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Original Article

Effect of appropriate assistive device on rehabilitation of children with cerebral palsy under ICF framework

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Abstract: *Objective:* To study the role and duration of application of assistive devices in children with cerebral palsy (CP). *Methods:* We randomly assigned forty-five children with dyskinetic CP: (1) no sitting chair group (DN group, fifteen children); (2) 1-3 hours of daily chair sitting group (DA group, fifteen children); and (3) 4-6 hours of daily chair sitting group (DB group, fifteen children). After six months of regular rehabilitation, both gross motor skills and fine motor skills were evaluated and compared. Additionally, we randomly assigned one hundred and twenty children with spastic CP who received walking training to the following groups: (1) no ankle-foot orthosis (AFO) wearing group (SN group, forty children); (2) 1-3 hours of daily AFO wearing group (SA group, forty children); (3) 4-6 hours of daily AFO wearing group (SB group, forty children). After six months of regular rehabilitation, both gross motor skills and fine motor skills were evaluated and compared. *Results:* The application of the sitting chair improved the gross motor function of children with dyskinetic CP. In addition, application of the assistive device improved fine motor activities. The ability Gross Motor Function Measure 66 (GMFM-66) Area II score of children from group DB was significantly higher than that of children from group DA (55.70 ± 2.58 *vs.* 40.89 ± 2.64, $P < 0.05$). Moreover, the ability Fine Motor Function Measure (FMFM) score of children from group DB was significantly higher than that of children from group DA (35.80 ± 0.73 *vs.* 32.49 ± 0.64, $P < 0.05$). Wearing AFO could improve the walking ability in children with spastic CP. In addition, it improved fine motor activities. The ability GMFM-66 Area II score of children from group SB was 63.45 ± 2.66, while that of children from group SA was 59.22 ± 2.71 ($P < 0.05$). The ability FMFM score of children from group SB was 47.28 ± 2.31, while that of children from group SA was 44.01 ± 2.30 ($P < 0.05$). *Conclusion:* Appropriate daily use of assistive devices has a great effect on the motor function and fine motor activity of children with CP. It further expands the children's range of movement and improves their social participation, in accordance to the idea of rehabilitation under ICF-CY framework.

Keywords: Assistive device, ICF-CY, cerebral palsy, appropriate

Introduction

Cerebral Palsy (CP) defines this disease according to a recent definition [1] as a group of persistent syndromes that result in limited movement and postural development abnormalities [2, 3]. It is one of the major diseases causing disabilities in children [4]. The motor impairments often accompany sensory, cognitive, communication, perceptual and/or behavioral disorders, epilepsy, and/or secondary musculoskeletal impairments [5]. The reported incidence of CP ranges approximately between 1.5-5‰ in China and is about 1.64‰ in Suzhou City, China. The high incidence of this disease has caused great burden on families and communities. Improving the rehabilitation of children with CP and reducing the burden of disabilities and barriers are currently the most urgent challenges.

Clinical rehabilitation and research so far focus on the issues of motor dysfunction and mobility improvement [6, 7]. Mobility improvement includes four major components: body structure and function, activities, participation, and environment. It objectively reflects the development of motor function of children with CP and focuses on the functions, skills, and spontaneous movement of these children. The different levels of mobility improvement are determined by the abilities in daily environment such as home, school, and communities [8, 9]. To achieve this goal, the application of assistive devices was gradually recognized.

In our study, we investigated the effects of the appropriate use of assistive devices in children with CP. We found that the appropriate timing of rehabilitation maximized the beneficial effects of treatment and avoid secondary injuries such as muscle atrophy and joint contracture.

Materials and methods

Subjects

All children with CP were recruited from the Department of Rehabilitation of The Children's Hospital of Soochow University between 2013 and 2016. All patients were provided with routine progressive individualized rehabilitation and family training, including physical therapy, occupational therapy (OT), and assistive device use. Assistive devices were not applied in the rehabilitation of children with CP in the control group; while others applied for short-term (1-3 hours) or long-term (4-6 hours) daily programs, depending on parents' compliance, children's cooperation, and therapists' propaganda and education. We included children with dyskinetic CP who needed sitting training and randomly assigned the same number of children in each group. We used the same including criteria for children with spastic CP who required walking training. In addition, the children who used assistive devices for more than 6 hours daily were not included in the research because of the low number of cases.

Grouping and processing of subjects

The children with dyskinetic CP (n=45) who required sitting training were distributed into three groups: (1) no sitting chair group (DN group) (n=15); (2) 1-3 hours of daily chair sitting group (DA group) (n=15); (3) 4-6 hours of daily chair sitting group (DB group) (n=15). Both gross motor and fine motor activities were evaluated before and after six months of regular rehabilitation.

The children with spastic CP (n=120) who required walking training were distributed into three groups: (1) no wearing of ankle-foot orthosis (AFO) group (SN group) (n=40); (2) wearing AFO for 1-3 hours daily group (SA group) (n=40); (3) wearing AFO for 4-6 hours daily group (SB group) (n=40). No significant difference in the age and sex was found between the groups by one-way analysis of variance ($P > 0.05$). Both gross motor and fine motor activities were evaluated before and after six months of regular rehabilitation.

Evaluation of motor function

The Gross Motor Function Measure 66 (GMFM-66) assessment scale was recognized as a testing tool for gross motor activities in children with CP [10, 11]. It is a standard contrasted development scale, which can reflect the motor function of these children. GMFM-66 consists of 66 items divided into five areas, namely the supine prone, sitting, crawling, kneeling position, standing, walking, and jumping positions, and reflects the gross motor function by percentage of ability.

The Fine Motor Function Measure (FMFM) assessment scale is used to evaluate the fine motor activities of children with CP, including the upper limb activities and sensory ability [12]. This scale includes five areas, namely audiovisual tracking ability, upper limb joint's ability, grasping ability, and hand-eye coordination, which reflect the fine motor function by a total percentage of ability.

All children with CP were evaluated by GMFM-66 and FMFM before and after six months of treatment. In this study, we compared the percentage of area II of GMFM-66 scale assessed before treatment with that assessed after the treatment, because all children with dyskinetic CP were in the gradation of siting training. In children with spastic CP, we compared the percentage of total GMFM-66 score assessed before the treatment with that obtained after the treatment, because all children were in the gradation of walking training. To compare the ability of fine motor function, we used the percentage of total aspects of FMFM.

Statistical analysis

All data were expressed as means ± SD. The differences were compared by paired Students' t-test between groups before treatment and after treatment. The differences among groups were analyzed by One-way analysis of variance (ANOVA), followed by Tukey's multiple-compari-

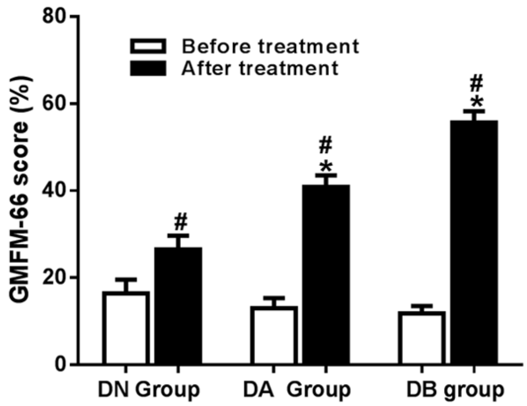

Figure 1. GMFM-66 scores after treatment (ADN, ADA, and ADB) were significantly better than the respective scores before the treatment (BDN, BDA, and BDB) (#P < 0.05), and were significantly improved by the duration of training (ADB > ADA > ADN, *P < 0.05).

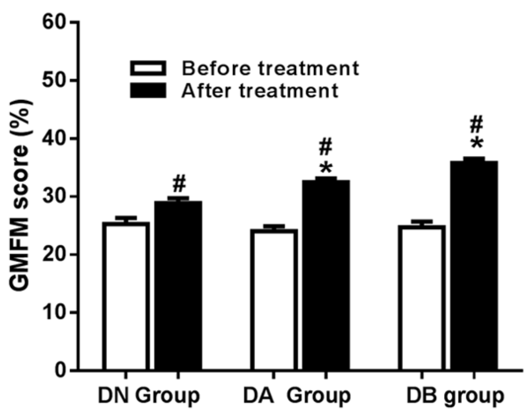

Figure 2. FMFM scores after treatment (ADN, ADA, and ADB) were significantly better than the respective scores before the treatment (BDN, BDB, and ADB) (#P < 0.05), and were significantly improved by the duration of training (ADB > ADA > ADN, *P < 0.05).

son test. *P* value < 0.05 was considered statistically significant.

Results

Sitting training in children with dyskinetic CP improved motor ability after six-month treatment

All children with dyskinetic CP were randomly divided into three groups. There was no significant difference in the age and sex between the groups by one-way analysis of variance (P > 0.05, data not shown). Before the treatment, children with dyskinetic CP in three groups had no significant difference in the gross motor ability and fine motor ability (P > 0.05). After treatment, the gross motor ability and fine motor ability were significantly better in each group than that before treatment (P < 0.05). The motor ability in the groups that used sitting chair was significantly better than that in the DN group (P < 0.05). The percentage of Area II of GMFM-66 in the DB group was significantly better than that in the DA group (55.70 ± 2.58 *vs.* 40.89 ± 2.64, P < 0.05, **Figure 1**). In addition, the percentage of total aspects of FMFM (35.80 ± 0.73) in the DB group was better than that in the DA group (32.49 ± 0.64, P < 0.05, **Figure 2**).

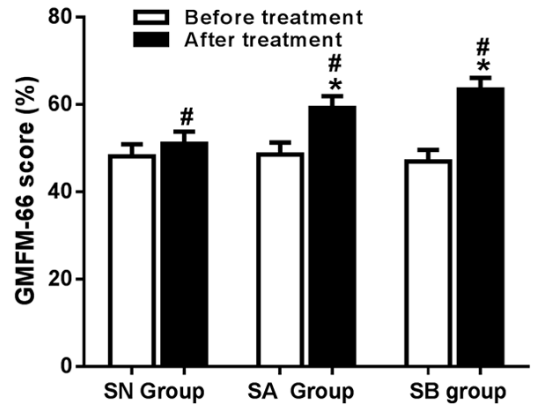

Figure 3. GMFM-66 scores after treatment (ASN, ASA, and ASB) were significantly better than the respective scores before the treatment (BSN, BSA, and BSB) (#P < 0.05), and were significantly improved by the duration of training (ASB > ASA > ASN, *P < 0.05).

Walking training in children with dyskinetic CP improved motor ability after six-month treatment

Before treatment, children with spastic CP in different groups had no significant difference in the gross motor ability and fine motor ability (P > 0.05). After treatment, the gross motor ability and fine motor ability in the ASB group and the ASA group were significantly better than in the control group (P < 0.05). The motor ability was significantly better in the group that used AFO than in the group that did not use AFO (P < 0.05). The percentage of Area II of GMFM-66 in the ASB group was significantly higher than that in the ASA group (63.45 ± 0.66 *vs.* 59.22 ± 2.71, P < 0.05, **Figure 3**). In addition, the per-

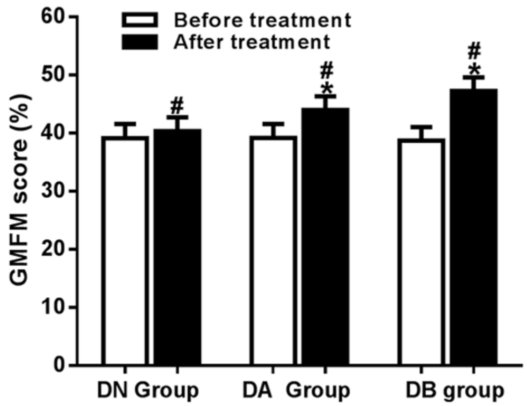

Figure 4. FMFM scores after treatment (ASN, ASA, and ASB) were significantly better than the respective scores before the treatment (BSN, BSA, and BSB) (#P < 0.05), and were significantly improved by the duration of training (ASB > ASA > ASN, *P < 0.05).

centage of total aspects of FMFM (47.28 ± 2.31) of ASB group was significantly higher than that in the ASA group (44.01 ± 2.30, P < 0.05, **Figure 4**).

Discussion

In this study, the application of appropriate assistive device therapy in children with CP improved the efficacy of rehabilitation. Adequate daily use of assistive devices improved the gross motor and fine motor skills, increased the awareness and social adaptation of these children, as well as their participation in social activities. Finally, two kinds of assistive device therapy improved the rehabilitation of children with CP, meeting the ideal stated under the ICF framework.

The rehabilitation of children with CP is a systemic therapy related to the body structure and function, activity and participation, environment, and situation [13, 14]. So the international understanding of CP generally follows the ICF core elements [15]. In this study, we paid more attention to the children's abilities of social cognition, especially to the influence of environmental factors on children with CP. Fine motor abilities and the cognition constantly promote the development of each other. The development of cognition is inseparable from the improvement of fine motor function because they share the same brain areas, such as the cerebellum and the prefrontal cortex. Therefore, the improvement of fine motor function also improves the cognitive function.

Different assistive devices are used to improve the motor function and abnormal posture. Saavedra found that the children with dyskinetic CP are more dependent on sitting chair than children with spastic CP [16]. This assistive device was especially important for children with CP requiring sitting balance training. It reduced the emergence of asymmetric posture and the stimulation of the original asymmetrical tonic neck reflex. By maintaining pelvic stability and increasing the stability of the body support, sitting chair can improve motor function and adaptation to the growth and development, therefore maximizing the use of residual function to improve upper limb function and feeding capacity [17, 18]. Nevertheless, it was necessary to protect the ankle joint of children with CP who started walking. Appropriate AFO could prevent ankle contracture and avoid secondary injury [19, 20]. Moving assistive devices can improve the training and movement of children with CP, and promote the development of their moving activity [21, 22].

Different assistive devices should be used for different motor levels or types of disability in these children. However, no data regarding the duration of daily sitting chair use and AFO are currently available. In this study, we found evidences that a longer duration of rehabilitation with 4-6 hours of daily was better than 1-3 hours. The percentage of Area II of GMFM-66 and FMFM after treatment in the 4-6 hours of daily chair sitting group were better than those obtained in the 1-3 hours of daily chair sitting group. The same results were obtained for the children with spastic CP. However, further investigation regarding possible muscular dystrophy development induced by the longer use of assistive devices in these children is necessary.

In conclusion, the use of the appropriate assistive device not only improved the gross motor function, but also improved the fine motor skills, thereby enhancing the children's cognitive and social adaptability.

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Disclosure of conflict of interest

None.

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