is the leading cause of motor disability in childhood. Recent studies have investigated that constraint induced movement therapy (CIMT) as an early intervention for infants and toddlers with hemiplegic CP (Paediatric stroke) is potentially effective. For various reasons, traditional form of therapy (CIMT) was neither considered feasible nor do child and family friendly for that modified form of CIMT has been followed. This Narrative Review aims to identify current evidence for effectiveness of modified CIMT (mCIMT) in Paediatric stroke

**OBJECTIVE OF THE STUDY:** The objective of this narrative review is to investigate whether mCIMT is supported with research of its effectiveness in Pediatric stroke

**METHODOLOGY:** Various online databases, including Google Scholar, Pubmed, Medline and Science Direct were searched for articles to identify the effects of mCIMT in children with hemiplegic CP (Paediatric stroke) that were published from 2010 to 2023. From that total 23 full text articles in English language were chosen for the review

**RESULT:** From 23 relevant research reports- Studies varied widely in type and rigor of design, subject, constraint time, and intervention characteristics and outcome measures.

**CONCLUSION:** According to evidence from a greater number of studies, Children with Hemiplegic cerebral palsy (Paediatric stroke) used their upper extremities more frequently after receiving mCIMT. Long term effect on hand function of hemiplegic CP (Paediatric stroke) children cannot be identified from the available research. The study to date makes it impossible to define the intensity that provides an adequate dose.

**KEY WORDS:** Modified CIMT, Hemiplegic cerebral Palsy (Paediatric stroke), Hand function

### INTRODUCTION

Pediatric stroke (Hemiplegia) accounts for 35% (1 in 1300) of the children with Cerebral Palsy and upper limb (UL) involvement is usually more pronounced than the lower limb.<sup>1</sup> They usually have difficulties with reaching and grasping with the involved upper extremity.<sup>2-4</sup> Children often tend not to use the affected extremity, resulting in a developmentally learned non-use of the involved upper extremity that can be termed as 'developmental disuse'.<sup>5,6</sup> Over the last few years, constraint-induced therapy (CIMT) (a method of teaching a child with Hemiplegic CP to use their affected upper limb) as an intervention, has received a great deal of attention.

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.<sup>7</sup>

Therapy accompanied this constraint for 6 hours per day. For various reasons, traditional form of therapy (CIMT) was neither considered feasible nor do child and family friendly for that modified form of CIMT has been followed. A number of variations are used in modified CIMT (mCIMT). It involves the application of a restraint on the unaffected upper limb with less than three hours per day of therapy. 13 and type of constraint used can be different

Modification of this approach for children with hemiplegic CP has followed, but until recently efficacy was limited to case reports and small prospective studies.8-12

This Narrative Review aims to identify current evidence for effectiveness of modified CIMT (mCIMT) in Paediatric stroke

### **OBJECTIVE OF THE STUDY**

To investigate whether mCIMT is supported with research of its effectiveness on hand function in Paediatric stroke

### **METHODOLOGY**

- Various electronic search engines were used for literature by entering Key words (Table-1)
- Articles since 2009 to 2023 years were searched.
- Search for literature on the effects of mCIMT in children with hemiplegic CP (Paediatric stroke)

Table-1 Search History

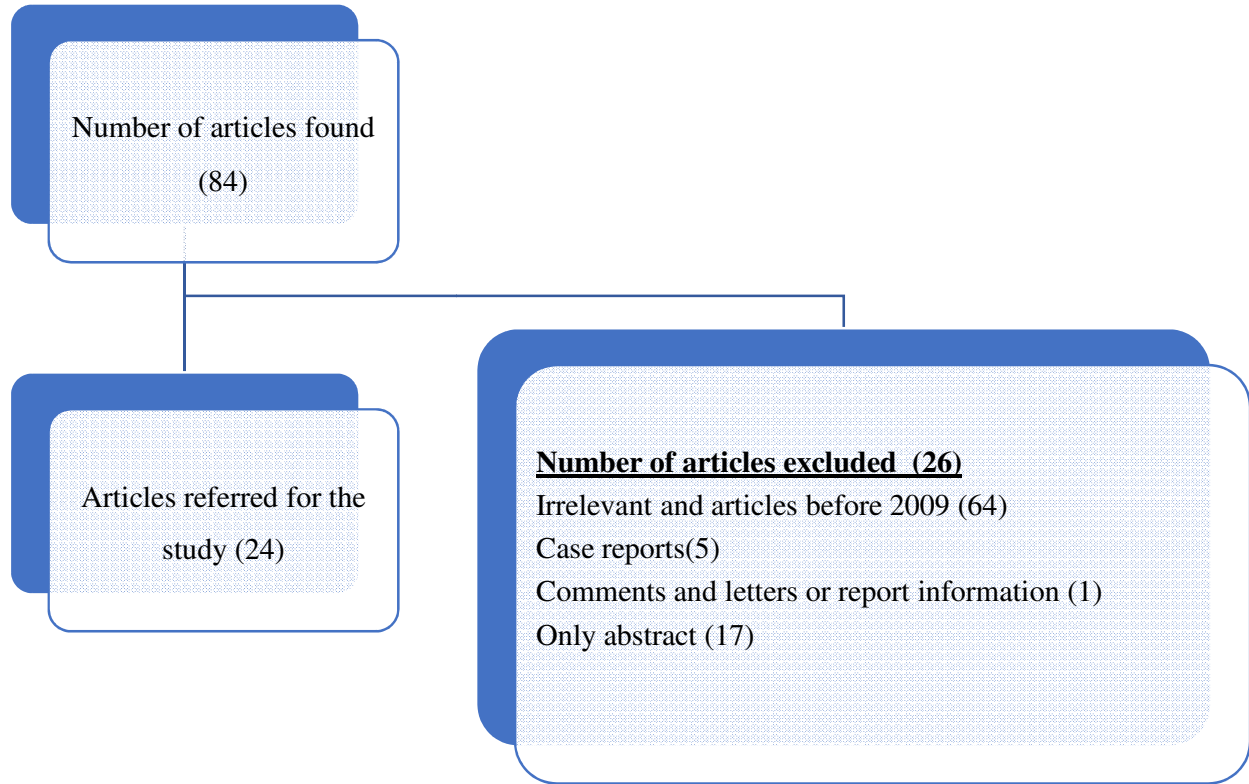
Search engines	Key words
1.Google scholar	Pediatric stroke
2.Pubmed	Hemiplegic Cerebral palsy
3.EBSCO	CIMT (Constarint induced movement Therapy )
4.Medline	mCIMT (Modified Constarint induced movement Therapy)
5.sciene direct	Hand Function
	Forced use
	Learned Non-use

### **Inclusion criteria:**

- Articles published in English language
- Articles between 2009 to 2023
- Modified CIMT used as a treatment in Paediatric stroke(Hemiplegic CP)

### **Exclusion criteria:**

- Articles published in languages other than English
- Case reports
- Comments and letters or report information
- Studies were also excluded if mCIMT used in condition other than pediatric stroke eg.,erb's palsy , adult stroke etc.



**RESULT**

Sr.no	Author name and year	Place of the study	Study title	Type of study	Conclusion
1	Smania N. , Aglioti S. M 2009 <sup>14</sup>	Italy	A modified constraint-induced movement therapy (CIT) program improves paretic arm use and function in children with cerebral palsy	Randomized crossover Comparative	The mCIMT program proposed in the present study showed to be a <u>promising rehabilitative procedure</u> in children with congenital arm palsy after cerebral palsy.

2	Gharib M, Hosseyani A, et.al; 2010 <sup>15</sup>	Iran	Effect of modified constraint induced movement therapy on quality of upper extremity skills in children with hemiplegic cerebral palsy	Experimental	This study showed that modified constraint induced movement therapy only <u>affect in quality of grasp.</u>
3	Pauline B. Aarts, Peter H. Jongerius, et.al; 2010 <sup>16</sup>	Netherlands	Effectiveness of Modified Constraint-Induced Movement Therapy in Children With Unilateral Spastic Cerebral Palsy: A Randomized Controlled Trial	RCT	mCIMT followed by task-specific training of goal-directed bimanual play and self-care activities is an <u>effective intervention to improve the spontaneous use of the more affected upper limb</u> in children with relatively good baseline upper extremity function.
4	Margaret Wallen, Jenny Ziviani, Olivia et.al; 2011 <sup>17</sup>	Australia	Modified constraint-induced therapy for children with hemiplegic cerebral palsy: a randomized trial	RCT	<u>Modified constraint-induced therapy is no more effective than intensive</u> occupational therapy for improving completion of activities of daily living or upper limb function in children with hemiplegic CP.

5	Rostami HR, Malami RA 201118	Iran	Effect of treatment environment on modified constraint-induced movement therapy results in children with spastic hemiplegic cerebral palsy: a randomized controlled trial	a randomized controlled trial	<u>Modified CIMT is effective in improving upper limb function in children with spastic hemiplegic cerebral palsy. In addition, more improved performance in home group places the practice in natural context as the preferred method for treatment of these children.</u>
6	Jaehoyu, Hyungkyu Kang et.al; 201219	Korea	Effect of modified constraint induced movement therapy on hand dexterity, grip strength and activities of daily living of children with cerebral palsy	Randomised controlled trial	<u>Their results are not generalizable to all children with cp because of the small no.of subjects Additional research on long term treatment for children with hemiplegic cerebral palsy should be carried out to verify its efficacy and long term effect</u>
7	Yvonne Geerdink Pauline Aarts 201320	Netherlands	Motor learning curve and long-term effectiveness of modified constraint-induced movement therapy in children with unilateral cerebral palsy: A randomized controlled trial	RCT	<u>Their study data give support to the notion that children of five years and older might profit from more than 54 h of mCIMT to reach their maximum unimanual capacity and retain this level during subsequent bimanual training. Future studies should specifically focus on these older children to establish the optimal dosage of mCIMT.</u>

8	Anita Choudhary, Sheffali Gulati, 201321	Delhi, India	Efficacy of modified constraint induced movement therapy in improving upper limb function in children with hemiplegic cerebral palsy	a randomized controlled trial	<u>The modified constraint induced movement therapy appears to be effective in improving upper limb function in 3-8 years old hemiplegic cerebral palsy children</u>
9	Katrijn Klingels, PhD, Hilde Feys, PhD 201322	Belgium	Randomized Trial of Modified Constraint-Induced Movement Therapy With and Without an Intensive Therapy Program in Children With Unilateral Cerebral Palsy	a randomized controlled trial	<u>The combination of m-CIMT with an intensive therapy program on distal hand function and strength enhances the effects of m-CIMT alone for improving bimanual performance.</u>
10	Pranali Thakkar 201423	Gujarat, India	Effect Of Modified Constraint Induced Movement Therapy On Hand Function Of Hemiplegic Cerebral Palsy	Experimental	<u>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.</u>

11	Muhammad Usman Khan, Amna Aamir Khan 201524	Pakistan	Effect of Modified Constraint Induce Therapy on affected upper extremity of Mild - Moderate Spastic Hemiplegic Cerebral Palsy children	RCT	<u>MCIT has proved more effective than conventional therapy. Therefore Continuation of this program will give better result and ultimately improve the quality of life of hemiplegic children.</u>
12	Pavlina Psychouli , OT, MSc, PhD; Colin R. Ken 201625	United Kingdom	Modified Constraint-Induced Movement Therapy as a Home-Based Intervention for Children With Cerebral Palsy	Clinical trial	<u>A non intensive form of home-based constraint-induced movement therapy was found to be effective. Improvements were larger after the second month of intervention.</u>
13	Rena Chamudot, Shula Parush 201826	Israel	Effectiveness of Modified Constraint-Induced Movement Therapy Compared With Bimanual Therapy Home Programs for Infants With Hemiplegia: A Randomized Controlled Trial	RCT	<u>The main conclusion of this study is that mCIMT and BIM therapy are both effective methods for treating infants with hemiplegia. This conclusion is based on the significantly large and equal improvement in hand function, gross motor function, and high treatment compliance demonstrated in both groups posttreatment</u>

14	Pauline M Christmas , Catherine Sackley et.al; 201827	UK	A randomized controlled trial to compare two methods of constraint-induced movement therapy to improve functional ability in the affected upper limb in pre-school children with hemiplegic cerebral palsy: CATCH TRIAL	Randomized Controlled trial	<u>Caregiver-directed constraint-induced movement therapy is feasible and associated with improvement in upper limb function at 10 weeks. More therapy was delivered with prolonged than with manual restraint, warranting further testing of this intervention in a longer term trial.</u> <u>Keywords</u>
15	Rocío Palomo-Carrión , Helena Romay-Barrero et.al; 202028	Spain	Modified Constraint-Induced Movement Therapy at Home—Is It Possible? Families and Children’s Experience	Qualitative study	<u>A facilitator within mCIMT would be the participation of the child’s parents through previous training and its approach at home, allowing greater family satisfaction and child–parent–therapist interaction to avoid complications.</u>
16	Young Sub Hwang1 Jeong-Yi Kwon 202029	korea	Effects of Modified Constraint-Induced Movement Therapy in Real-World Arm Use in Young Children with Unilateral Cerebral Palsy: A Single-Blind Randomized Trial	Single-blind randomized controlled trial.	<u>mCIMT with continuous restraint applied to infants and toddlers with unilateral CP appeared to have a positive effect on paretic hand use in the real world.</u>



17	Rocío Palomo-Carrión , Rita-Pilar Romero-Galisteo 202030	Spain	Application of Low-Intensity Modified Constraint-Induced Movement Therapy to Improve the Affected Upper Limb Functionality in Infantile Hemiplegia with Moderate Manual Ability: Case Series	case series, prospective and longitudinal study	<u>low dose (50 h) of mCIMT increased the functionality of children diagnosed with congenital hemiplegia between 4 and 8 years of age with moderate manual ability.</u>
18	Ankita Bansal, Shraddha Diwan 202131	Gujarat, India	Effect of Modified Constraint Induced Movement Therapy and Hand Arm Bimanual Intensive Training on Upper Extremity Skills and Functional Performance in Children with Spastic Hemiplegic Cerebral Palsy	Non blinded Quasi Experimental study	<u>mCIMT and HABIT (Hand arm Bimanual Intensive Training) can be used equally to increase upper extremity skills and occupational performance in children with spastic hemiplegic cerebral palsy.</u>
19	Dr. Trishala Jain, Dr. Rahul Bisen et.al; 202132	Pune, India	Effectiveness Of Modified Constraint-Induced Movement Therapy Compared To Hand-Arm Bimanual Intensive Therapy On Quality Of Upper Extremity Function In Hemiplegic Cerebral Palsy Children - An Experimental Study	Experimental Study	<u>This study concluded that mCIMT is more effective than HABIT alone in improving quality of upper extremity function in hemiplegic cerebral palsy children.</u>

20	Sezen Tezcan , Tamer Çankaya 202133	Turkey	The effect of modified constraint-induced movement therapy in children with hemiparetic cerebral palsy. Consecutive or intermittent days?	Comparative (experimental)	<u>Administration of mCIMT on intermittent days facilitate the adaptation of a child, it was concluded to be a more tolerable method and could be more effective.</u>
21	Mamoona TasleemA fzal , Imran Amjad 202234	Pakistan	Comparison of classic constraint-induced movement therapy and its modified form on upper extremity motor functions and psychosocial impact in hemiplegic cerebral palsy	Comparative	<u>Both the treatment approaches (CCIMT AND MCIMT) are effective in enhancing the upper limb motor functions and psychosocial life of children with HCP.</u>
22	Hasan Bingöl , Mintaze Kerem Günel. 202235	Turkey	Comparing The Effects Of Modified Constraint-Induced Movement Therapy And Bimanual Training In Children With Hemiplegic Cerebral Palsy Mainstreamed In Regular School: A Randomized Controlled Study	RCT	<u>The potential advantage of mCIMT versus BIT has the larger short-term effect sizes (ESs) and the more sustainable improvements.</u>

23	Ostadzadeh A , Amini M, hassanim ehraban A, 202336	Iran	The Effect of Occupation-Based Modified Constraint-Induced Movement Therapy on the Participation of Children with Cerebral Palsy: A Single-Blind Randomized Controlled Trial	single-blind clinical trial	<u>m-CIMT accompanied by occupation-based and activity analysis and the client-centered paradigm substantially enhances the manual ability of children with hemiplegia and their participation in the ADL.</u>
24	Tien-Ni Wang , Kai-Jie Liang 202337	Taiwan, Taipei	Effects of Intensive Versus Distributed Constraint-Induced Movement Therapy for Children With Unilateral Cerebral Palsy: A Quasi-Randomized Trial	RCT	<u>The 2 dosing schedules of CIMT had similar effectiveness for children with unilateral CP. The intensive CIMT yielded additional improvement on parent rated motor quality of the more-affected hand at 8 weeks after the initiation of treatment.</u>

## **DISCUSSION**

In the review it is found that a greater number of studies have used different forms of Modification and different intensities and different size of Constraint for their study. More Number of the studies shows mCIMT is effective in improving hand function in paediatric stroke 14,18,21,23,29 but additional research requires on long term effect for Paediatric stroke. 3 comparative studies shows mCIMT is more effective than conventional therapy, HABIT, BIT 24,32,35 while few comparative studies shows mCIMT is equally effective as Coventional CIMT, BIM and HABIT 26,31,34 In some of the studies, show effect of mCIMT as home based is also effective 25,27,28 While 2 studies show m CIMT is no more effective than occupational based therapy and Intensive CIMT 17,37

Out of eighteen - Two of the studies show mCIMT is only effective in improving quality of grasp and use in spontaneous use of affected upper limb 15,16 And two studies show additional effect of mCIMT is more effective if added With Intensive Programme and with occupation based techniques for manual Abilities<sup>22,36</sup> and two studies focus on dosage of mCIMT to see the effect<sup>20,30</sup>

## **CONCLUSION**

In current review it is evident that majority of available articles shows Children with Hemiplegic cerebral palsy (Paediatric stroke) used their upper extremities more frequently after receiving mCIMT. Long term

effect on hand function of hemiplegic CP (Pediatric stroke) children cannot be identified from the available research. The study to date makes it difficult to define the intensity that provides an adequate dose.

## **REFERENCES**

1. Surman G, Hemming K, Platt MJ, Parkes J, Green A, Hutton J, Kurinczuk JJ. Children with cerebral palsy: severity and trends over time. *Paediatr Perinat Epidemiol.* 2009;23(6):513-21.
2. Smith LR, Ponten E, Hedstrom Y, Ward SR, Chambers H, Subramaniam S, Lieber RL: Novel transcriptional profile in wrist muscles from cerebral palsy patients. *Biomedical Central Medical Genomics* 2009, 2(1):44.
3. Katherine T. Ratlife. Mosby. *Clinical Pediatric Physical Therapy – A Guide for the Physical therapy*
4. Roberta B. Shepherd, *Physiotherapy in pediatric*, Columbia, 3<sup>rd</sup> rev. ed.
5. Thames Valley Children's Centre – Cerebral Palsy – Causes and Prevalence". Archived from on 2007-08-23. Retrieved 2007-06-11.
6. Johnson, Ann "Prevalence and characteristics of children with cerebral palsy in Europe". *Developmental medicine and child neurology* 2002 44 (9): 633–40.
7. Stanley FJ, Blair E, Alberman ED. *Cerebral Palsies: Epidemiology and Causal Pathways*. London, UK: Cambridge University Press; 2000.
8. Wiklund LM, Uvebrant P: Hemiplegic cerebral palsy. Correlation between CT morphology and clinical findings. *Dev Med Child Neurol* 1991, 33(6):512-523.
9. World Health Organization. *International classification of functioning, disability and health (ICF)*. Geneva: World Health Organization; 2001.
10. Charles J, Gordon AM. A critical review of constraint-induced movement therapy and forced use in children with hemiplegia. *Neural Plast.* 2005;12(2-3):245-61.
11. Gordon AM, Charles J, Wolf SL. Methods of constraint-induced movement therapy for children with hemiplegic cerebral palsy: development of a child-friendly intervention for improving upper-extremity function. *Arch Phys Med Rehabil.* 2005;86(4):837-44.
12. Eliasson AC, Bonnier B, Krumlinde-Sundholm L. Clinical experience of constraint induced movement therapy in adolescents with hemiplegic cerebral palsy - a day camp model. *Dev Med Child Neurol.* 2003; 45(5):357-
13. Eliasson AC, Krumlinde-Sundholm L, Shaw K, Wang C: Effects of constraint-induced movement therapy in young children with hemiplegic cerebral palsy: an adapted model. *Developmental Medicine and Child Neurology* 2005, 47(4):266-275.
14. Smania N, Aglioti SM, Cosentino A, Camin M, Gandolfi M, Tinazzi M, Fiaschi A, Faccioli S. A modified constraint-induced movement therapy (CIT) program improves paretic arm use and function in children with cerebral palsy. *Eur J Phys Rehabil Med.* 2009 Dec 1;45(4):493-500.
15. Gharib MA, Hosseini A, Fahimmi N, Salehi MA. Effect of modified constraint induced movement therapy on quality of upper extremity skills in children with hemiplegic cerebral palsy. *Journal of Gorgan University of Medical Sciences.* 2010 Sep 10;12(3):29-36.
16. Aarts PB, Jongerius PH, Geerdink YA, Van Limbeek J, Geurts AC. Effectiveness of modified constraint-induced movement therapy in children with unilateral spastic cerebral palsy: a randomized controlled trial. *Neurorehabilitation and neural repair.* 2010 Jul;24(6):509-18.
17. Wallen M, Ziviani J, Naylor O, Evans R, Novak I, Herbert RD. Modified constraint-induced therapy for children with hemiplegic cerebral palsy: a randomized trial. *Developmental Medicine & Child Neurology.* 2011 Dec;53(12):1091-9.
18. Rostami HR, Malamiri RA. Effect of treatment environment on modified constraint-induced movement therapy results in children with spastic hemiplegic cerebral palsy: a randomized controlled trial. *Disability and rehabilitation.* 2012 Jan 1;34(1):40-4.

19. Yu J, Kang H, Jung J. Effects of modified constraint-induced movement therapy on hand dexterity, grip strength and activities of daily living of children with cerebral palsy: a randomized control trial. *Journal of Physical Therapy Science*. 2012;24(10):1029-31.
20. Geerdink Y, Aarts P, Geurts AC. Motor learning curve and long-term effectiveness of modified constraint-induced movement therapy in children with unilateral cerebral palsy: a randomized controlled trial. *Research in developmental disabilities*. 2013 Mar 1;34(3):923-31.
21. Choudhary A, Gulati S, Kabra M, Singh UP, Sankhyan N, Pandey RM, Kalra V. Efficacy of modified constraint induced movement therapy in improving upper limb function in children with hemiplegic cerebral palsy: a randomized controlled trial. *Brain and Development*. 2013 Oct 1;35(9):870-6.
22. Klingels K, Feys H, Molenaers G, Verbeke G, Van Daele S, Hoskens J, Desloovere K, De Cock P. Randomized trial of modified constraint-induced movement therapy with and without an intensive therapy program in children with unilateral cerebral palsy. *Neurorehabilitation and Neural Repair*. 2013 Nov;27(9):799-807.
23. Thakkar P. Effect of modified constraint induced movement therapy on hand function of hemiplegic cerebral palsy. *International Journal of Current Research and Review*. 2014 Sep 1;6(17):29.
24. Khan MU, Khan AA, Huma SI. Effect of Modified constraint induce therapy on affected upper extremely of mild moderate spastic hemiplegic cerebral palsy children. *IOSR-JDMS*. 2015;14(12):124-9.
25. Psychouli P, Kennedy CR. Modified constraint-induced movement therapy as a home-based intervention for children with cerebral palsy. *Pediatric Physical Therapy*. 2016;28(2):154-60.
26. Chamudot R, Parush S, Rigbi A, Horovitz R, Gross-Tsur V. Effectiveness of modified constraint-induced movement therapy compared with bimanual therapy home programs for infants with hemiplegia: a randomized controlled trial. *The American Journal of Occupational Therapy*. 2018 Nov 1;72(6):7206205010p1-9.
27. Christmas PM, Sackley C, Feltham MG, Cummins C. A randomized controlled trial to compare two methods of constraint-induced movement therapy to improve functional ability in the affected upper limb in pre-school children with hemiplegic cerebral palsy: CATCH TRIAL. *Clinical Rehabilitation*. 2018 Jul;32(7):909-18.
28. Palomo-Carrión R, Romay-Barrero H, Romero-Galisteo RP, Pinero-Pinto E, López-Muñoz P, Martínez-Galán I. Modified Constraint-Induced Movement Therapy at Home—Is It Possible? Families and Children’s Experience. *Children*. 2020 Nov 22;7(11):248.
29. Hwang YS, Kwon JY. Effects of modified constraint-induced movement therapy in real-world arm use in young children with unilateral cerebral palsy: a single-blind randomized trial. *Neuropediatrics*. 2020 Aug;51(04):259-66.
30. Palomo-Carrión R, Romero-Galisteo RP, Pinero-Pinto E, López-Muñoz P, Romay-Barrero H, José FG. Application of low-intensity modified constraint-induced movement therapy to improve the affected upper limb functionality in infantile hemiplegia with moderate manual ability: case series. *Children*. 2020 Sep 4;7(9):127.
31. Bansal A, Diwan S. Effect of Modified Constraint Induced Movement Therapy and Hand Arm Bimanual Intensive Training on Upper Extremity Skills and Functional Performance in Children with Spastic Hemiplegic Cerebral Palsy.
32. Jain T, Bisen R, Ranade P. Effectiveness Of Modified Constraint-Induced Movement Therapy Compared To Hand-Arm Bimanual Intensive Therapy On Quality Of Upper Extremity Function In Hemiplegic Cerebral Palsy Children-An Experimental Study. *National Journal of Integrated Research in Medicine*. 2021 Mar 1;12(2).
33. Tezcan S, Çankaya T. The effect of modified constraint-induced movement therapy in children with hemiparetic cerebral palsy. Consecutive or intermittent days?. *Disability and Rehabilitation*. 2022 Nov 20;44(24):7500-7.

34. Afzal MT, Amjad I, Ghous M. Comparison of classic constraint-induced movement therapy and its modified form on upper extremity motor functions and psychosocial impact in hemiplegic cerebral palsy. JPMA. The Journal of the Pakistan Medical Association. 2022 Jul 1;72(7):1418-21.
35. Bingöl H, Günel MK. Comparing the effects of modified constraint-induced movement therapy and bimanual training in children with hemiplegic cerebral palsy mainstreamed in regular school: A randomized controlled study. Archives de Pédiatrie. 2022 Feb 1;29(2):105-15.
36. Ostadzadeh A, Amini M, Mehraban AH, Maroufizadeh S, Farajzadeh A. The Effect of Occupation-Based Modified Constraint-Induced Movement Therapy on the Participation of Children with Cerebral Palsy: A Single-Blind Randomized Controlled Trial. Iranian Journal of Child Neurology. 2023;17(2):39.
37. Wang TN, Liang KJ, Liu YC, Shieh JY, Chen HL. Effects of Intensive Versus Distributed Constraint-Induced Movement Therapy for Children With Unilateral Cerebral Palsy: A Quasi-Randomized Trial. Neurorehabilitation and Neural Repair. 2023 Feb;37(2-3):109-18