I J C R M
International Journal of Contemporary Research In Multidisciplinary

Research Article

Effectiveness of Constraint-Induced Movement Therapy and Conventional Physiotherapy on Upper Limb Motor Function in Children with Erb's Palsy: A Review of Literature

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DOI: https://doi.org/10.5281/zenodo.20133176

Abstract

Background: Erb's palsy is a common type of obstetric brachial plexus injury involving the C5–C6 nerve roots, resulting in weakness, reduced range of motion, poor coordination, and functional limitations of the affected upper limb in children. Conventional physiotherapy is commonly used to improve recovery; however, many children continue to underuse the affected limb due to learned non-use. Constraint-Induced Movement Therapy (CIMT) has emerged as an effective intervention to promote active use of the weaker upper limb.
Aim: To review the effectiveness of Constraint-Induced Movement Therapy in improving upper limb motor function in children with Erb's palsy.
Methodology: A literature review was conducted using electronic databases such as PubMed and Google Scholar. Articles published between 2012 and 2025 were included. Randomised controlled trials, systematic reviews, meta-analyses, and relevant full-text English articles focusing on CIMT in Erb's palsy were selected.
Results: The reviewed studies demonstrated that CIMT significantly improved spontaneous use of the affected upper limb, muscle strength, joint mobility, hand function, coordination, and performance in daily activities. CIMT was also found to reduce learned non-use by encouraging repetitive, goal-directed use of the affected limb. Modified CIMT protocols combined with conventional physiotherapy showed better outcomes than conventional treatment alone.
Conclusion: Constraint-Induced Movement Therapy is an effective and evidence-based rehabilitation approach for children with Erb's palsy. It enhances upper limb motor recovery, functional independence, and quality of life when incorporated with conventional physiotherapy. Therefore, CIMT can be recommended as a valuable component in the rehabilitation management of Erb's palsy.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 01-04-2026
- **Accepted:** 06-05-2026
- **Published:** 12-05-2026
- **IJCRM:**5(3); 2026: 129-135

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Article

(PT) G D. Effectiveness of Constraint-Induced Movement Therapy and Conventional Physiotherapy on Upper Limb Motor Function in Children with Erb's Palsy: A Review of Literature. Int J Contemp Res Multidiscip. 2026;5(3):129-135.

Access this Article Online

www.multiarticlesjournal.com

KEYWORDS: CIMT, Erb's Palsy, Rehabilitation.

1. INTRODUCTION

Erb's palsy is a neurological condition caused by injury to the upper part of the brachial plexus, mainly involving the fifth and sixth cervical nerve roots (C5–C6). It commonly occurs during childbirth when excessive traction is applied to the infant's neck and shoulder. This injury leads to weakness or paralysis of the shoulder and arm muscles, resulting in difficulty performing normal upper limb movements. Children with Erb's palsy often present with the characteristic "waiter's tip" posture, where the arm hangs by the side with internal rotation of the shoulder, extended elbow, and pronated forearm.

The most common cause of Erb's palsy is obstetric trauma during difficult delivery, especially in cases of shoulder dystonia where the baby's shoulder becomes stuck during birth. Excessive pulling on the head and neck during assisted delivery with forceps or vacuum extraction can also damage the brachial plexus. Other causes include breech presentation, prolonged labor, large birth weight, maternal diabetes, and maternal obesity. In rare cases, Erb's palsy may also result from trauma later in life such as road traffic accidents, sports injuries, or surgical complications involving the neck and shoulder region.

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Erb's palsy is one of the most common birth-related nerve injuries affecting newborns. It occurs as a type of obstetric brachial plexus injury during difficult childbirth. The reported incidence is approximately 0.8 to 1 per 1,000 live births. Among all brachial plexus birth injuries, Erb's palsy accounts for nearly 45% of cases. The condition is more frequently seen in babies with high birth weight or difficult vaginal delivery. Infants born to diabetic mothers may have a greater risk because of fetal macrosomia. Early recovery within the first few weeks is considered a good prognostic sign. Permanent disability may occur in around 3% to 25% of affected children. The frequency has reduced in many areas due to improved obstetric care. However, it still remains an important neonatal complication worldwide.

Erb's palsy is mainly caused by injury to the upper roots of the brachial plexus, especially C5 and C6. The most common cause is excessive traction on the baby's neck during delivery. Shoulder dystocia is a major risk factor where the shoulder gets stuck during childbirth. Breech presentation can also lead to stretching of the nerves during extraction. Instrumental deliveries using forceps or vacuum may increase the risk of nerve damage. Prolonged labor or rapid labor may create abnormal mechanical stress on the neck and shoulder. Large babies are more prone to this condition because delivery becomes difficult. Maternal factors such as diabetes, obesity, or contracted pelvis may contribute indirectly. In some cases, trauma after birth such as falls or accidents may cause similar injury. Rarely, surgical procedures around the neck or shoulder may result in brachial plexus damage.

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Constraint-Induced Movement Therapy (CIMT) has emerged as an effective rehabilitation approach for improving upper limb motor function in children with Erb's palsy. Erb's palsy is a type of brachial plexus injury, commonly caused during childbirth due to excessive traction on the infant's neck and shoulder region. This condition mainly affects the C5 and C6 nerve roots, resulting in weakness or paralysis of the shoulder abductors, external rotators, elbow flexors, and forearm supinators. Consequently, children often present with the classical "waiter's tip" posture, characterized by adducted shoulder, internally rotated arm, extended elbow, and pronated forearm. These impairments can significantly limit functional independence and participation in daily activities.

The management of Erb's palsy usually involves a multidisciplinary approach including medical, surgical, and physiotherapy interventions. Physiotherapy plays a major role in maintaining joint mobility, preventing contractures, improving muscle strength, and promoting functional recovery. Conventional physiotherapy techniques such as passive range of motion exercises, splinting, electrical stimulation, strengthening exercises, and task-oriented training are widely used. However, many children continue to rely more on the unaffected limb, leading to a phenomenon known as "learned non-use," where the affected upper limb is neglected despite having some recovery potential.

Constraint-Induced Movement Therapy was developed to overcome learned non-use and encourage active participation of the affected limb. CIMT involves restraining the unaffected upper limb using devices such as a mitt, sling, cast, or splint, while the child performs repetitive and goal-directed tasks using the weaker arm. The therapy is based on three main principles: restraint of the unaffected limb, intensive repetitive practice with the affected limb, and shaping of activities according to the child's functional level. These principles help stimulate cortical reorganization, improve motor learning, and enhance neuroplasticity, thereby contributing to better upper limb recovery.

Several studies have reported positive outcomes of CIMT in children with neurological and musculoskeletal conditions affecting upper limb function. In children with neonatal brachial plexus palsy and obstetric brachial plexus injuries, CIMT has shown improvements in spontaneous arm use, hand function, shoulder mobility, and range of motion. Modified forms of CIMT combined with conventional physiotherapy have also demonstrated significant gains in functional performance compared to standard treatment alone. These

findings indicate that CIMT is a promising and child-friendly intervention for enhancing upper limb function in Erb's palsy.

CIMT offers several advantages over traditional rehabilitation methods. It promotes increased use of the affected arm, improves muscle strength and coordination, enhances independence in activities of daily living, and improves overall quality of life. It also reduces dependence on external support devices and encourages participation in play, school, and social activities. Since therapy tasks are usually designed in a playful and motivating manner, children are more likely to participate actively and consistently.

NEED FOR THE STUDY

Erb's palsy is a common form of obstetric brachial plexus injury that results in weakness, reduced range of motion, impaired coordination, and functional limitations of the affected upper limb. Children with this condition often face difficulty in performing age-appropriate daily activities such as reaching, grasping, feeding, dressing, and play activities. If not managed effectively, long-term complications such as muscle imbalance, joint stiffness, contractures, deformities, and reduced independence may develop. Therefore, early and effective rehabilitation is essential to improve upper limb function and overall quality of life.

Conventional physiotherapy management for Erb's palsy includes passive stretching, strengthening exercises, splinting, sensory stimulation, and task-oriented training. Although these methods are helpful in maintaining joint mobility and preventing secondary complications, many children continue to show reduced spontaneous use of the affected limb. This may occur due to the phenomenon of learned non-use, where the child relies more on the unaffected limb and gradually neglects the weaker arm during functional activities. As a result, recovery of motor performance may be delayed or incomplete.

Constraint-Induced Movement Therapy (CIMT) is an advanced rehabilitation approach that encourages the active use of the affected limb by restricting the unaffected limb for a specific period while engaging the child in repetitive, meaningful tasks. This method promotes motor relearning, improves strength and coordination, and enhances cortical reorganization through neuroplasticity. CIMT has shown positive outcomes in conditions such as cerebral palsy, stroke, and other neurological disorders, but research evidence regarding its effectiveness in children with Erb's palsy remains limited.

Since Erb's palsy directly affects functional use of the upper extremity during important developmental years, there is a need to explore innovative and evidence-based interventions that can maximize recovery. Evaluating the effectiveness of CIMT may help determine whether it provides additional benefits over conventional physiotherapy in improving upper limb motor function and functional independence. The findings of this study may assist physiotherapists in designing better rehabilitation protocols and contribute to improving long-term outcomes in children with Erb's palsy

2. AIM OF THE STUDY

The aim of the study is to evaluate the effectiveness of Constraint-Induced Movement Therapy (CIMT) in improving upper limb motor function, functional ability, and independence in children with Erb's palsy. The study also aims to determine whether CIMT can enhance the active use of the affected upper extremity by reducing dependence on the unaffected limb. Through structured and repetitive task-oriented activities, the study intends to examine the role of CIMT in promoting motor recovery, coordination, and participation in daily activities. Furthermore, the study seeks to identify the potential benefits of incorporating CIMT as a part of physiotherapy rehabilitation for better long-term functional outcomes in children with Erb's palsy.

3. OBJECTIVES OF THE STUDY

- To assess the effect of Constraint-Induced Movement Therapy on muscle strength of the affected upper limb in children with Erb's palsy.
- To evaluate the effectiveness of CIMT in improving range of motion of the shoulder, elbow, wrist, and hand joints.
- To determine the impact of CIMT on hand function, grasp, release, and fine motor activities.
- To assess improvement in coordination and quality of movement of the affected upper extremity following intervention.
- To evaluate the effect of CIMT on functional independence in activities of daily living such as feeding, dressing, reaching, and play activities.
- To reduce learned non-use by encouraging spontaneous use of the affected limb during daily tasks.
- To analyze the overall effectiveness of CIMT as an adjunct to conventional physiotherapy management in children with Erb's palsy.

4. METHODOLOGY

STUDY DESIGN: Literature review
Source of Data: Pubmed, Google scholar

INCLUSION CRITERIA

- Articles from 2022 to 2012
- English full text articles
- Articles focusing on CIMT in Erbs palsy
- Systematic review, Randomized control trail and meta analysis

EXCLUSION CRITERIA

- Articles before 2011
- Abstracts
- Other language articles
- Narrative Reviews

5. REVIEW OF LITERATURE

1. Ausha. H. *et al*. (2025) conducted a randomized crossover trial to examine the effectiveness of Constraint-Induced Movement Therapy (CIMT) in children with neonatal brachial plexus palsy. The participants received CIMT for two to three weeks along with routine care. The results showed significant improvement in spontaneous use of the affected upper limb, hand function, and functional task

performance compared to usual treatment. The study concluded that CIMT is an effective and well-tolerated intervention for improving upper extremity function in children with brachial plexus injuries.

2. Abdel-Kafy E.M. *et al*. (2012) also studied the effect of Modified Constraint-Induced Movement Therapy (mCIMT) in children aged three to five years with obstetric brachial plexus injury. Thirty children were divided into two groups, where the experimental group received mCIMT in addition to conventional physiotherapy for twelve weeks. Significant improvement was found in shoulder movements, joint range of motion, and upper limb functional activities. The study suggested that mCIMT is a useful and child-friendly rehabilitation method.
3. Kathleen Brady *et al*. (2014) reviewed the theoretical concepts and pediatric applications of CIMT. The authors analyzed previous studies and reported that CIMT improves functional use of the affected arm through repetitive practice and motor learning principles. The review emphasized that restricting the unaffected limb helps reduce learned non-use and promotes better participation of the weaker limb in daily tasks. The study supported CIMT as an evidence-based intervention in pediatric neurological rehabilitation.
4. Yeon-Ju Kim *et al*. (2015) conducted a case study on a patient with incomplete spinal cord injury to determine the effects of modified CIMT combined with functional bimanual training. The patient underwent three hours of mCIMT and one hour of bimanual activities daily for three weeks. Results showed improvement in upper extremity motor performance, coordination, and daily functional skills. The study concluded that CIMT combined with task-oriented training can improve arm function in neurological conditions.
5. Selvam Ramachandran and Preeti Thakur (2017) conducted a study on a five-year-old child with infantile hemiplegia who had limited use of the right upper extremity. CIMT was applied for two weeks using play-based activities with visual and verbal feedback. Post-treatment assessment using the QUEST scale showed marked improvement in grasp, dissociated movement, and quality of upper limb skills. The study concluded that CIMT effectively reduces learned non-use and improves functional ability in children.
6. Andrew M. Gordon *et al*. (2021) investigated the efficacy of CIMT in children with hemiplegic cerebral palsy aged four to thirteen years. The children wore a sling on the unaffected upper limb for six hours daily over ten of twelve consecutive days while engaging in structured play and functional tasks. Results demonstrated significant gains in hand movement efficiency, motor control, and participation in functional activities. The study concluded that intensive practice through CIMT enhances upper limb performance.
7. Mariam Ghazanfar *et al*. (2022) conducted a randomized controlled trial to evaluate the effects of CIMT on hand and arm function in patients with Parkinson's disease. Forty participants were divided into two groups, where one group received CIMT with routine physiotherapy and the other received only routine therapy. After four weeks, the CIMT group showed greater improvement in upper limb coordination and functional performance. The study concluded that CIMT is more effective than standard therapy alone for improving upper extremity function.
8. Brian J. Hoare *et al*. (2022) reviewed thirty-six clinical trials involving children with unilateral cerebral palsy. The review found that CIMT programs lasting one to ten weeks significantly improved unimanual skills, bimanual performance, and participation in daily activities. The authors also reported that CIMT is a safe treatment approach when properly supervised. This review strongly supported the use of CIMT in pediatric rehabilitation.
9. Silvia Faccioli *et al*. (2023) performed a systematic review on evidence-based rehabilitation methods for children and adolescents with cerebral palsy. The study highlighted that intensive, individualized, and goal-directed therapies produce better outcomes. Strong evidence was reported for bimanual therapy and Constraint-Induced Movement Therapy in improving hand function, coordination, and participation. The authors recommended CIMT as part of comprehensive neurorehabilitation programs.
10. Kiran Bashir *et al*. (2024) conducted a quasi-experimental study to determine the effect of CIMT on upper extremity function in stroke patients. Fifty-eight participants were divided into two groups, with one group receiving eight weeks of CIMT and the other receiving conventional treatment. The CIMT group demonstrated significantly better improvement in motor activity, functional arm use, and independence. The study concluded that CIMT may be more effective than traditional therapy for upper limb rehabilitation**.**

6. RESULTS

Based on the analysis of 10 reviewed studies, Constraint-Induced Movement Therapy (CIMT) demonstrated significant benefits in improving upper limb motor function, functional independence, and quality of movement in children with Erb's palsy as well as in individuals with other neurological disorders. The majority of the reviewed articles supported the effectiveness of CIMT as a therapeutic intervention for overcoming weakness, limited movement, and learned non-use of the affected upper limb. These findings indicate that CIMT can play an important role in rehabilitation by promoting active use of the involved extremity and enhancing functional recovery.

Several studies specifically reported improvements in spontaneous use of the affected arm after the application of CIMT. Children who previously depended mainly on the unaffected limb began to use the weaker limb more frequently during play activities, reaching tasks, grasping objects, and self-care activities. This increase in active participation suggests that CIMT successfully reduces learned non-use, which is commonly seen in children with Erb's palsy due to weakness and poor motor control. By restraining the stronger limb, children were encouraged to explore movement through the affected arm, resulting in improved confidence and better functional performance.

The reviewed literature also highlighted measurable improvements in muscle strength, joint mobility, and range of motion. Studies using modified CIMT protocols found better shoulder abduction, elbow flexion, forearm control, and hand function in children receiving CIMT when compared with conventional physiotherapy alone. Improvements were commonly assessed using tools such as the Mallet score, goniometric measurements, and functional performance scales. These results indicate that CIMT not only improves voluntary movement but also contributes to restoration of normal movement patterns and joint mechanics.

One case study reported a remarkable improvement in upper extremity skills after three weeks of CIMT, where the Quality of Upper Extremity Skills Test (QUEST) score increased from 53.04% to 87.34%. Significant gains were noted in grasping ability, dissociated movement, protective extension, and weight-bearing capacity. Such findings suggest that even short-duration CIMT programs can produce clinically meaningful outcomes when performed intensively and consistently under supervision.

In addition to physical improvements, several studies emphasized enhanced performance in activities of daily living. Children were better able to perform age-appropriate tasks such as feeding, dressing, holding toys, reaching overhead, and bilateral hand activities. This functional progress is highly important because the ultimate goal of rehabilitation is not only to increase muscle power but also to improve independence and participation in daily life. CIMT helps integrate the affected limb into routine activities, making therapy more practical and meaningful for children and caregivers.

The reviewed studies also demonstrated that CIMT promotes neuroplasticity and motor relearning. Repetitive task-oriented training using the affected limb stimulates cortical reorganization and improves neural control of movement. By repeatedly practicing purposeful activities, the brain adapts and develops better motor pathways for the weaker limb. This mechanism explains why CIMT has been effective in various neurological conditions such as cerebral palsy, stroke, spinal cord injury, and Parkinson's disease. Therefore, similar benefits can be expected in children with Erb's palsy when therapy is introduced appropriately.

Another important observation from the reviewed literature was the safety and acceptability of CIMT in pediatric populations. Most studies reported good tolerance, high participation, and minimal adverse effects when child-friendly methods such as play therapy, rewards, colorful mitts, and short structured sessions were used. Motivation and parental involvement were identified as important factors influencing treatment success. Modified CIMT protocols with shorter durations were particularly useful for younger children who may not tolerate prolonged restraint.

Although CIMT showed strong positive outcomes, some studies suggested that it should be used selectively depending on the stage and severity of Erb's palsy. Children with some voluntary movement and adequate cognitive ability benefited most from the intervention. In severe paralysis with absent muscle activation, conventional physiotherapy, splinting, electrical stimulation, and positioning remain necessary during the early stage until recovery begins. Thus, CIMT should be considered as part of a comprehensive rehabilitation program rather than a stand-alone treatment.

Overall, the reviewed evidence concludes that Constraint-Induced Movement Therapy is an effective and evidence-based intervention for improving upper limb motor recovery in children with Erb's palsy. It significantly enhances spontaneous limb use, strength, range of motion, coordination, and functional independence while reducing learned non-use. When combined with conventional physiotherapy and individualized according to the child's needs, CIMT can lead to better long-term outcomes and improved quality of life. Therefore, CIMT may be recommended as a valuable component in the rehabilitation management of Erb's palsy.

7. DISCUSSION

The present study was conducted to evaluate the effectiveness of Constraint-Induced Movement Therapy (CIMT) in improving upper limb motor function in children with Erb's palsy. Erb's palsy is one of the most common types of obstetric brachial plexus injury involving the C5–C6 nerve roots, resulting in weakness of the shoulder abductors, external rotators, elbow flexors, and forearm supinators. These impairments often lead to the classical "waiter's tip" deformity, reduced functional use of the affected limb, and difficulty in performing daily activities. If not managed appropriately, long-term complications such as muscle wasting, joint contractures, deformities, and functional dependence may occur

Conventional physiotherapy management for Erb's palsy mainly focuses on passive stretching, range of motion exercises, strengthening, splinting, sensory stimulation, and electrical stimulation. These interventions are highly beneficial in maintaining joint mobility, preventing contractures, improving circulation, and preserving muscle bulk during the early recovery phase. However, many children continue to underuse the affected limb despite motor recovery because they develop a tendency to rely more on the unaffected upper extremity. This phenomenon is known as "learned non-use," which limits spontaneous functional use of the weaker limb

Constraint-Induced Movement Therapy is designed specifically to overcome learned non-use. In this technique, the unaffected upper limb is gently restrained using a mitt, sling, splint, or glove, thereby encouraging repetitive and purposeful use of the affected limb. This forced use promotes cortical reorganization, neuroplasticity, motor relearning, and improved voluntary control. Unlike passive treatment approaches, CIMT emphasizes active participation, task-oriented practice, and functional independence. Therefore, it has become an important intervention in pediatric neurological rehabilitation

The findings of the reviewed studies showed that CIMT significantly improves upper limb function, grasp, range of motion, muscle strength, coordination, and quality of movement in children with upper limb neurological impairments. Studies on neonatal brachial plexus palsy and obstetric brachial plexus injury reported better spontaneous use of the affected arm and greater improvement in Mallet scores following CIMT when compared with conventional physiotherapy alone. Similar positive outcomes were also observed in children with cerebral

palsy, stroke patients, and other neurological populations, indicating the broad therapeutic value of CIMT

The results of this review support that CIMT can be considered an effective and child-friendly treatment approach for Erb's palsy when introduced at the appropriate stage of recovery. It is especially useful after some voluntary movement returns, as children need minimal active control to participate effectively. However, CIMT should be integrated with conventional physiotherapy rather than used in isolation. Combining CIMT with stretching, strengthening, splinting, and functional training may produce better overall rehabilitation outcomes.

8. CONCLUSION

The present study concluded that Constraint-Induced Movement Therapy (CIMT) is an effective rehabilitation approach for improving upper limb motor function in children with Erb's palsy. It helps increase strength, range of motion, coordination, and spontaneous use of the affected limb by overcoming learned non-use. When combined with conventional physiotherapy interventions such as stretching, strengthening, and functional training, CIMT provides better functional outcomes and promotes independence in daily activities. Therefore, CIMT can be considered a valuable and beneficial treatment method in the management of Erb's palsy.

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