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Research

Constraint-induced movement therapy improves upper limb activity and participation in hemiplegic cerebral palsy: a systematic review

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KEY WORDS

Cerebral palsy
Systematic review
Meta-analysis
Randomised controlled trials
Constraint-induced movement therapy

ABSTRACT

Questions: Does constraint-induced movement therapy improve activity and participation in children with hemiplegic cerebral palsy? Does it improve activity and participation more than the same dose of upper limb therapy without restraint? Is the effect of constraint-induced movement therapy related to the duration of intervention or the age of the children? **Design:** Systematic review of randomised trials with meta-analysis. **Participants:** Children with hemiplegic cerebral palsy with any level of motor disability. **Intervention:** The experimental group received constraint-induced movement therapy (defined as restraint of the less affected upper limb during supervised activity practice of the more affected upper limb). The control group received no intervention, sham intervention, or the same dose of upper limb therapy. **Outcome measures:** Measures of upper limb activity and participation were used in the analysis. **Results:** Constraint-induced movement therapy was more effective than no/sham intervention in terms of upper limb activity (SMD 0.63, 95% CI 0.20 to 1.06) and participation (SMD 1.21, 95% CI 0.41 to 2.02). However, constraint-induced movement therapy was no better than the same dose of upper limb therapy without restraint either in terms of upper limb activity (SMD 0.05, 95% CI –0.21 to 0.32) or participation (SMD –0.02, 95% CI –0.34 to 0.31). The effect of constraint-induced movement therapy was not related to the duration of intervention or the age of the children. **Conclusions:** This review suggests that constraint-induced movement therapy is more effective than no intervention, but no more effective than the same dose of upper limb practice without restraint. **Registration:** PROSPERO CRD42015024665. **[Chiu H-C, Ada L (2016) Constraint-induced movement therapy improves upper limb activity and participation in hemiplegic cerebral palsy: a systematic review. *Journal of Physiotherapy* 62: 130–137]**

Introduction

Cerebral palsy is a non-progressive neurological condition resulting in motor impairments that can change over time.[1] The impairments may originate directly from damage to an immature brain, or indirectly from compensatory movements or disuse during development.[1] Such impairments may result in activity limitations that require rehabilitation throughout life.[1] Among children with cerebral palsy, 29% have hemiplegia, that is, one side of the body is affected much more than the other, and the upper limb is typically more involved than the lower limb.[2] They may develop 'learned non-use' in their affected upper limb, because they tend to learn alternative strategies to manage daily tasks using the less affected limb.[3–5] Performance of tasks is often more efficient using the less affected upper limb, even if there is only mild impairment in the more affected limb.[3] Children with hemiplegic cerebral palsy usually have the intellectual capacity to attend regular schools, yet impaired upper limb function tends to restrict their participation in education and leisure, and impact their social image.

Therapists working with children with hemiplegic cerebral palsy encourage movement of the affected limb by repetitive practice of unilateral and bimanual activities. Constraint-induced movement therapy (CIMT) aims to overcome 'learned non-use' by intensive, targeted practice with the more affected limb during restraint of the less affected limb.[5] While restrained, only the affected upper limb can be used to carry out activities, forcing children to find solutions to their movement problems.[4,5]

There are four systematic reviews specifically examining the effect of CIMT in children with cerebral palsy or hemiplegia from other causes.[5–8] Two of the reviews included all published studies, regardless of design, and included low levels of evidence such as case studies.[5,8] The Cochrane review on this topic has not been updated since 2007 and includes only three randomised trials. These three trials were not pooled into a meta-analysis but the authors concluded that there was a trend towards a beneficial effect of CIMT.[7] The most recent review[6] to focus on CIMT reported a standardised effect size of 0.55 from the pooled estimate of 27 randomised trials of CIMT versus conventional therapy. One of the post-hoc analyses carried out was to divide the trials on the basis of the equivalence of dose of intervention. When CIMT was compared with a dose-equivalent intervention, the effect was much smaller (SMD 0.37) than the effect among trials without a dose-equivalent comparison group (SMD 0.84). These results give insight into the mechanism of CIMT. The effect of CIMT may be due to nothing more than the large amounts of practice that restraint of the less affected upper limb produces.

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In order to fully investigate the effect of CIMT on children with hemiplegic cerebral palsy, trials where CIMT is compared with no intervention need to be pooled separately from trials where CIMT is compared with the same dose of practice without restraint of the unaffected limb. The present systematic review therefore took this approach. In addition, this review examined outcomes at the level of activity and participation, because not only is the effect of CIMT on upper limb activity of interest, but also how improved activity might translate into the broader context of using the upper limb to participate at home, at school and in the community. This review also sought to determine whether the amount of benefit obtained from CIMT is associated with certain characteristics of the children or the CIMT.

Therefore, the research questions for this systematic review were:

1. Does CIMT improve activity and participation in children with hemiplegic cerebral palsy?
2. Does CIMT improve activity and participation more than the same dose of upper limb therapy without restraint?
3. Is the effect of CIMT related to the duration of intervention or the age of the child?

Method

Identification and selection of studies

Searches were conducted of Medline (1966 to June 2015), CINAHL (1982 to June 2015), PubMed (1966 to June 2015), Embase (1974 to June 2015), the Cochrane Library (1966 to June 2015), Web of Science (1945 to June 2015) and the Physiotherapy Evidence Database (PEDro) (to June 2015), without language restrictions using words related to *cerebral palsy* and *randomised controlled trials* and words related to *constraint-induced movement therapy* (such as constraint-induced movement therapy, forced and massed practice) (see Appendix 1 for full search strategy). Titles and abstracts were displayed and screened by one reviewer to identify relevant studies. Full-text copies of relevant studies were retrieved and their reference lists were screened. The methods of the retrieved papers were screened independently by two reviewers against the inclusion criteria: randomised or quasi-randomised trials; children or adolescents (< 18 years of age) with hemiplegic cerebral palsy; experimental intervention of CIMT; control intervention of no/sham intervention or same dose of upper limb therapy; and outcome measure(s) of activity or participation (Box 1).

Box 1. Inclusion criteria.

Design
- randomised or quasi-randomised trial

Participants
- children (ie, < 18 years old)
- hemiplegic cerebral palsy
- any level of disability

Intervention
- constraint-induced movement therapy (ie, restraint of the less affected limb) applied during supervised activity practice of the more affected upper limb

Outcome measures
- measures of activity or participation

Comparisons
- constraint-induced movement therapy vs no/sham intervention (sham defined as usual therapy ≤ 20% of time restrained)
- constraint-induced movement therapy vs same dose of upper limb therapy (defined as ≥ time restrained)

Assessment of characteristics of studies

Quality

The quality of included studies was assessed by extracting PEDro scores from the PEDro website. Each score on the PEDro website is generated by two accredited raters scoring the trial, with any discrepancies in rating resolved by a third accredited rater.

Participants

Studies involving participants of either gender, regardless of the level of initial disability, were included. The Manual Ability Classification System was used to quantify the severity of upper limb disability. The Manual Ability Classification System classifies how children with cerebral palsy use their hands to handle objects in daily activities, with I = minor limitations and V = severe limitations.[9] Age and Manual Ability Classification System level were recorded so that the similarity of participants between studies could be examined. If the Manual Ability Classification System level was not reported, reviewers classified the participants based on the available information.

Intervention

The experimental group had to have received CIMT (defined as restraint of the less affected upper limb during task practice of the more affected upper limb). To be eligible to answer the first study question, the control group had to receive no/sham intervention, defined as usual therapy ≤ 20% of the time that the experimental group spent restrained. To be eligible to answer the second study question, the control group received the same dose of upper limb therapy (unilateral or bilateral or both), defined as equal to or greater than the time that the experimental group spent restrained. Participants could be receiving other therapy as long as both groups received it. The frequency and duration of the intervention was recorded so that the similarity of intervention between studies could be examined.

Outcome measures

Measures that reflected upper limb activity and participation were used in the analysis. Upper limb activity was measured as what the child could do with their more affected limb. Therefore, measures using direct observation of unimanual performance of standardised upper limb tasks, such as Jebsen-Taylor Test of Hand Function, Nine-Hole Peg Test or Bruininks-Oseretsky Test of Motor Proficiency, Quality of Upper Extremity Skills Test or Melbourne Assessment of Unilateral Upper Limb Function, were used and reported as either level of difficulty or time taken. Upper limb participation was measured as what the child did in real life. Therefore, measures using direct observation or parent perception of bimanual real-life play, such as the Assisting Hand Assessment or Pediatric Motor Activity Log, were used and reported as level of difficulty.

Data analysis

Data were extracted from the included studies by one reviewer and cross-checked by a second reviewer. Information about the method (ie, design, participants, intervention and measures) and outcome data (ie, number of participants, mean (SD) activity and participation) were extracted. Authors of papers with missing data were contacted.

Most studies reported post-intervention scores immediately after intervention; therefore, these scores were used to obtain the pooled estimate of the effect of intervention. Since different measurement tools were used, the effect size was reported as Cohen's standardised mean difference (SMD, 95% CI). A random-effects model was used. The analyses were performed using MIX 2.0, which is a statistical add-in for performing meta-analysis in Excel.[10,11]

Simple linear regression was used to determine the association between the duration of CIMT and the effect of CIMT (on activity