Clinical Usefulness of Child-centered Task-oriented Training on Balance Ability in Cerebral Palsy

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Abstract. [Purpose] This study was conducted in order to investigate the effects of child-centered task-oriented training on balance ability in patients with cerebral palsy. [Subjects] Twenty-six subjects with cerebral palsy were recruited. [Methods] This study applied a child-centered task-oriented training program to 26 subjects during a period of 15 weeks, with two 40-minute sessions per week. The Pediatric Berg Balance Scale (PBS) was used for measurement of the effect of child-centered task-oriented training. [Results] Balance ability showed a significant change after the intervention in age groups younger than nine, between 10 and 12, and older than 13. In addition, a significant difference in balance ability was observed in the spastic type, athetoid type, diplegia, and quadriplegia transport groups, including an independent walking group, a group of subjects who used walkers, and a group of subjects who used wheelchairs. [Conclusion] Although we suggest conduct of a follow-up study on child-centered task-oriented training, the results of this study showed improved balance ability in patients with cerebral palsy. Therefore, these results recommend a variety of applications in clinical trials of conservative therapeutic methods.

Key words: Cerebral palsy, Task-oriented training, Balance

INTRODUCTION

Cerebral palsy (CP) is a nonprogressive disorder of movement due to brain injury in childbirth or after birth1). It leads to limitations of activity, such as paresthesia, cognitive impairment, dysesthesia, and behavioral disturbance2). In addition, a child with CP has no experience of various normal movement of the trunk, pelvis, and lower extremities against gravity.

Even though a child with spastic diplegia is walk, child raises the upper limb high or overextends the upper body to compensate for the lack of antigravity. The anterior tilt of the pelvis is excessive due to improper control of muscles that are attached around the pelvis. Forward tilting of the pelvis leads to limitation of movement of the hip or knee joint, such as adduction and flexion during gait. Impaired posture control mechanism is a major problem disturbing independent development of activity of daily living in children3).

Children with CP are treated over a long period of time, and achievement of independent functional activity is very difficult. In addition, due to a shortage of skilled people to provide specialized care, functional activity in children with CP is abnormal. In particular, although a child with CP is able to walk independently, the gait is not considered normal independent walking. The abnormal gait leads to deformity in the hip joint or spine, as weight is supported asymmetrically by the legs due to asymmetry of the bilateral pelvis.

Task-oriented training is used as a rehabilitation strategy to improve motor skill and as a rehabilitation program for improvement of muscle strength or function4, 5). It should include specific tasks to improve function as an effective treatment for functional improvement of patients with disorders of the central nervous system6, 7). Task-oriented training is a neural rehabilitation approach to helping functional systematization, including not only an intended result but also significant activity of a patient. It can be performed through repeated training of activity tasks associated with daily activity.

It is a training method that supports interesting tasks for children with CP and leads to effectively functional movement8). Behavior involves body movement in space and time. Attention and adjustment processes need to systemize subject accomplishment, communication, and coordinated social activity. Therefore, behavior is required for spatio-temporal adaptation of a child to the environment, and it is organized with intentional repetitions9). Interaction between human and environment is important to a child’s capability. Therefore, treatment should include not only training with a child but also provide environmental adaptation in order to stress a child’s functional behavior.

The child is actively emphasized in the training process. The child is encouraged courage and convinced of a positive reward starting with self-support, self-motivation, and self-satisfaction10). If a patient is not interested in treatment, in other words, the effect of treatment is expected to be low, the patient has poor prognosis10). The method of traditional rehabilitation movement is composed of simple repeated movements. It does not attract a patient’s interest. Because
it does not provide an accurate analysis or feedback regarding a patient’s movement, the effect of training is decreased due to accumulated errors made due to incorrect movements by the patient10, 11).

This study applies a task-oriented training program to children with CP and then analyzes impacts on the balance and effects of training on disability types, impaired part, and transfer method. On the basis of evaluations of these analyses, the results of this study suggest development of a proper child-centered task-oriented training program for improvement of balance in children with CP.

SUBJECTS AND METHODS

The subjects were 26 children with CP (14 boys and 12 girls, mean age, 11.8 ± 3.54 years; mean height, 126.12 ± 9.45 cm; mean weight, 22.79 ± 3.70 kg, IQ≤70, GMFCS I, II, III level) from an elementary school for physically disabled children in Korea. The CP subjects had no history of newly developed neurological problems, musculoskeletal disorders, or botulinum toxin injections in the past six months.

The study applied a child-centered task-oriented training program to 26 subjects during a period of 15 weeks, providing two 40-minute sessions per week. During the training period, a child was the starter of all activities, and the therapist was an observer or had a role as a facilitator. When a child had no change in any activity over a period of two minutes, the training program was applied to him or her. A child was able to choose various activities during the child-centered task-oriented training program; a therapist took on the role of an assistant when a child wanted to perform an activity. However, a therapist provided verbal cues and physical activity guidance when a child showed abnormal or compensatory movement patterns during the training program. In addition, the task-oriented training program was applied to integration of somatosensory and proprioceptive sensibility. Therapists provided feedback using a mirror to correct his or her posture as well. The child-centered task-oriented Training Program used in this study is illustrated in Table 1.

The Pediatric Berg Balance Scale (PBS) was used for evaluation of balance. The PBS, a modified version of the Berg Balance Scale (BBS) used for assessment of the balance ability of adults, is a tool for evaluation of infants12–14). The PBS, which has been widely used in assessment of balance performance, has strong internal consistency and high intrarater reliability and interrater reliability (ICC=0.98–0.99)15). The scale consists of measurement of a subject’s ability to perform 14 activities, such as stair climbing, or donning pants in a standing position, requiring balance and reflecting of functional activities. The score for each of the 14 test items ranges from 0 to 4 points. Possible total scores range from 0 to 56 points. Higher scores indicate greater balance ability and functional independence with respect to the activities tested16).

The SPSS 17.0 program was used for statistical analyses. The Shapiro-Wilk test was used for determination of the general properties and variables of the subjects. The paired t-test was used for comparison of pretest and posttest results within each group, and one-way ANOVA was performed for analysis of changes between groups of dependent variables. A post-hoc test using the Scheffe method was employed for comparison of each group. A p value under 0.05 was considered significant.

RESULTS

Baseline characteristics for the 26 participants who completed the study are shown in Table 2. Changes in the scores of the PBS are shown in Table 3. The PBS score of the group younger than nine years of old was significantly changed, increasing by 4.18 points, from 19.55 points to 23.73 points, after the intervention (p<0.05). The group between 10 and 12 years old showed a significant difference, increasing by 5.40 points from 19.60 points to 25.00 points. The group older than 13 years old also showed a significant change, increasing by 3.70 points from 26.30 points to 30.00 points after the intervention (p<0.05). However, no significant differences were observed among the three age groups. The PBS score in the spastic type showed a statistically significant difference, increasing by 4.41 points from 21.71 points

| Table 1. Child-centered task-oriented training program |
|----------------------------------|
| **Active region** | **Programs** |
| Hammock | Doing the splits on a hammock with swaying back and forth, side to side. |
| Vestibular set | Lying on one side with swaying back and forth, side to side. |
| Swing | Playing quoits. |
| Roll | Moving from side to side on a roll, rolling. |
| Physioball | Rolling while lying on a physioball, bouncing while sitting on a physioball. |
| Activity on a sway board | Keep balance with lying down, sitting, and standing on sway board. |
| Activity while standing | Weight bearing, walking while holding a bar. |
| Activity on a mat (5 cm thick) | Rolling, weight bearing from side to side while sitting. |
| Activity of proprioceptive sensibility | Movement (pushing a ball), standing up, standing, walking. |
| | (tug-of-war, chin-up). |
| | Muscular strength of upper/lower extremities (dumbbell exercise). |
to 26.12 points (p<0.05).

The Athetoid type also showed a significant change, increasing by 4.50 points after the intervention (p<0.05). The mixed type did not show a significant change, increasing by 2.67 points from 25.67 points to 28.33 points. However, there was no significant difference between the types of cerebral palsy.

The PBS score in diplegia showed a significant change, increasing by 4.75 points from 23.42 points to 28.17 points after the intervention (p<0.05). That for quadriplegia showed a statistically significant change, increasing by 3.77 points from 19.85 points to 23.63 points (p<0.05).

The PBS score in the independent walking group showed a significant difference, increasing by 3.20 points from 23.40 points to 29.50 points (p<0.05).

There was a significant change in the wheelchair use group after the intervention, with the score increasing by 3.00 points from 15.81 points to 18.82 points (p<0.05). In addition, a statistically significant difference in pre- and post-intervention values was observed between the independent walking group and the wheelchair group (p<0.05). A significant difference change in value was observed between the walker group and wheelchair group (p<0.05).

**DISCUSSION**

Rehabilitation of central nervous system disease has changed from neuromuscular facilitation based on facilitation-inhibition techniques to a task-oriented approach with functional activities16). The task-oriented approach is based on motor learning and involves repeat training with task-oriented activities. It is effective for improvement of the functional performance of a child with CP. In addition, it is a training method for encouraging functional movement while providing children with an interesting task7).

In our study of a child-centered task-oriented training program designed to affect the balance of a child with CP used in this study, balance ability was significantly changed after the intervention in the spastic type, athetoid type, di-

| Table 2. Characteristics of the subjects |
|------------------------------------------|
| Cerebral palsy                           |
| Gender                                   |
| Male                                     | 14 (53.80)a |
| Female                                   | 12 (46.20) |
| Age (y)                                  | 11.80 (3.54)b |
| Height (cm)                              | 126.12 (9.45) |
| Weight (kg)                              | 22.79 (3.70) |
| Type of cerebral palsy                   |
| Spastic                                  | 17 (65.38) |
| Athetoid                                 | 6 (23.08) |
| Mixed                                    | 3 (11.54) |
| Monoplegia                               | 1 (3.85) |
| Involved part                            |
| Diplegia                                 | 12 (46.15) |
| Quadriplegia                             | 13 (50.00) |
| Independent walk                         | 5 (19.23) |
| Locomotion                               |
| Walker use                               | 10 (38.46) |
| Wheelchair use                           | 11 (42.31) |
| aNumber (%). bMean (SD)                  |

**Table 3. Comparison within groups (N=26)**

| Age groups                                    | Pre         | Post        | Change values |
|-----------------------------------------------|-------------|-------------|---------------|
| 9 yr below (n=11)                             | 19.55 (8.80)| 23.73 (10.12)* | 4.18 (2.14) |
| 10–12yr (n=5)                                 | 19.60 (7.37)| 25.00 (8.40)* | 5.40 (2.88) |
| 13 yr over (n=10)                             | 26.30 (10.87)| 30.00 (10.36)* | 3.70 (1.49) |
| Type of cerebral palsy                        |             |             |               |
| Spastic (n=17)                                | 21.71 (8.72)| 26.12 (9.11)* | 4.41 (2.21) |
| Athetoid (n=6)                                | 21.67 (9.83)| 26.17 (10.91)* | 4.50 (2.07) |
| Mixed (n=3)                                   | 25.67 (17.21)| 28.33 (16.65) | 2.67 (0.58) |
| Involved part                                 |             |             |               |
| Monoplegia (n=1)                              | 37.00       | 41.00       | 4.00          |
| Diplegia (n=12)                               | 23.42 (7.68)| 28.17 (8.31)* | 4.75 (2.22) |
| Quadriplegia (n=13)                           | 19.85 (10.71)| 23.62 (10.72)* | 3.77 (2.01) |
| Locomotion                                    |             |             |               |
| Independent walk (n=5)                        | 33.60 (9.10)a| 36.80 (9.01)a,b | 3.20 (0.84) |
| Walker use (n=10)                             | 23.40 (6.87)| 29.50 (7.11)* | 6.10 (2.13)c |
| Wheelchair use (n=11)                         | 15.81 (6.83)| 18.82 (6.65)* | 3.00 (0.77) |
| Total (n=26)                                  | 22.15 (9.67)| 26.38 (9.98)* | 4.23 (2.08) |

Values are means (SD)  
* Statistically significant difference between pre- and post-test values (p<0.05). a, Statistically significant difference between the independent walk group with wheelchair use group (p<0.05). b, Statistically significant difference between the independent walk group with walker use group (p<0.05). c, Statistically significant difference between the walker use group and the independent walk and wheelchair use groups (p<0.05).
plegia, and quadriplegia. To be included, patients met the following criteria: subjects had an intelligence quotient (IQ) score of more than 70 with the ability to understand and follow instructions or make their own choices as self-determination. These factors might positively affect the results of this study.

There was no significant change in the mixed type. Balance is a neurophysiological process for maintenance of the stability of the body within the base of support with the least sway\(^1\). The balance control ability of a child with CP is very important in the clinic, especially in the standing and sitting positions. Improvement of quality of life through activities of daily life is important\(^2\).

According to the results of this study, in children with diplegia and quadriplegia a large percentage of the children with CP showed remarkable progress in balance ability. Improvement of balance ability might have resulted from facilitation of proprioceptive sense, leading to change in various supports. In particular, equine gait which results from weakness of the peroneal and anterior tibia is the most common gait pattern in spastic CP. Ankle stability is required to treat instability in standing or walking and can be improved with extension of calf muscles. Ankle stability in this study might have been improved by the following activities: (1) sitting on a physioball with the feet on the floor and bouncing up and down on the ball, (2) weight bearing activities for the ankle joint while going up and down stairs, and (3) activities for proprioceptive sensibility. In the future, a follow-up study of the child-centered task-oriented training program for stability of the ankle joint will be conducted.

The stability of the body appears to be higher when pressure is on the rear foot, compared with the forefoot. Therefore, the relative increase in pressure on the rear foot is one of the important factors in controlling the stability of the body\(^3\). This study found on improvement of the ability of the body of a child with CP to provide support and balance ability. In a child with CP, walking is deeply associated with improvement of stability in the standing position. In a study of the relation between standing balance and walking, Liao et al.\(^4\) reported that slow walking speed reflects the decrease in balance ability, loss of muscular strength, and asymmetry of injured vital dynamics. Flynn, Palma, and Bender\(^5\) reported that fast movement with a stable condition on the base of support leads to a new base of support and changes from the control of static balance to that of dynamic balance. These dynamic tasks are able to improve balance ability. The present study showed a statistically significant difference between the independent walk group with wheelchair use group. The pre-post difference was significant in the independent walking group and the walker group.

Therefore, the method of transport for a child with CP is able to affect balance ability. In particular, the independent walking group showed better balance ability than the walker group, and the wheelchair group, however, the features of the PBS led to a ceiling effect. Therefore, statistically significant improvement was observed after application of a child-centered task-oriented training program, but the changes in values did not show significant improve-

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