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ORIGINAL ARTICLE

Effect of hand-arm bimanual intensive therapy on fine-motor performance in children with hemiplegic cerebral palsy

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Abstract Children with hemiplegic cerebral palsy have impairments in bimanual coordination above and beyond their unilateral impairments.

Aim of the study: The current study was conducted to examine the effect of hand-arm bimanual intensive therapy (HABIT) on the affected upper extremity use in children with hemiplegic cerebral palsy.

Subjects and procedures: Thirty hemiparetic children ranged in age from 3 to7 years with mild to moderate hand involvement participated in this study and they were divided equally into two groups (control and study). Children in the study group were engaged in play and functional activities that provided structured bimanual practice 3 h per day for 12 weeks, while children in the control group received traditional physical therapy program directed toward improving upper extremity use. Each child in the two groups was evaluated before and after the suggested treatment duration for detecting the level of hand performance using the Peabody Developmental Test of Motor Proficiency and hand grip strength by a hand held dynamometer.

Results: Children in both groups demonstrated improved scores on the Hand grip strength while only children in the study group showed significant improvement in fine-motor performance scores ($p < 0.05$).

Conclusion: The results suggest that, hand-arm bimanual intensive therapy appears to have a positive impact on hand function in children with hemiparetic cerebral palsy.

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1. Introduction

In hemiplegic cerebral palsy (CP) the resulting movement impairments are largely localized to one side, with the upper extremity usually being affected more than the lower extremity [1,2]. The resulting impairments to upper extremities may

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demonstrate abnormal muscle tone with posturing into wrist flexion, ulnar deviation, elbow flexion, and shoulder internal or external rotation in addition to reduced strength, as well as tactile and proprioceptive disturbances. All the previous impairments can result in abnormal development of hand skills and consequently affect functional independence and quality of life as well as skilled independent finger movement [3,4].

Brain damage associated with hemiplegia often includes areas known to be involved in bimanual coordination such as the supplementary motor area and the parietal lobe [5,6]. During symmetrical bimanual movements there is a coupling of movements of the two extremities with one or both of the movements being affected [7–9].

Impairments of the involved upper extremity in children with hemiplegic CP may underlie some of the functional limitations that decrease their independence [10–13]. There is some suggestion that initial unimanual practice can transfer to improvements in bimanual coordination suggesting that this treatment can ameliorate their poor bimanual coordination. However, this might be best accomplished by practicing bimanual skills directly [9,14].

There is some evidence that the impaired hand function is not static during development [15,16], as the rate of development of the involved hand of children with CP largely parallels to that of typically developing children, so one key to rehabilitation is to alter the rate of development that may enable children with CP to more closely approximate the functional independence and social integration observed in typically developing children [17].

Consequently as children with hemiplegia have impairments in bimanual coordination; an interventional approach to increase functional independence during activities of daily living by using both hands in cooperation in a form of bilateral hand-arm bimanual intensive therapy is needed. So the aim of the current study was to detect the effect of HABIT on changing the quality of the affected upper extremity performance in children with hemiplegic CP.

1.1. Methodology

The study was conducted at the outpatient clinic of the Faculty of Physical Therapy Cairo University after the approval of the Faculty of Physical Therapy ethics committee and parents of the children participated in this study. The work was also carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

1.2. Subjects

Thirty hemiparetic CP children (due to prenatal and/or perinatal brain damage according to the Hagberg classification) of both sexes (20 boys, 10 girls) ranged in age from 3 to 7 years with hand spasticity ranged between 1 and 1+ grades according to the Modified Ashworth Scale participated in this study. They were selected from the outpatient clinic of the Faculty of Physical Therapy, Cairo University. Children with moderate and severe spasticity or fixed upper limb deformities or children with mental retardation were excluded from this study. Children who followed the previous inclusion criteria were assigned randomly into two groups of equal number of control and study groups. Children in the control group (9 boys, 6 girls) received a selected physical therapy program directed toward improving upper extremity functions, while children in the study group (11 boys, 4 girls) received hand-arm bimanual intensive therapy program (HABIT). The treatment was conducted for twelve successive weeks in each group at the rate of three sessions per week.

1.3. Instrumentation

Peabody developmental motor scale (PDMS-2) was used for the detection of Fine motor skills (grasping section), and a calibrated hand-held dynamometer was used for measuring hand grip strength. Different sizes and shapes of occupational therapy tools including balls, cubes, cards, dough, marbles, scissors, puzzle, keys, zipper, beads, tooth brush and paste, buttons, jar, lock and key were used in the treatment of both groups.

1.4. Procedures

Assessment of fine motor skills of Grasping section in PDMS-2 included administration of 26 subtests that measure child's ability to use his/her hands. It begins with the ability to hold an object with one hand and progresses up to actions involving the controlled use of the fingers of both hands. Application of the scale included detecting entry point (in which 75% of children in the normative sample at that age passed), basal level (the last score of 2 on three items in a row before the 1 or 0 scores) and ceiling level (when the child scores 0 on each of three items in a row) for each child before and after treatment application. The entry point of grasping subtest in the current study was determined at item 21 which starts from 35 to 71 months. This scale is based on scoring each item as follows: 2: The child performs the item according to the criteria specific for mastery. 1: The child performance shows a clear resemblance to the item mastery criteria but does not fully meet the criteria. 0: The child cannot or will attempt the item, or the attempt does not show that skill is emerging.

Evaluation of hand grip strength: It was carried out by asking the child to squeeze the dynamometer while maintaining elbow joint flexed 90°, forearm in mid position and rested on an arm-chair with the wrist joint in neutral position.

Treatment procedures: Children in the control group received a unimanual treatment program for the involved upper extremity directed toward improving upper limb function including reflex inhibiting pattern, hand weight bearing, shaping the affected hand with different occupational therapy tools, and repetitive task practice as dice activities, turning cards, putting marbles into bottle and dough activities.

Patients in the study group received HABIT that focuses on: (1) provision of structured practice increasing in complexity; (2) provision of functional activities that necessitate bimanual hand use.

Bimanual activities were selected that supposed to improve the movement deficits and engage the child in activities of increasing complex bimanual coordination. Demonstration of each task performance and how each hand will be used was clarified to the child before the start of each task to prevent use of compensatory strategies.

A number of age-appropriate fine motor and manipulative gross motor activities that require use of both hands are

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