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Effectiveness of Neurodevelopmental Technique and Task Specific Training with Strengthening Exercise on functional Performance of Lower Extremities in Spastic Diplegia Children 4-12 Years

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Abstract

Objective: To assess the effectiveness of Neurodevelopmental technique and Task specific training with strengthening exercise on children with spastic diplegic cerebral palsy.

Method: A randomized controlled trial was carried out in twenty four children with Spastic diplegia. Children were randomly assigned into two groups, conventional group I underwent Neurodevelopmental technique and experimental group II underwent Task specific training with strengthening exercise for a period of four months. The Outcome Measures used for the study are Gross motor function measure (walking); Modified timed up go test, Gait right and left stride length measurements. The Statistical techniques used for analyzing the data are one way repeated measures ANOVA, Newman kuel's post hoc test and Analysis of Co-variance (ANCOVA).

Results: Statistical significance differences were found between groups in Gross motor function measure (walking) were F ratio value is 11.195, Gait right and left stride length measurements were F value is 6.517 and 4.798 respectively. Significant difference were found within groups in one way repeated measures ANOVA and post hoc test in Neurodevelopmental technique group ANOVA -F values were 63.067, 92.172, 38.315, 43.792 in Gross motor function measure (walking), Modified timed up go test, Gait right and left stride length measurements respectively and in Task specific training with strengthening exercise group ANOVA -F values were 102.065, 100.180,70.117, 102.508 for Gross motor function measure (walking), Modified timed up go test, Gait right and left stride length measurements respectively.

Conclusion: Task specific training in addition with strengthening exercise can be applied in spastic diplegia children to improve walking ability with increased stride lengths.

Keywords: Cerebral palsy; Spastic diplegia; Neurodevelopmental technique; Task specific training; Strengthening; Gait

Introduction

Spastic diplegia is a form of cerebral palsy involving both upper and lower extremities (lower limbs more affected than the upper limbs) [1]. Spastic diplegia children adapt abnormal posture because of the tightness in spastic agonist muscles and weak antagonist muscles and the antagonist muscle cannot function effectively to overcome the strong pull of the spastic agonist muscles and thereby correction of abnormal posture becomes difficult [2]. Structural changes in spastic muscles are seen as a result of adaptation and abnormal movement patterns. Spastic muscles are normal in structure but are not as extensible causing difficulty of muscle elongation.

Physical therapy professionals around the world are trying to establish an effective therapeutic method to improve the functional abilities in spastic diplegic children. The movement-disabled individual must attempt to gain or regain effective motor performance in at least essential everyday actions such as standing up, walking, reaching in sitting and standing, and manipulation [3].

Neurodevelopmental technique

Bobath concept is a problem-solving approach with assessment and treatment of individuals with disturbances of function, movement and postural control due to a lesion of the central nervous system [4]. Treatment delivered according to the abilities and disabilities of the client and severity and involvement. Muscles generate the most efficient active force at the mid-length so it is important to gain alignment. This may involve muscle stretching to achieve length. Stimulation of muscle activity through use of weight bearing, resistance, sensory stimulation in appropriate postures and patterns to enable the person to have a sufficient basis for the training of functional tasks [5].

Physiotherapist guides patient to perform motor function in appropriate way without causing increase in muscle tone. The concept is primarily a way of observing, analyzing and interpreting task performance [6]. Few studies reported that neurodevelopmental approach in children with cerebral palsy will lead to improvements in gross motor function [7], motor skills functionality.

Task specific training with strengthening exercise

Task specific training are therapeutic exercise program taught to clients who suffer from neurological impairments and unable to perform functional activities independently. After looking into research evidences of functional improvements due to Task specific exercise in stroke clients based on motor learning principles, movement control and functional anatomy it is chosen as one of the treatment method in this research [8]. The requirements for motor activity learning are repetition of movements, encouragement, functional goal, and expected results. Motor learning refers to the acquisition and modification of movement [9]. Skill acquisition is dependent upon motor learning. Motor learning requires the intention to perform a task, practice and feedback (both intrinsic and extrinsic) [10]. Certain types of practice are more beneficial for task acquisition as well as task transference.

Developing the ability to stand up is essential to independent performance of other actions such as walking which require the ability to get into standing. Strength and control of propulsion and support over a fixed foot can be practiced by step up and down exercise. This approach uses various techniques of muscle stretching and strengthening exercises, and functional activities.

The task specific exercise applied in adults who suffered stroke showed improvements in functional tasks. Few studies are conducted in cerebral palsy children to evaluate the effectiveness of this kind of therapeutic application. Recent evidence suggests that weakness is a problem for the neurologically impaired adult and child. Therapist can work to increase strength by the use of activity, repetition and weigh bearing, it has been shown that when used appropriately, strengthening can improve function and does not increase spasticity [11]. Studies that support task related strengthening, spastic variety cerebral palsy can be benefitted with functional related resistance therapy [12], and resistance therapy is one beneficial technique to recover walking ability of individuals with cerebral palsy.

Need for the study

Current treatments for cerebral palsy focus either neurodevelopmental approach principles or task specific training with functional strengthening methods.

The gross motor function, gait stride length and gait speed improvements brought about in functional performance in spastic diplegia between neurodevelopmental technique and Task specific training with strengthening exercise is not clearly studied and reported. Hence, this study aims to quantify the functional improvement when spastic diplegia children are given Neurodevelopment technique and Task specific training with strengthening exercise and to identify the better treatment.

Hypothesis

The hypothesis of the study can be stated as there may be significant difference between Neurodevelopmental technique and Task specific training with strengthening exercise on functional performance of lower extremities of spastic diplegic children of 4-12 years.

Material and Methods

A randomized, controlled clinical trial that involves 12 children with spastic diplegia in conventional group I and 12 children with spastic diplegia in experimental group II. Duration of follow up period was four months.

The inclusion criteria were as follows, children clinically diagnosed as spastic diplegia cerebral palsy alone considered for the study, cerebral palsy children aged between 4 to 12 years, both male and female children participated in the study, children who scored 30 and above in Modified mini mental state examination are considered for the study and Modified ashworth scale score of 1 and 1+ were included for the study.

The exclusion criteria were as follows, children with cognitive impairment, cardiac and pulmonary problems, undergone cardiac, hip, knee, ankle and spinal surgeries and Gross motor functional classification system (Level I, III and IV).

Intervention

Neurodevelopmental technique protocal

a. **Sit to stand**: Patient in long sitting. Therapist sits back of the patient. Hands placed on the lower anterior thighs. Therapist assists the patient to come up to stand. Facilitation provided from back encouraging sit to stand from standard bench.

b. **Weight shift to stand from half kneeling**: The Therapist's assisting hands remains on the client's lower rib cage and the guiding hand is placed symmetrically over the client's hip extensors. The therapist's hands and body guide the client's weight diagonally forward and up over the forward leg. The therapist and the client both move through a step-stance position.

c. **Standing (Symmetrical Stance):** Weight shift to the lateral borders of the feet therapist assisted with both arms stretched. Proximal control for lower extremity extension to activate gluteus maximus.

Pivot to step stance, the therapist's guiding hand externally rotates the client's face-side (right) femur so that the client's foot, lower extremities, and trunk pivot to the right with weight shift. At the end of the pivot, the face-side leg is in front of the other leg. Both of the client's feet point in the direction of the rotation. Pivot to step stance, mid-stance position, the therapist's guiding hand stabilizes the client's front leg and shifts the client's weight forward onto the right foot. The assisting hand stabilizes the client's back leg in hip and knee extension with neutral rotation. The back foot plantar flexes and the toes extend.

Pivot to step stance, terminal stance position, the therapist's assisting hand maintains the forefoot and toes of the client's back foot on the floor while the thumb presses up toward the hip and shifts the client's weight forward and facilitates terminal stance. The calcaneous inverts.

Forward walking, facilitation from the rib cage and pelvis. Passive stretching to Quadriceps, Hip flexors and adductors, Ilio-tibial band, Hamstrings and Gastroneumius, Three treatment sessions per week for four months.

Task specific training with strengthening exercises protocal

Sit to stand (Wooden bench 40 cm and 20 cm): Training is aimed at giving the child practice in standing up and sitting down with prescribed number of repetitions from 40 cm bench and 20 cm bench.

Step-up and step-down exercises

a. **Forward step-ups**: Left foot on a step (15 cm). Forward and upward translation of the body mass over the foot with upper body remaining erect. Therapist assist and places the foot on to the step.

b. **Lateral step-ups**: Left foot on a step. Step up with left limb with body mass remaining erect. Speed up the step ups, tapping down lightly and quickly every time. Lateral step up with 1 kg weight cuff in the other side forearm.

3. **Calf muscle exercise**: Forefoot on step, heels free. Heels are lowered as far as possible then rose to plantigrade. Hips and knees remain extended throughout the exercise.

4. **Stair Walking**: Children walk up and down with ½ kg weight cuff wrapped around left ankle. (10 steps, 2 times).

5. Simple active exercise isolated hip extension training. Passive stretching to Quadriceps, Hip flexors and adductors, Ilio-tibial band, Hamstrings and Gastroneumius, Three treatment sessions per week for four months.

Strengthening exercise

Free ankle weights of ½ kg and 1 kg used to give resisted exercise, three treatment sessions for 4 months, ten repetitions concentric slowly with rest as needed, 10 repetition eccentric for each muscle.

Evaluations

All the subjects were assessed and Pre-test score is recorded before commencement of treatment. During treatment, evaluation is done at the end of second month (Mid test) and end of study (4 months- Post-test) for both groups. The following parameters were assessed during all evaluations,

1. Gross motor function measure (walking), 24 items were tested and score ranges from 0 if does not initiate to 3 if completes the activity. (Validity was high with an ICC of 0.99 (95% confidence interval= 0.972-0.997, Reliability was high with ICCs of greater than 0.98 (95% confidence interval=0.965-0.994). Brunton and Barlett [13] strongly support the instrument after determined the validity and reliability of two abbreviated versions of Gross motor function measure.

2. Modified timed up go test, the child sits in a chair, on instruction 'Go' from the evaluator should stand up, walk the line on the floor reach 10 metres distance, turn around walk back to chair and sit down. Time taken to cover 10 metres distance and come back to chair and sit down is recorded in seconds. Reliability of assessment was high, with ICC of 0.99 for within-session reliability and 0.99 for test –retest reliability [14]. Studies that support the instrument are [15] to review the benefits of using two different outcome measure Gross motor function measure and to examine whether the assessment tests the improvements in physical activity in subjects with cerebral palsy who were provided with therapy.

3. Gait right and left stride length measurements, lengthy white sheet pasted on the ground, the children should put both the feet on the ink pad and should walk on the white sheet. The inch tape used to measure the distance between the two heel strikes right to the next right heel strike is measured as right stride length. The best distance between one left heel strike to the next left heel strike measured as left stride length. Study of Handa et al. [16] examined the reliability and validity of walking speed, cadence, stride length comparison of measurement with stop watch and three dimension motion analyzer, for stride length contribution ratio was 85%, gradient around 0.80 and the intercept 8.9, high reliability and strong validity.

Results

Twenty eight children with spastic diplegia cerebral palsy were screened and twenty four spastic diplegia children who full filled the eligibility criteria were selected. Figure 1 displays the flowchart of the study. Two Children who underwent Hamstring and gastroneumius lengthening and two undergone ayurvedic management were excluded. The statistical analysis used for the study were one way repeated measures ANOVA, Newman Keuls' post hoc test. The comparison between groups was statistically analysed using Analysis of Co-variance (ANCOVA). To find out whether the modified timed up and go test, Gross motor function measure (walking), right and left stride length measurements Post-test values between Neurodevelopmental technique group and Task specific training with strengthening group differ significantly after adjusting the effect of Pre-test values.

ANCOVA result shows (Appendix Tables 1-14) that the calculated F ratio values between groups is 3.667, 11.195, 6.517 and 4.798 for Modified timed up and go test, Gross motor function measure (walking), gait right and left stride length measurements respectively. The Critical value is 4.325. Since the calculated value is greater than the table value, it is inferred that the post-test values differ significantly between Neurodevelopmental technique and Task specific Training with strengthening exercise groups. Hence there is a significant difference in the Gross motor function measure walking, gait right and left stride length measurements (Post-test) values between Neurodevelopmental Technique and Task specific training with strengthening after adjusting with Pre-test values.

Based on advanced statistical analysis made using ANCOVA there is no significant difference in the Modified timed up and go test- post-test values between Neurodevelopmental Technique and Task specific training with strengthening exercise after adjusting with Pre-test values (Appendix Tables 14-23 and Figures 1-13). Considering the statistical analysis made using ANOVA and post hoc test, there is significant improvements in walking speed in Timed up go test in both Neurodevelopmental technique and Task specific training with strengthening exercise groups (Appendix Table 4 & Figures 2,3,7,8).

Discussion

The purpose of this study is to determine and validate the effects of Neurodevelopmental technique and Task specific training with strengthening exercise on functional performance of lower extremities in spastic diplegia children.

The results of this study reveal that Task specific training with strengthening exercise group had significantly improved in GMFM walking and gait strides than the Neurodevelopmental technique group. The task specific training results in larger gains in gross motor skills and it is superior to neurodevelopmental approach (Appendix Tables 3-10). Sit to stand activity, lateral step ups, stair climbing with weights, walking with weights wrapped around ankle and strengthening exercise with weights delivered through therapy improved the walking ability. So the alternate hypothesis is accepted that is "Task specific Training with strengthening exercise can bring out significant improvement in functional performance of lower

extremities than the Neurodevelopmental technique among the spastic diplegia children of 4 to 12 years".

The results of this study reveal that "Task specific training with strengthening exercise did not show significant improvement than Neurodevelopment technique on Modified timed up and go test". These results supports study done by Buchner et al. [17] in older adults and suggested that a curvilinear relationship exists between lower limb function and strength. Below a certain threshold, strength has a direct linear relationship with functional ability. Above that threshold, further increases in strength may not be associated with corresponding increase in function for example no relationship was found between strength and walking speed in able bodied younger adults.

In conclusion Task specific training with strengthening exercise showed better improvement than Neurodevelopmental technique on performance of gross motor function measure (walking), gait stride measurements in children with spastic diplegia. Children showed interest towards therapy and were able to learn task specific exercise easily. Strengthening exercise provided with weight cuffs, walking with weights wrapped around ankles, lateral step ups with weight in contralateral arm, stair climbing with weights and calf muscle exercise increased the gait stride length of lower extremities.

Clinical Message

Task specific Training with strengthening exercise requires cost effective equipments like lateral step up, wooden bench and weight cuffs. Children show interest towards therapy and was able to learn task specific exercise easily.

Conflict of Interest

The authors declare no conflict of interest

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