Research in Developmental Disabilities 41–42 (2015) 86–93

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Improvements in bimanual hand function after baby-CIMT in two-year old children with unilateral cerebral palsy: A retrospective study

Linda Nordstrand [a,*], Marie Holmefur [b], Annika Kits [c], Ann-Christin Eliasson [a]

[a] Department of Women's and Children's Health, Karolinska Institutet, Stockholm, Sweden
[b] School of Health and Medical Sciences, Örebro University, Sweden
[c] Department of Neuroradiology, Karolinska University Hospital, Stockholm, Sweden

ARTICLE INFO

Article history:
Received 10 December 2014
Received in revised form 13 April 2015
Accepted 7 May 2015
Available online 19 June 2015

Keywords:
Constraint-induced movement therapy
Cerebral palsy
Early intervention
Hand function
Upper extremity
Hemiplegia

ABSTRACT

The common assumption that early-onset intensive intervention positively affects motor development has rarely been investigated for hand function in children with unilateral cerebral palsy (CP). This retrospective study explored the possible impact of baby constraint-induced movement therapy (baby-CIMT) on hand function at two years of age. We hypothesized that baby-CIMT in the first year of life would lead to better bimanual hand use at two years of age than would not receiving baby-CIMT. The Assisting Hand Assessment (AHA) was administered at age 21 months (SD 2.4 months) in 72 children with unilateral CP, 31 of who received baby-CIMT. When dividing the children into four functional levels based on AHA, the proportional distribution differed between the groups in favour of baby-CIMT. Logistic regression analysis indicated that children in the baby-CIMT group were more likely than were children in the no baby-CIMT group to have a high functional level, even when controlling for the effect of brain lesion type (OR 5.83, 95% CI 1.44–23.56, $p = 0.001$). However, no difference was found between groups in the odds of having a very low functional level (OR 0.31, 95% CI 0.08–1.17, $p = 0.084$). The result shows that baby-CIMT at early age can have a positive effect. Children who received baby-CIMT were six times more likely to have a high functional level at two years of age than were children in the no baby-CIMT group.

1. Introduction

There is evidence of a sensitive time window for intervention of hand motor development during the first year of life. For children with neonatal stroke and other unilateral neonatal brain damage, promotion of activity of the involved hand during this period is suggested to mitigate the effects of early brain damage more effectively than intervention at later age (Basu, 2014). In children later diagnosed with unilateral cerebral palsy (CP), asymmetric hand use is usually apparent from 3 to 5 months of age (Chen, Lo, & Heathcock, 2013; Guzzetta et al., 2010), enabling an early start of intervention. So far, intervention programmes especially addressing hand function in young infants with signs of unilateral CP are rare and evaluating their

Abbreviations: AHA, assisting hand assessment; CIMT, constraint-induced movement therapy; CP, cerebral palsy; CT, computer tomography; MCA, middle cerebral artery; MRI, magnetic resonance imaging; WMDI, white matter damage of immaturity.

* Corresponding author. Tel.: +46 851778074.
E-mail address: linda.nordstrand@ki.se (L. Nordstrand).

http://dx.doi.org/10.1016/j.ridd.2015.05.003
0891-4222/

effects is difficult (Lowes et al., 2013; Spittle, Orton, Anderson, Boyd, & Doyle, 2012). Retrospectively investigating a group of older children who were involved in a hand treatment programme before one year of age is a first step towards increased knowledge of the impact of early motor intervention.

The theoretical basis for early intervention of hand function is that intervention during the sensitive window of activity-dependent motor system plasticity preserves the typical pattern of development of descending motor pathways to the hands (Basu, 2014; Friel, Chakrabarty, Kuo, & Martin, 2012; Martin, Chakrabarty, & Friel, 2011; Martin, Friel, Salimi, & Chakrabarty, 2007). Ipsilateral corticospinal pathways are typically present at birth but retract during the first years of life due to competition for synaptic space from contralateral corticospinal pathways (Eyre et al., 2007). This activity-dependent reorganization does not always occur after early unilateral brain lesion, which results in an organizational pattern correlated with poorer functional outcome of hand function and bimanual hand use (Holmstrom et al., 2010). When Martin et al. (2007) synchronized constraint-induced movement therapy (CIMT)-type of activity-based training in the time period of corticospinal tract development in an animal model of CP, motor function restoration was possible. They did not find restoration if the intervention was performed at an older age (Friel et al., 2012). If similar potential is present in humans, early intervention might have a positive impact on the future development of hand function in children with unilateral CP.

The timing of brain lesion occurrence is reported to critically affect both the lesion characteristics and later outcome in children with CP (Krageloh-Mann & Horber, 2007). White matter damage of immaturity (WMDI) is a result of brain lesions occurring in the second trimester of pregnancy, while middle cerebral artery infarct (MCA) causes lesions closer to full-term age. These types of lesions have also been found to relate to different developmental patterns of hand function in children with unilateral CP, in favour of WMDI (Feys et al., 2010; Holmefur et al., 2013; Holmstrom et al., 2010).

The activity-dependent plasticity indicates that early activity-based intervention will have a positive impact on motor development also in the presence of an early acquired brain lesion. Based on this rationale, some years ago we developed a baby-CIMT programme adapted for young infants aged 4–12 months (Eliasson, Sjöstrand, Ek, Krumlinde-Sundholm, & Tedroff, 2014). Evidence from randomized controlled studies indicates that CIMT effectively improves hand function in children with unilateral CP over two years of age (Sakzewski, Ziviani, & Boyd, 2014). It is reasonable to assume that such training would benefit young children as well, as indicated by results from some case studies (Coker, Lebkicher, Harris, & Snape, 2009; Cope, Forst, Bibis, & Liu, 2008; Lowes et al., 2013).

This retrospective study aimed to explore the impact of a baby-CIMT programme on children's hand function at two years of age. We hypothesized that participating in baby-CIMT in the first year of life could predict better use of the affected hand in bimanual activities at two years of age than would not participating in baby-CIMT.

2. Methods

2.1. Design

The study used a retrospective explorative design including children with unilateral CP.

2.2. Participants

The study included a convenience sample of 72 children with unilateral spastic cerebral palsy that participated in previous projects at our research unit. Inclusion criteria were: (1) availability of an Assisting Hand Assessment (AHA) below 28 months of age, (2) information regarding participation in a baby-CIMT programme (3) diagnosed with unilateral CP and (4) no participation in other intensive intervention before the used AHA.

The participating children had one AHA assessment at an average age of 21 months (SD 2.4 months) (Table 1). Thirty-one children had participated in a baby-CIMT programme in their first year of life (four of these children at 13–16 months) and 41 children had not. At the time of AHA administration, all children could walk, none had any additional confirmed diagnosis

Table 1
Demographic data on participants in the baby-CIMT and no baby-CIMT groups; no significant difference between groups except for proportion of brain imaging.

	Baby-CIMT ($n = 31$)	No baby-CIMT ($n = 41$)
Gestational age (weeks), mean (SD)	37 (5.3)[a]	38 (4.1)[b]
Preterm birth (<week 37), *n* (%)	9 (29)	10 (26.3)
Female, *n* (%)	16 (52)	18 (44)
Brain imaging, *n* (%)[c]	25 (80.6)	25 (60.9)
Right hand affected, *n* (%)[d]	22 (73)	23 (58)
Age at end of baby-CIMT (months), mean (SD)	12 (2.2)	–
Age at AHA (months), mean (SD)	21 (2.4)	21 (2.4)
AHA units, median (range)	53 (0–86)	46 (7–77)

[a] Median = 39.
[b] Median = 39, $n = 38$.
[c] Pearson's chi-square 7.37, $p = .007$.
[d] Data on one participant in each group are missing.