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EFFECTIVENESS OF FUNCTIONAL RESISTANCE TRAINING ON GAIT SPEED IN SPASTIC DIPLEGIC CEREBRAL PALSY

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ABSTRACT

Background and objectives: Cerebral palsy is defined as a non-progressive insult to a developing or immature central nervous system (CNS), particularly to those areas that affect motor function. People with spastic diplegia typically walk slowly and have difficulty in performing activities such as walking up and down steps or running. People with spastic diplegia typically walk slowly and have difficulty in performing activities such as walking up and down steps or running. The purpose of this study is to find out that whether functional resistance training can improve the gait speed and if this exercise protocol is successful then it can be implemented for children with spastic diplegia. **Method:** 30 subjects which include both the genders and aged between 7-12 yearssatisfying all the inclusion and exclusion criteria were taken for the the study. Thesubjects were given functional resistance training for 12 weeks which includes foursupervised training sessions per week. The subjects were measured for pre and posttreatment values for the outcome scales GMFSC and 10 METER walk test. The functional resistance training will be periodised, comprising multiple sets of repetitions between 6-12. The number of sets and set structure will be progressing every four weeks and training load could be adjusted during any session. **Results:** The statistical analysis done for GMFSC and 10 METER walk test after functional resistance training showed significant results($p<0.0001$) stating the effect on gait speed. **Conclusion:** The results of this experimental trial support the view that 12 weeks offunctional resistance program was effective in increasing cadence and distance walked in 10 meter walk test in children with spastic diplegia.

KEYWORDS: Cerebral palsy, Resistance training, Gait speed, Gross motor classification, 10 meter walk test.

INTRODUCTION

Cerebral palsy is defined as a non-progressive insult to a developing or immature central nervous system (CNS), particularly to those areas that affect motor function. The impairment of voluntary motor control is the hallmark of cerebral palsy (CP).[1]

The causes can be specified as: intra uterine exposure to infection, inflammation, disorders of coagulation, interruption of oxygen supply during birth, low APGAR score, seizures, low birth weight, pre term and non-specific indicators of neonatal illness.CP can be classified based on the movements as hypertonic or spastic, ataxic, dyskinesia, mixed and hypotonic. Based on thefunction, CP is classified as quadriplegic, diplegic, hemiplegic and monoplegic.[2]

Spasticity is the most common movement disorder among the patients with CP. Spastic diplegia is most prevalent form of CP. Spastic Diplegic CP is the commonest and it occurs due to the particular type of brain damage inhibits the proper development of UMN function impacting the motor cortex, the basal ganglia and the corticospinal tract.[3] The term diplegia refers to muscle weakness and movement inco-ordination involving the lower limb more than the upper limb. People with spastic diplegia typically walk slowly and have difficulty in performing activities such as walking up and down steps or running.Alterations of the reflexes and muscle tonus are neurologic sequels commonly found at CP which change directly both the movement as well as the posture control[4]

The most common gait patterns are characterized by excessive knee and hip flexion,implicating weakness of the ankle plantar flexors, knee extensors, and hip extensors.[5] Toe walking with flexed knees are common attributes in crouched gait, whereas the scissoring gait is mainly present with adducted and internally rotated hips with inverted foots.[6] The physiotherapy management such as stretching, neurodevelopmental therapy, strengthening, balance training, gait facilitation, treadmill training, hydrotherapy, electrical stimulation, constraint induced movement therapy, massage, sensory integration, whole body vibration and vojta are given to improve the functional status of the children. Each treatment technique has a confined effect on the spastic diplegic CP children.[7,8,9]

The functional resistance training has been shown that task specific training yields long lasting cortical re organization which is specific to the areas of brain being used with a task.[10] Studies have also shown that patients making larger gains in functional tasks used in rehabilitation and since they are more likely to continue practicing these tasks in everyday activities. Training to improve functional strength involves more than simply increasing the force-producing capability of a muscle or group of muscles.[11] As people with CP have severe muscle weakness, they may compensate with stronger muscles when performing multi joint exercises.[12]

Anttila H et al study suggested that functional resistance training of the flexors using single-joint exercises improves muscle strength, muscle volume, walking speed and stride length. This power production of plantar flexor muscles is important for step length and walking speed by generating ankle power at push-off.[13]

AIM OF THE STUDY

To Find out the effectiveness of functional resistance training on gait speed in children with spastic diplegic cerebral palsy.

OBJECTIVES OF THE STUDY

To determine the effectiveness of functional resistance training on gait speed in children with spastic diplegic cerebral palsy.

METHODOLOGY

Study Setting

The study was conducted at physiotherapy outpatient department SIMS College OfPhysiotherapy,Guntur.
Study Design: Experimental study
Study Duration: One year study
Treatment Duration: 12 weeks (4 sessions per week)
Sample Size: 30 subjects
Sampling Design: Convinent sampling

MATERIALS USED

- Exercise mat
- Leg press station
- Weight cuffs for additional weights
- Chair without back support and arm rest
- Hack squat back machine
- Therabands
- Vest belt
- Stepper
- Stop watch
- Consent form
- Questionnaire
- Recording sheets
- Stationeries

INCLUSION CRITERIA

- Children aged between 7-12 years
- Children clinically diagnosed with spastic type CP, Gross Motor Function Classification System (GMFCS) levels I-III.
- Gender: both males and females
- Children who are ambulatory with minimum/without assistance
- Children who are co-operative and parents who are willing

EXCLUSION CRITERIA

- Children with cognitive and sensory deficits
- History of any surgery in past 12 months
- Children who are not ambulatory
- History of any seizures or other systemic illness or unstable medical condition
- Children who are not willing to continue the 12 week protocol

OUTCOME MEASURES

- GROSS MOTOR FUNCTION CLASSIFICATION

The Gross Motor Function Classification System or GMFCS is a 5 level clinical classification system that describes the gross motor function of people with cerebral palsy on basis of self-initiated movement abilities. Particular emphasis in creating and maintaining the GMFCS scale rests on evaluating sitting, walking, and wheeled mobility. Distinctions between levels are based on functional abilities and to much less extent the actual quality of life.

- The 10-meter walk test: participants were instructed to walk as fast as possible with- out running or skipping, and the time taken by the participant to complete it was recorded.

PROCEDURE

The parents (or) the care giver of all the participants were explained about the study and a written consent (Annexure I) was obtained. All the participants were assessed by the pediatric assessment(Annexure II) which consists of - age, gender, height, weight, developmental history, motor function, gait parameters and physical examination.

The selected spastic diplegic CP children were sampled to the intervention group toundertake four supervised training sessions per week, for 12-weeks. The parents (or) the care giver of all the participants were explained about the study- comprising the following exercises: seated bent knee calf raise, leg press, seated straight knee calf press, seated TA raise, and standing calf raise. The functional resistance training will be periodised, comprising multiple sets of between 6 – 12 repetitions. The number of sets and set structure were progressed every four weeks and training load could be adjusted during any session. The weight bearing sessions consisted of a warm up, the main program and the cool down period.[14,15] During the warm up period muscle stretching, gentle massages for major muscles and aerobics were given.[16]

The main program incorporated had functional weight bearing exercises for the lower limbs such as: seated straight knee calf press against resistance band (TheraBand), seated straight knee calf press with a leg press machine, standing calf raises against body weight with or without additional resistance, sit to stand, front and lateral step up, side walking in a circuit training format.[17] The participants had to rise from a chair and sit down (sit to stand) with a backpack with weights. Forward/lateral walking can be performed by dragging a loaded box over-ground with belt around the hip.Step up and down movements can be performed by loaded vest. The lateral or front step up or sits to stand were performed according to the participant's capabilities with low charging.

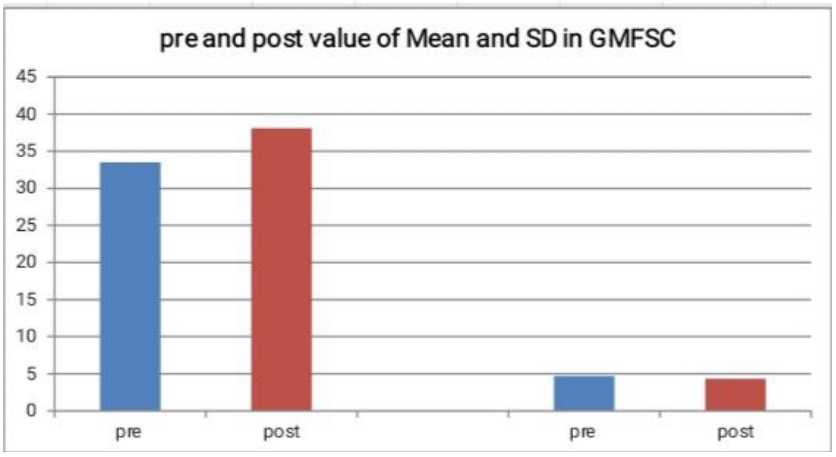
For the seated straight knee calf press against resistance band, the band has beenplaced around the ball of the foot. The length of the resistance band and the position of the participant's hands when holding the band will be kept constant during this exercise. Participants will plantar flex at the ankle and push against the resistance band. When a participant can complete more than the prescribed number of repetitions, they will progress to a stiffer resistance band until they are able to progress to a different exercise. The stiffness of the resistance band increases according to the colour of the band, from least resistance to most resistance as follows: yellow, red, green, blue, black, silver, gold. For the standing calf raise exercise, participants will be instructed to raise and lower their body using their calf muscle. If necessary, they are allowed to hold onto a chair for balance. Participants may also complete standing calf raises using a hack squat machine in the group session. For the seated straight knee calf press with the leg press machine, participants will be instructed to push against the foot- plate with the ball of their foot. Unilateral exercises will be performed where possible. If a participant is unable to perform unilateral exercises, they performed bilateral exercises initially until they are able to progress to unilateral exercises. The training volume was determined by load, velocity, and number of repetitions.[18] When children became faster and performed the distance of the exercise in less than 25 seconds, the load had increased by10%. After each week of therapy session the data has to be recorded using the assessment tools and on completing the 12 weeks treatment protocol the data recorded has to be analysed and the outcome results are concluded depending upon the analysis gained.

STATISTICAL ANALYSIS AND RESULTS

The aim of the study was to find the effectiveness of functional resistance training inspastic diplegic CP. A total of 30 subjects who met inclusion criteria have undergone baseline assessment.

Table 1: Analysis of Mean Score of Pre and Post Test In Gmfcs.

GFMCS	MEAN	SD	P VALUE	t value	Inference
PRE values	33.5	4.681	<0.0001	3.987	Highly significant
POST values	38.1	4.313			

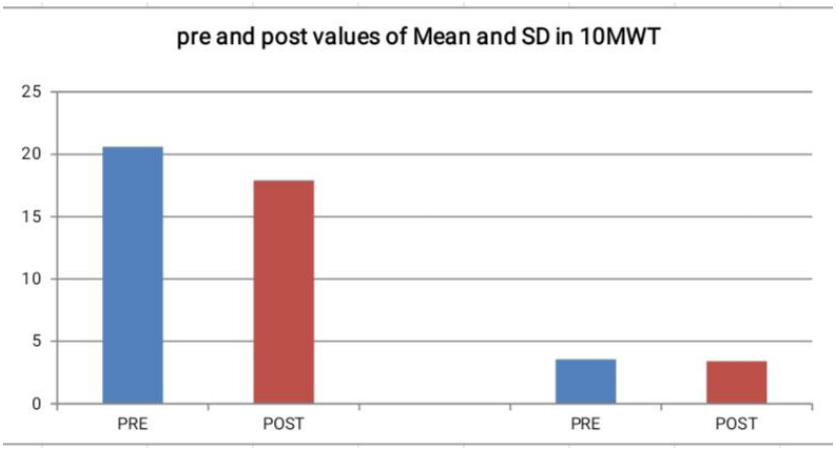


GRAPH 1: Comparison of pre and post mean values of GMFSC.

Results: The above table and graph shows mean values changes within the groups from pre test and post test were found to be statistically significant(p<0.0001)

Table 2: Analysis of mean scores of pre and values of 10 meter walk test.

10MWT	MEAN	SD	P VALUE	t value	Inference
PRE values	20.6	3.557	<0.0001	3.004	Highly significant
POST values	17.9	3.403			



GRAPH 2: Comparison of pre and post mean values of 10 mwt.

Results: The above table and graph shows mean values changes within the groups from pre test and post test were found to be statistically significant($p<0.0001$)

DISCUSSION

The study was aimed to investigate the effects of resistance training on gait speed in spastic diplegic CP children. The children with spastic diplegic CP have the problem of muscle imbalance in the lower limb which limits their functional activity. These children can walk independently with (or) without assistance, but with poor mobility and gross motor function, compared with other children without disabilities.

For the study purpose 30 spastic diplegic CP children were selected on the basis ofselection criteria. Based on the level of severity, 10 children were comes under theGMFM level I, 15 children were comes under the GMFM level II, and the remaining 5 children were comes under the GMFM level III. Based on the age parameter 24 children were in the age group of 4-7 and 6 children were in the age group of 8-10. Based on the gender 19 of them were boy and remaining 11 were girls.This study shows that an intervention can make a change in the GMFM even after these ages. Wang and Yang report a change of 3.71 on the GMFM-66 to be a clinically visible improvement.[19] At the baseline of the study all the participant were evaluated initially for the gait speed using the two outcome measures which are GMFCS and 10 meter walk test. The collected data were taken as the pre interventional scores for analysis. Then the children were given resistance training protocol after which the post treatment values were recorded for the same parameter which is gait speed. The treatment duration was over a period of 12 weeks. After the treatment duration all the participants were re-evaluated by the same assessment tools and the collected data were taken as post interventional scores for analysis.

The collected data was statistically analyzed in order to compare the variables with in the group was done by paired 't' test. The difference were considered at the significant level of '$p'<0.05$. The statistical analysis of the variables with in the group result showed significant difference. **GMFM** results showed in the Table I and Graph I confirmed the effect of treatment on the gait speed using GMFCS. The 10 meter walk test results showed in table 2 and graph 2 confirmed the effect of muscle strengthening through resistance training in improving gait speed.The results confirmed the effect of resistance training was effective in the improvement of the gait speed without the adverse effects of increasing spasticity.

The result supported the previous studies which stated the resistance training can improve the functional status without the adverse effect. Result of the study showed the relationship with the muscle strength and gross motor function. The study determined that there was significant strength gain in the muscle targeted in the lower limbs, which was also stated in the other studies showed the direct relationship between the lower limb muscle strength and gait parameters.The gained strength of the lower limb muscles can improve the function by strengthened hip muscle stabilizing the pelvic motions in walking, the strengthened knee muscle can improved the degree of crouch gait and increased fast walking, the strengthened ankle muscle can improve the propulsive action of the foot in terminal stands phase, decreased energy consumption by normalizing the abnormal joint posistion, and cardiovascular fitness gained after the resistance training. All these factors contributed for the improvement in the gait parameters such as increased speed, increased stride length, increased cadence and increased single limb balancing during walking. With respect to the outcome variables, a significant effect was detected for the knee extension and hip abduction isometric strength for the experimental group.

The results are in agreement with Blundell et al.[21], Scholtes et al.[22] and Dood et al.[23] who examined the isometric strength after a functional resistance program. Similar results, regarding the strength of knee extensors, were reported by Chen et al. and Fowler et al.[22] who examined strength with an isokinetic dynamometer. The contradictive research evidence may be due to the different assessments and protocols conducted.

Liao et al.[23] for example assessed the strength isometrically, while the respective program exercisedthe muscles isotonically. Overall, an increased mobility was evident and the positive effects may be due to the repetitive task oriented characteristics and specificity of functional strength training that was employed in the present intervention program. Further, the participants exhibited no adverse effects and increased their muscle strength of the lower limbs above the lower threshold that is necessary for daily activities. It appears therefore that the increased strength was not at the highest threshold or ceiling effect that could not be accompanied with mobility improvements. Given that functional resistance training could supported by most spastic diplegic cerebral palsy patients, we will support now that the functional resistance training should be considered as to improve gait speed in spastic diplegic cerebral palsy patients.

CONCLUSION

Individuals in this study participated in 12 weeks intervention period which is functional resistance training program. After the intervention, the study showed that the resistance training for spastic dipelgic CP can increase the strength of the muscle thus improve gross motor function and mobility by increasing the gait speed without the adverse effect of increased muscle tone.

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