RESEARCH ARTICLE

COMPARISON BETWEEN THE EFFECT OF NEURODEVELOPMENTAL TREATMENT AND SENSORY INTEGRATION THERAPY ON GROSS MOTOR FUNCTION IN CHILDREN WITH CEREBRAL PALSY

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Received: 4-Apr-2010
Last Revised: 28- Apr-2010
Accepted: 14-June-2010

Abstract

Objective

This study was planned to compare the effects of neurodevelopmental treatment and sensory integration therapy on gross motor function in children with cerebral palsy

Materials & Methods

Twenty two children with spastic CP were randomly divided into two groups. Sensory integrative therapy was given to the first group (n=11), and neurodevelopmental treatment was given to the second group (n=11). All children were evaluated with GMFM-88. Treatment was scheduled for three - one hour sessions per week for 3 months.

Results

Twenty two children with spastic CP (11 diplegia and 11 quadriplegia) participated in this study. When two groups were compared, a significant difference was found in lying and rolling (P=0.003), sitting (0.009), crawling and kneeling (0.02) and standing ability (P=0.04). But there was no significant difference in walking, running, and jumping abilities between the two groups (0.417). Paired t-tests revealed a significant difference between pre and post test results, with increases in scores of lying and rolling, sitting, crawling and kneeling, standing in sensory integration therapy (SIT) and neurodevelopmental treatment (NDT) approaches.

Conclusion

Neurodevelopmental treatment and sensory integration therapy improved gross motor function in children with cerebral palsy in four dimensions (lying and rolling, sitting, crawling and kneeling, standing). However, walking, running and jumping did not significantly improve.

Keywords: Cerebral palsy, Children, Neurodevelopmental treatment, Gross motor function, Sensory integration therapy

Introduction

Cerebral palsy (CP) is described a group of permanent disorders of the development of movement and posture, causing activity limitations, which are attributed to nonprogressive disturbances that occurred in the developing fetal or infant brain. The motor disorder of cerebral palsy is often accompanied by disturbances of sensation, perception, cognition, communication and behaviour, by epilepsy, and by secondary musculoskeletal problems (1, 2). Cp is clinically classified as spastic, athetoid, spastic, and hypotonic (3). The primary problem in CP is gross motor dysfunction (4). Also, the severity of limitation in gross motor function among

children with CP, the most common physical disability, is highly variable (5). Occupational therapy in children with CP is performed to avoid abnormal muscle tone and posture, treat muscle and joint deformities, and reduce motor and sensory disorders (6).

Currently, several approaches are used for the treatment of children with CP, which show promising effects on improving motor and functional activities. Among these approaches, the neurodevelopmental treatment (7, 8, 9) and sensory integration therapy (10, 11, 12, 13) are the pioneers for serving children with CP in the field of occupational therapy.

The neurodevelopmental treatment approach for CP is the most widespread and clinically accepted to target the central nervous and neuromuscular systems and 'teaches' the brain to improve motor performance skills and to achieve 'as near normal function as possible', in view of the specific lesion in the central nervous system. The main purpose of this approach is to correct abnormal postural tone and to facilitate more normal movement patterns for performing performance skills (14, 15). On the other hand, sensory integration therapy (SIT) is one of the rehabilitative approaches that was originally developed by A. Jean Ayres in the 1970s. The principles of SIT are used by occupational therapists in developing treatment approaches for children with sensory processing difficulties, including CP. The SIT approach attempts to facilitate the normal development and improves the child ability to process and integrate sensory information. It is proposed that this will allow improved functional capabilities in motor function (6).

Some studies have shown that the NDT approach is effective in improving measures of motor performance in children with CP, especially in gross motor ability, postural control, and stability (16, 17, 18, 19, 20). In contrast, other investigators have found that the SIT is one of the methods for promoting motor activity skills and improving measures of motor performance in children with CP because a child with cerebral palsy may experience sensory integration dysfunction as a result of central nervous system damage, or sensory integration dysfunction might develop secondary to the limited sensory experiences that these children have as a result of their limited motor abilities (6, 21, 22). So, children with cerebral palsy frequently receive NDT and SID from occupational therapists to reduce the problems of impaired movement and coordination. However, the comparison between these two methods has not yet been done. Therefore, this study was conducted to compare the effect of the sensory integration therapy and neurodevelopmental treatment on gross motor function of the children with CP.

Materials & Methods

Participants

Twenty two children with spastic CP were selected from a population of individuals with CP who had been followed up at Baqiyatallah Hospital. Inclusion criteria were as follows: a diagnosis of spastic CP (patient's diagnosis of CP confirmed by an expert pediatrician and a neurologist), no other severe abnormalities such as seizure, no participation in other therapeutic programs except for occupational therapy, age between 2 and 6 years, and referral to the occupational therapy clinic of the children with disabilities, Baqiyatallah Hospital, for a 12-week course of treatment. Our exclusion criteria were (a) receipt of medical procedures likely to affect motor function such as botulinum toxin injections, (b) orthopedic remedial surgery, (c) mental retardation or learning disability

Instrumentation

GMFM

Gross Motor Function Measure (GMFM) was used to evaluate the gross motor function of the patients. GMFM is the first evaluative measure of motor function designed for quantifying changes in the gross motor abilities of children with cerebral palsy (22). The measure is widely used internationally, and is now the standard outcome assessment tool for clinical intervention in cerebral palsy. In children with CP, GMFM has been shown to be sensitive to changes during the periods of therapy (24, 25, 26). This clinical measure consists of 88 items grouped into 5 gross motor function dimensions; lying and rolling (17 items), sitting (20 items), crawling and kneeling (14 items), standing (13 items), and walking, running, and jumping (24 items). The 88 items of the GMFM are measured by child observation and scored on a 4-point ordinal scale (0=does not initiate, 1=initiates <10% of activity, 2=partially completes 10% to <100%

of activity, and 3=completes activity). Scores for each dimension are expressed as a percentage of the maximum score for that dimension. The total score is obtained by averaging the percentage scores across the 5 dimensions. The entire GMFM is administered without mobility aids or orthoses (27). Also, In Iran, this test has been used to assess gross motor function in children with cerebral palsy (6, 37). There is evidence to back up the reliability and validity of GMFM scores (23, 27).

NDT

The NDT approach for CP is the most widespread and clinically accepted to target the central nervous and neuromuscular systems and teaches the brain to improve motor performance skills and to achieve as near normal function as possible (7, 8, 9). This program includes passive stretching of lower limb muscles (e.g. hamstrings, gastrosoleus), followed by techniques of reducing spasticity and facilitating more normal patterns of movements while working on motor functions. These treatment outcomes are supposed to be achieved through physical handling of the child during movement, giving the child more normal sensorimotor experiences. As the child gains postural control, the therapist gradually withdraws support. Handling techniques and treatment activities undergo continual changes as they are adapted to the responses of a particular child (28).

SIT

SIT is a treatment approach that was originally developed by Jean Ayres (10). It helps children with CP to achieve their optimal level of sensory and motor functioning (10, 11, 13). It is typically given by an occupational therapist with training and expertise in sensory integration. SIT is an active therapy, and the activities usually involve visual-motor co-ordination training, ocular-pursuit training, moving ball and pegboard activities, turning left and right side and awareness of the body parts through touch (6, 21, 22). It is a process occurring in the brain that enables children to make sense of the world by receiving, registering, modulating, organizing and interpreting the information that comes to their brains from their senses. SIT helps to overcome problems experienced by many children in absorbing and processing sensory information. Encouraging these abilities ultimately improves balance and steady movement by training (29, 30). Also, in a research by shamsoddini and hollisaz, the result showed that SIT intervention had a significantly positive effect on gross motor function in children with diplegic spastic CP (6).

Procedures

Ethical approval was granted to the study and informed written consents were signed by all parents. Gross motor abilities of the subjects were first evaluated in five dimensions (Lying and rolling; Sitting; Crawling and kneeling; Standing; Walking, running and jumping). Participants were then randomly divided into two experimental groups. There were 11 children in each group. In one group, children were treated by NDT and in the other group, children received SIT. Duration of the treatment for the two groups were three days a week for 3 months, each session being 1.5 hour and was then re-evaluated by the GMFM again after the interventions. All of patients were treated by occupational therapists with at least 8 years of experience. The treatment was conducted in one rehabilitation centre for all participants in the two groups.

Statistical analysis was performed with SPSS (version 17). Normal distribution of variables was assessed with the Kolmogrov-smirnov test. Independent sample t-test was used for comparison of scores between two groups. The pre and post intervention mean scores for each group were analyzed using a paired-sample t-test, to determine whether there were any significant differences. P-values less than 0.05 were considered statistically significant.

Results

A total of 22 children based on the inclusion criteria were enrolled in the study and completed the course of the treatment for 3 months. Information on sample characteristics including sex, type and distribution of CP are listed in Table 1. The SIT and the NDT group had a mean age of 3.6 years and 3.1 years, respectively. Pre- and post-treatment mean, standard deviation, minimum and maximum scores for the GMFM-88 are given in Table 2.

The independent simple t-test showed significant improvements in GMFM-88 scores in both groups in lying and rolling (P=0.003), sitting (P=0.009),

crawling and kneeling (P=0.02) and standing positions following SIT and NDT (P=0.04). However, there were no significant improvements in walking, running and jumping (P=0.417) (Table 3). The paired t-test, used for comparing the values before and after intervention in the SIT group, revealed significant changes in GMFM-88 scores of lying and rolling, sitting, crawling and kneeling, and standing (P> 0.05). However, no significant difference was observed in walking, running and jumping abilities before and after SIT intervention (P> 0.05) (Table 4).

The Student t-test revealed significant changes in children who received NDT in GMFM-88 scores of lying and rolling, sitting, crawling and kneeling, standing, and walking, running and jumping before and after NDT intervention (P< 0.05) (Table 4).

Table 1. Characteristics of the samples

Group	n	Male	Female	Diplegia		Quadriplegia	
				Male	Female	Male	Female
SIT	11	6	5	3	2	3	3
NDT	11	8	3	4	2	4	1
Total	22	14	8	7	4	7	4

Table 2. Descriptive statistics in the SIT and NDT groups

Group	Assessment	GMFM-88*			
		Mean	SD**	Min***	Max****
SIT	After treatment	102.1	10.7	75	122
	Before treatment	117.6	9.1	103	148
NDT	After treatment	99.6	9.6	81	120
	Before treatment	102.7	8.9	104	152

GMFM*, Gross Motor Function Measure; SD**, Standard Deviation; Min***, Minimum Max****, Maximum

Table 3. Comparison of differences between groups

	Group	Mean ± SD		p
		Before	After	
lying and rolling	SIT	39±3.3	48±4.1	0.003
	NDT	35±3.6	47±3.9	
sitting	SIT	43±4.1	52±4.3	0.009
	NDT	46±4.2	55±4.7	
crawling and kneeling	SIT	20±2.3	26±2.5	0.02
	NDT	22±2.5	28±2.8	
standing	SIT	15±1.7	18±2.1	0.04
	NDT	17±1.9	31±3.2	
walking and running and jumping	SIT	29±2.8	31±2.3	0.417
	NDT	31±2.9	32±3.1	

Table 4. Pre and Post GMFM-88 scores between the NDT and SIT groups

		Lying & rolling	Sitting	Crawling & kneeling	Standing	Walking & running & jumping
GMFM scores in SIT	Before	39±3.3*	43±4.1	20±2.3	15±1.7	29±2.8
	After	48±4.1	52±4.3	26±2.5	18±2.1	31±2.3
P Value		0.000	0.001	0.003	0.001	0.842
GMFM scores in NDT	Before	35±3.6	46±4.2	22±2.5	17±1.9	31±2.9
	After	47±3.9	55±4.7	28±2.8	31±3.2	32±3.1
P Value		0.000	0.000	0.004	0.002	0.03

*Value is Means ± Standard Deviation

Discussion

Improvement of gross motor function is one of the most important aims of treating children with CP. Mainly, the aim of SIT and NDT is also to promote gross motor function for children with cerebral palsy. In this study, two interventions, which were administered for 3 months in children with spasticity - distribution of diplegia and quadriplegia- significantly improved their gross motor function as measured with the GMFM-88.

To the best of our knowledge, this is the first study that has compared neurodevelopmental treatment and sensory integration therapy on gross motor function of children with cerebral palsy. Various occupational therapy methods have been applied to obtain normal motor development, to prevent postural abnormalities, sensory defenses, gross motor dysfunction and deformities and to increase functional capacity in children with cerebral palsy (6, 16, 19, 21, 30).

According to the results, after comparing the two groups of children with CP for gross motor function, four dimensions of gross motor function, i.e. lying and rolling, sitting, crawling and kneeling, and standing, significantly improved following sensory integration therapy and neurodevelopmental treatment. However, walking, running and jumping showed no significant improvement between two groups. In a research by Ketelaar et al., a significant difference was noticed in rolling and sitting and kneeling after neurodevelopmental intervention (32). These results were consistent with our study showing significant changes in lying and rolling, sitting, crawling and kneeling and standing after NDT intervention. In another study, Fetters and kluzik reported that use of neurodevelopmental approach for treating children with cp caused improvement of motor functions (33). To date, few studies have investigated the effect of SIT on gross motor function improvements in similar intervention periods (a few weeks). In a randomized controlled trial by Carlsen, individuals were assigned to either the control group (n=6) or the SIT group (n=10), which received 2 hours of therapy per week over 6 weeks. This intervention period is almost similar to that of our study. Similar to our study, the group that received SIT experienced a significantly better improvement in sitting and crawling abilities compared to the control group (34). In our study, comparison of the two methods and also pre and post-treatment scores of both types of treatments showed a significant improvement in gross motor function over the 3 months of treatment with SIT and NDT. However, this effect might be anticipated as SIT and NDT focus on preparing, practicing, and gaining new functional skills (35). Published literature shows that sensory integration therapy programs have been used to facilitate motor functions. Each type of treatment (SIT or NDT) might be expected to yield different changes in motor performance. The SIT approach tries to facilitate normal development and to improve the child's ability to process and integrate sensory information (visual, perceptual, proprioceptive, auditory, etc) (36). Furthermore, one important aspect of choosing the SIT approach is that the motivation of the child plays a crucial role in the selection of the activities (37). In our study, comparison between pre and post intervention values of walking, running and jumping showed no significant difference in NDT or SIT approaches (36). Also, in a before-after study by Akbari et al. in which gross motor function of the subjects was assessed using GMFM, the results showed that a functional therapy program might be effective in increasing gross motor function and improving daily activities in children with cerebral palsy (38).

In conclusion, this study showed that neuro-developmental treatment and sensory integration therapy improved gross motor function. Four dimensions of gross motor function, including lying and rolling, sitting, crawling and kneeling, and standing, significantly improved after intervention. However, walking, running and jumping did not improve significantly.

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