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EFFICACY OF TASK ORIENTED MOTOR SKILL TRAINING PROGRAM WITH SEGMENTAL TRUNK STABILIZATION ON ACQUISITION OF POSTURAL CONTROL IN YOUNG CHILDREN WITH CEREBRAL PALSY

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ABSTRACT

Children with CP are extremely heterogeneous in terms of etiology and clinical features. The diversity of symptoms among CP syndromes is a challenge for different areas of health research in terms of definition and classification. This study is designed to find the effectiveness of task oriented motor skill training with stabilization at specific spinal segments at improving postural control in children with CP. A matched pairs randomised, evaluator-blinded trial was carried out using functional training program to evaluate the efficacy of the training on postural control with trunk stabilization at different level in children with cerebral palsy aged 5 to 10years.Goal Attainment Scaling (GAS) was used to evaluate goal attainment Segmental Assessment of Trunk Control (SATCo) to measure trunk control. This test indicates that children with severe CP lost postural control in the cervical or upper thoracic spine while those with moderate CP lost control in the upper to mid thoracic spine. ANOVA showed significant differences between groups for static ($F(5,70)=48.79$, $p<.0005$), active ($F(5,70)=35.89$, $p<.0005$), and reactive ($F(5,70)=36.09$, $p<.0005$) tests on the SATCo. The repeated measures design of the present study was chosen to take anticipated variability in the children's functioning into consideration, along with considerations regarding feasibility. While the same child is tested in each condition, variability among the children can be measured and separated from error, and smaller but consistent change can be detected as opposed to group designs, where the variability among subjects are uncontrolled and are treated as error. When the task oriented motor skills training was used with trunk segmental trunk stabilization, children decreased the amount of compensatory trunk displacement during reaching and grasping activities. However, when task oriented motor skills training was used alone, the improvement in movement quality could be accompanied by an increase in compensatory trunk displacement.

INTRODUCTION

Children with CP are extremely heterogeneous in terms of etiology and clinical features. The diversity of symptoms among CP syndromes is a challenge for different areas of health research in terms of definition and classification. Despite the efforts of many studies in examining rehabilitation strategies to improve motor abilities in children with CP, the confidence in the validity of these studies' evidence is still moderate to low [1]. One of limitations here is the lack of strong evidence related to the type of outcome. Most of the studies' outcomes are

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not sensitive enough to detect change (lack of responsiveness), or they are not related to age. Nor did they describe the movement quality or how the activity is performed. The description of movement quality is important, because early brain injuries are more susceptible to 'maladaptative' plasticity [1], which leads to abnormal movement behaviors. Motor compensations, such as excessive trunk displacement, have been described to occur during UL movements in children with CP.

The majority of available RCTs that aimed to investigate the efficacy of interventions on this population did not report or lacked the power to prove treatment effectiveness [2]. In addition, it has been questioned if generalization of treatment effects by group comparisons, especially in children with CP, is transferable to clinical practice [2]. This study is designed to find the effectiveness of task oriented motor skill training with stabilization at specific spinal segments at improving postural control in children with CP. Specifically, we investigated Whether task oriented motor skill training program with segmental trunk stabilization improves postural control in young children with cerebral palsy or not?

METHODOLOGY

A matched pairs randomised, evaluator-blinded trial was carried out using functional training program to evaluate the efficacy of the training on postural control with trunk stabilization at different level in children with cerebral palsy aged 5 to 10 years. In our study, the baseline assessment consisted performed one week before the intervention. The post intervention assessment was performed twice after weeks and three months of intervention was completed. For the follow-up assessment, the evaluation was scheduled one month after the post intervention assessment.

Potential participants were identified according to the criteria, listed below, then suitable children and their parents were invited to participate in the randomised trial and informed consent to participate were obtained from the child and/or by her/his parents prior to enrolment in the randomized control trial [3].

The inclusion criteria to participate in the study were; children aged between 5-10 years with confirmed diagnosis of cerebral palsy according to 2005 definition (MRI and clinical history)&predominant spasticity rather than dystonia CP with Modified Ashworth scale (MAS) grade ≤ 2; no sensory impairment; no history of seizures or seizures well controlled by therapy & parents able to commit to an intensive therapy program for 10 weeks. The excusion criteria for this study were moderate or severe muscle spasticity and/or contracture (MAS > 2)4 which would require spasticity management or orthoses; uncontrolled epilepsy; BOTOX-A injection in the UL within 6 months prior to study entry; the presence of cognitive deficits; athetoid movements; ataxia or choreoathetosis; chronic pain or orthopedic problems affecting the arm, neck or trunk; contractures of more than 10 degrees in the elbow or shoulder joints, and if the CP had a trauma etiology [5].

All parents signed the consent form approved by the ethics committee and the Institutional Review Boards of Singhania University.

According to CONSORT [5] guidelines the sample size estimates were based on projected treatment effect on the primary outcome measure. Calculation by a statistician indicated that in order to detect effect size at significant level of 0.05 and 80% power a minimum sample size of 35 per group is required in our study.A computer random allocation was used to randomly assign the subjects of each pair to experimental or control group by a computer random allocation. We choose a matched pairs design because it minimises the likelihood of group differences at baseline that has often been present in UL rehabilitation studies. All randomisation, sequence generation, and preparation of group allocation materials will be performed by a third party, who has no direct contact with the clinical aspects of the trial. In order to make blind the study the children enrolled and their parents were informed about general description of the design of the study. The treating therapists and study personnel, committed to help during the treatment, were blinded of group allocation.

Estimation of spasticity was performed in muscles around the shoulder, elbow and wrist. Goal Attainment Scaling (GAS) [6] was used to evaluate goal attainment. GAS is an individualized, criterion-referenced measure, with five grades starting from -2, indicating the child's performance at baseline, through 0, indicating the expected performance, and ending at +2, signifying a much better outcome than expected. A functional reach test was used to assess the trunk displacement. The functional reach test was performed without segmental trunk displacement.

Spasticity was measured using the Modified Ashworth Scale. The level of severity of UL function in each child was classified with the Manual Ability Classification System for Children with Cerebral Palsy (MACS). MACS is a 5 level ordinal scale used to classify the ability to manipulate objects in daily activities in children between the ages of 4 and 18 years [7]. A MACS level 1 score means that the child handles objects easily and successfully and a score of level 5 indicates that the child cannot handle objects at all and is severely limited in the performance of even simple actions.

Segmental Assessment of Trunk Control (SATCo) is a reliable and valid clinical measure of trunk control in TD infants as well as children with neuromotor disability. It provides discrete assessments from head

control through thoracic, lumbar, and finally full spinal control; it documents static, active and reactive control at each level tested. The range on this test is related to the anatomical level of the spine where each aspect of postural control was achieved: 1 = head control, 2 = upper thoracic control, 3 = mid-thoracic control, 4 = lower thoracic control, 5 = upper lumbar control, 6 = lower lumbar control, 7 = pelvic control, 8 = full spine control.

All children participated in training intervention consisting of a 1 hour treatment session, 3 times per week for 12 weeks. The completed intervention therefore included 36 sessions with a total of 36 hours of treatment. The intervention was delivered by Physiotherapist in the respective center. Fifteen sets of daily life upper extremity exercises were planned for this study. Each set is composed by three sequential upper limb goal actions of increasing complexity. The first 8 sets are unimanual exercises (total of 24), while the last 7 sets bimanual (total of 21) where the two upper limbs have different roles in an integrated action. The setting of all exercises is the same but the proposed type of movement (i.e. range of movement) is simplified for the children with more severe impairment. Moreover, 15 sets of computer games with no biological movements were chosen (i.e. quiz games, crossword, Simons etc.).

A special fiberglass support device was fabricated for use during Goal Direct Therapy session for segmental stabilization of spine. Pelvic strapping and a rigid posterior support that circles the spine and trunk provided upright stability of the spine below the level of interest. The posterior support was adjusted to allow evaluation of 4 different spinal segments (cervical-upper thoracic (under arms), mid-thoracic (midribs), thoracic-lumbar (waist) and pelvis (hips), with segments evaluated in a pseudo-random order. The trunk stabilizing device allows rigid positioning of the lower spine and prevents the pelvic misalignment that is common in children with cerebral palsy. Children were randomly allocated to receive either goal directed functional training with or without segmental trunk stabilization. During 12 weeks, the children practiced in their everyday environment and once a week together in a group (7–8 children/group). Focus was on motivating the child to be active in the individually tailored task oriented motor skills training, on offering a high frequency of opportunities to practice both goal-skills and sub-skills and on letting the child meet peers for inspiration and joyful play. At the group meetings, the children participated in activities pertaining to everyday skills such as eating, playing, communication and mobility. To optimize the child's opportunities to practice towards the goals, parents and preschool staff were guided on efficiently encouraging the child. Support and instructions from the professional team were given during the group meetings and at regular preschool and home visits twice a month. Each child had a diary in which the goals were written and the parents, preschool staff and the professionals wrote suggestions for good practice. Together with the child, they added pictures and photos to visualize the activities, making it easier for the child to understand the goal.

GMFM-66 was performed three times; one baseline assessments, one assessment after 12 weeks of intervention and one follow-up, one month after the intervention (16th Week). GAS was performed three times (goal-setting and two evaluations) and body functions (PROM, spasticity and SMC) were assessed before and after the intervention.

RESULTS

Scores of the Gross Motor Function Measures (GMFM), and Segmental Assessment Trunk Control (SATCo) were calculated according to the procedures given in the manuals. Statistical analyses were performed in SPSS 20.0 for Windows. Normality of scores was examined by inspecting Q-Q plots and Shapiro Wilks test for small samples. Repeated measures one-way ANOVA was used for the analysis of GMFM-scores, with time as a four level within-subjects factor. Post hoc analysis was performed, using pared t-tests between measurements with Bonferroni adjustment of the alpha level.

Five goals were assigned to each child, for a total of 110 goals. At the baseline all goals started at -2. After 6 weeks of therapy, the goal attainment to the expected level or higher was achieved in 63/110 goals and at the end of the intervention in 93/110 goals. The not fully attained goals were evenly distributed within the group of children. Six weeks after the end of therapy, goal attainment to the expected level or higher was reached in 98/110. At the last follow-up, goal attainment to the expected level or higher was achieved in 103/110 goals.

The median value of the total t-score for all goals in the group at the last follow-up was 68.09 (percentile 25th–75th: 64.33–74.12). No significant differences in t-scores were observed with respect to group, GMFCS levels or MACS levels.

Segmental Assessment of Trunk Control (SATCo) Mean level of postural control for children in each group. Three aspects of control are tested static, the ability to align in vertical (black bars), active, the ability to hold alignment while turning head or reaching (dark gray bars) and reactive, the ability to hold alignment when given a brief nudge (light gray bars).

This test indicates that children with severe CP lost postural control in the cervical or upper thoracic spine while those with moderate CP lost control in the upper to mid thoracic spine.

ANOVA showed significant differences between groups for static ($F(5,70)=48.79$, $p<.0005$), active ($F(5,70)=35.89$, $p<.0005$), and reactive ($F(5,70)=36.09$, $p<.0005$) tests on the SATCo.

Table 1. Mixed Model analysis of Variance of SATCo scores between baseline, post-tests & follow up scores between the groups

Source	Type III Sum of Squares	F	Sig.
SATCo	5476	410	.000
SATCo *Group	9.350	.350	.06
SATCo *GMFCS	86.653	2.163	.02
SATCo *Group*GMFCSL	30.976	.387	.885
Error	788.056		

Computed using alpha = .05

Post hoc tests show that GMFM level of the child directly affect the postural control at significantly lower levels of the spine than all groups with CP (p <.001 for all comparisons).

Fig 1. Evaluation of Goal Attainment scaling (GAS) according to its 5 grades.

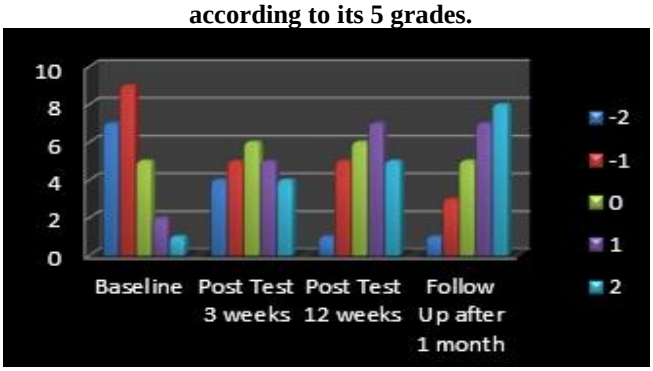
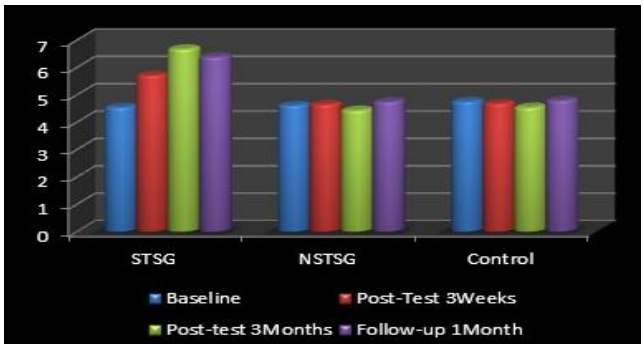


Fig 2. Segmental Assessment of Trunk Control



DISCUSSION

The purpose of this study was to investigate the preliminary effect of Task Oriented Motor Skill Training Program on acquisition motor abilities and postural control in children with cerebral palsy. Our specific objective was to examine if Task Oriented Motor Skill Training Program combined with segmental trunk stabilization had a better effect than goal directed functional training. Our first hypothesis was that a task oriented intervention would improve aspects of motor ability and that improvement would remain during the three months following the end of the intervention. Our second hypothesis was that children who received task oriented training with segmental trunk stabilization would make greater improvements in acquiring motor ability due to a decrease in movement compensations [10].

In the present study change in function was examined in a heterogeneous sample of children with CP. The children's basic motor abilities improved, and predetermined individual goals were the least met in 35 (66 %) of the 53 goals. Group training seemed to have a positive impact on the children's and family's daily life since the parents reported that the children's functional skills in self-care at home had increased and their need for caregiver's assistance in self-care and mobility had decreased. The quality of the children's fine and gross motor function, showed improvement, but not statistically significant. The internationally well acknowledged GMFM was used as the main outcome measure [11].

The individual goal setting for the children was accomplished as a process during the baseline period between parents, child and professionals. However, the contents of the goals changed minimally from the first to the last assessment in the baseline period, although the precision increased, implying that parents/child and professionals very early in the baseline period agreed upon goals for the training. Goals explicitly related to e.g. play and social function were less common even if the attainment of many of the goals might contribute in these areas. The potential relationship between movements, activities and participation could possibly be better elucidated to the parents [12].

Our study showed that elbow extension consistently improved across both target distances regardless of treatment intervention. The effect size for elbow extension after the intervention for both groups was large, ranging from 0.60 to 3.75. This range of improvement in elbow movement may be clinically meaningful when considering the presence of flexion contractures in children's elbow. In addition, in the follow-up assessment all children who received the STS training were able to maintain their improvements better than the children who received the NSTS training. A previous well conducted RCT investigating the effect of task specific home based intervention using trunk restraint in adults with stroke[102] reported an effect size of 1 for elbow extension after the intervention, with a minimal mean difference of 5 degrees extension for the group that

received the trunk restrain. In contrast, in our study all children benefited from the intervention in terms of elbow extension. One reason why there was not a greater effect of STS on improvements in the range of elbow extension in our study, as has been reported for a similar intervention in adult stroke survivors might be that the underlying mechanisms of reaching and grasping impairments in children with CP are different from those after adult-onset brain lesions. In adult-onset stroke it is possible that the combination of neurophysiological and biomechanical constraints that arise due to the lesions might prevent them from re-establishing well-coordinated arm and trunk movements during reaching that had been acquired previously [13]. Thus, the application of trunk restraint may have permitted the system to re-experience previously learned movement coordination. On the other hand, considering the early brain lesions in children with CP and concomitant excessive plasticity where corticospinal tract connections may be replaced by extrapyramidal tracts in spinal segments, it is probable that children have not developed optimal movement coordination patterns. In adult stroke survivors and children with CP, excessive trunk involvement might serve a similar purpose with respect to assisting in the transport of the hand to the target. The training outcome in children, however, may differ from that in adults since the children with CP are still learning or never acquired optimal upper limb coordination patterns during reaching tasks. Thus, directed practice in reaching with or without segmental trunk stabilization may have helped them to use elbow extension more effectively [14].

Training session's intervention was mostly organized as play activities with all the children participating in the same activity, whereas the individualization of training was high. Individual adjustments of the environment and the tasks, along with supervision of the children's escorts, were continuously carried out. When the task motivated the child and the demands on the child was individually tailored, the intensity of the training was high, and the child performed many focused and repeated efforts to complete the task. The experience of being part of a group and of mastering new skills seemed important for the children's motivation, and the group training seemed to give an opportunity for repetition and intensity of training essential for motor learning. It is also interesting to notice that different teaching strategies seemed to be applied when the training was organized as a group activity as opposed to individual activities within the group frame. Contribution from experienced professionals seemed necessary in order to select appropriate goals, e.g. in line with what a child was just about to manage. Experience was also needed to implement the children's individual goals into a group program and to facilitate motor learning for the individual child during the group session, and at the same time facilitate the group process and supervise the escorts.

Most of the group activities were gross motor activities, but hand motor activities were also included. The QUEST showed improvement after the intervention, but not significant. More specific hand motor training, such as Constrained Induced Movement Therapy has shown significant improvements[14], and may be included in the training or offered in separate periods to give children with unilateral CP more focused hand training. The repeated measures design of the present study was chosen to take anticipated variability in the children's functioning into consideration, along with considerations regarding feasibility. While the same child is tested in each condition, variability among the children can be measured and separated from error, and smaller but consistent change can be detected as opposed to group designs, where the variability among subjects are uncontrolled and are treated as error. The design is thus advantageous in heterogeneous samples. The baseline, intervention and follow up phases were of equal length, giving an opportunity to control maturation effects. This strengthens validity of the change scores in the study. As the GMFM-66 credits new skills, improved scores after the intervention, as shown in all children, strengthens the clinical significance of the results. Whether other types of interventions, like practicing tasks in a child's natural environments, are more or less effective than the present Task Oriented Motor Skill Training Program remains to be shown. Some parents demand intensive therapy programs for their children, and preferably in a group setting [15]. The training was well tolerated, but also demanding for both child and family. The children's caregivers appreciated the effort and intensive focus on attainable goals in a restricted time frame. They experienced that the group training was fun and motivating for the children and appreciated that the group was arranged in their local environment. A challenge is to secure that such intensive periods with focused training, are integrated in a child's total habilitation plan.

CONCLUSION

When the task oriented motor skills training was used with trunk segmental trunk stabilization, children decreased the amount of compensatory trunk displacement during reaching and grasping activities. However, when task oriented motor skills training was used alone, the improvement in movement quality could be accompanied by an increase in compensatory trunk displacement.

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