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A Study to Analyze the Effectiveness of Functional Strength Training in Improving Gross Motor Function among the Children with Spastic Diplegic Cerebral Palsy

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Abstract

Objective: To compare the efficacy of functional strength training in improving gross motor function among the children with spastic diplegic cerebral palsy.

Design: Experimental study design with pre-test and post-test.

Background: The primary goal of rehabilitation for spastic dipelgic cerebral palsy is functional enhancement by maximizing the independence, life style, and dignity of the patient. A new development for treatment in specialized and well organized manner generated by different neurological treatment approach includes functional strength training. There has been less research explaining about the importance of functional strength training for improvement in functional activities.

Method: Fifteen subjects spastic diplegic cerebral palsy were selected under purposive sampling technique and received functional strength training for a period of 10 weeks.

Outcome measure: Gross motor function measure-the gross motor function measure is a standardized observational instrument designed to measure changes in gross motor function over time in children with CP.

Results: Statistical analysis done by using student's t-test and showed that there was significant improvement in subjects who received functional strength training.

Conclusion: The statistical results show that there is an improvement in gross motor function after 10 weeks of functional strength training program

Keywords: Cerebral palsy; Functional strength training; Gross motor function

Introduction

Cerebral palsy (CP) is a common developmental disability that affects thousands of babies and children each year. In India, the prevalence of Cerebral palsy is high. Cerebral palsy is characterized by motor dysfunction due brain damage in children usually associated with disabilities ranging from total dependency and immobility to abilities of talking, independent self-care and gross motor functions including standing walking, running and jumping. This condition poses considerable diagnostic challenges with degree of involvement ranging from minimal disability to severe and associated with severe co morbid conditions. Cerebral palsy is primarily a disorder of movement and posture. The children who have taken proper and regular therapy with earlier intervention they will be promoted as near normal children. The least expected by a parent in these children is to be independent on the gross motor function particularly the functions of standing, walking, running and jumping in the age group of 4-6 years. Cerebral palsy is defined as an "umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early Stages of its development" [1]. It is a common problem the worldwide incidence is being 2 to 2.5 per 1000 live births. The majority of people with CP have the spastic syndrome of which diplegia is the commonest. Low birth weight infants are at greater risk of developing CP than larger birth weight babies. The most important risk factor seems to be prematurity and low birth weight with the risk of CP decreasing gestation age and birth weight [1].

Despite being complex and heterogeneous condition, all cases of CP are ultimately caused by a neurological problem namely a lesion in the brain. The lesion is acquired at some point early in development, either during gestation while the fetus is in the mother's womb, during or soon after delivery or at any time up to two years. Prenatal causes are uterine infections, Thyroid abnormalities, Methyl mercury expose during pregnancy, Seizure disorder in the mother and multiple gestations. Perinatal causes are Forceps delivery, Breech presentation, perinatal asphyxia and intrauterine growth retardation. Postnatal causes are Bacterial meningitis, viral encephalitis, Hyperbilirubinemia and Problem with lungs and heart [2]. Cerebral Palsy is classified based on the type of neuromuscular deficit into 3 types as 1. Spastic 2. Ataxic 3. Athetoid. Spastic type is the most common and accounts for 70 to 80% of all the cases in which some of the muscles in the body are tight and weak, drawing of the limbs in and making control of movement is difficult. The spastic CP contains variations includes monoplegic, diplegic, quadriplegic and hemiplegic [3].

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

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corticospinal tract. No type of CP is officially a progressive condition and indeed spastic diplegia does not clinically get worse given the nerves damaged permanently at birth neither recover nor degrade. Spastic diplegic CP is entirely congenital in origin that is almost always acquired shortly before or during a baby's birth process. The most common cause of spastic diplegia is periventricular leucomalecia more commonly known as neonatal asphyxia. Above the hips, persons with spastic diplegia typically retain normal or near normal muscle tone and ROM, though some lesser spasticity may also affect the trunk and arms depending on the severity of the condition in the individual. In addition, because leg tightness often leads to instability in ambulation, extra muscle tension usually develops in the shoulders, chest, and arms due to compensatory stabilization movements. Regardless of the fact that the upper body itself is not directly affected by the condition [3].

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. The degree of spasticity in spastic diplegia varies widely from person to person. No two people with spastic diplegia are exactly alike. Balance problems and/or stiffness in gait can range from barely noticeable all the way to misalignments so pronounced that the person needs crutches or a cane to assist in ambulation. Less often, spasticity is severe enough to compel the person to use a wheel chair. In many cases, the IQ of a person with spastic diplegic CP may be normal however other side effects like strabismus are common. The impairments of spastic diplegic children are spasticity in lower limbs, ROM deficits and selective motor control problems. These impairments may limit the performance of gross motor, fine motor with limitations of participation in daily life [1].

The management of patients with CP must be individualized based on the child, clinical presentation and requires a multidisciplinary approach. The common treatment given to the cerebral palsy children are 1. Medications, 2. Surgery, 3. Physiotherapy, 4. Occupational therapy, 5. Speech therapy. Traditional physiotherapy used in children with CP has been shown to improve muscle strength, local muscular endurance and overall joint ROM. Routinely used as a part of interdisciplinary treatment approach for school aged children because it fulfills the need for certain degrees of cooperation and active participation on the part of the child.

Functional Strength Training

The strength training is given based on the functional activities mainly to focus on the functional limitations and to improve the quality of life. The functional strength training is designed to incorporate task and context specific practice in areas meaningful to each patient with an overall goal of functional independence. In the case of CP the exercises included in the functional strength training are more focused about the children independency in the school.

The functional strength 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. Studies have also shown that patients making larger gains in functional tasks used in habilitation and since they are more likely to continue practicing these tasks in everyday activities. Better results during follow up are obtained. The functional strength training is mainly dealt with anti-gravity muscles and aiming at maximal carry over in day to day activities. The functional strength training can be given by the use of resistance and it may be gravity, body weight, resistance bands and free weights. The exercises are specific to the muscle or muscle groups recruited during the functional activities [4]. This study was aimed to give awareness among the practicing physiotherapists regarding the misconception about the strength training in cerebral palsy. This study was done to find out the effectiveness of functional strength training in improving gross motor function among the spastic diplegic children [5-10]. A single group study to evaluate the effectiveness of functional strength training in improving gross motor function among the children with spastic diplegic CP [11-17]. The study will assess the improvements in the gross motor function after functional strength training program in spastic diplegic children and measure improvement the child functional independency in school environment.

Functional strength training

It is the practice of motion against resistance to build strength, balance and coordination and to improve the ability to perform day to day activities [18-21].

Gross motor function measure

The gross motor function measure is a standardized observational instrument designed to measure changes in gross motor function over time in children with CP [2].

Spastic diplegia

Historically known as Little's Disease, is chronic neuromuscular condition of hypertonia and spasticity manifested as an especially high and constant "tightness" or "stiffness" in the muscles of the lower extremities of the human body, usually those of the legs, hips and pelvis [2].

Materials and Methodology

A Study design adopted was a Single group pre-posttest, randomized control study. This study was conducted at, Outpatient department, RVS Hospital, Sulur and Amrit centre for special needs, Mettupalayam road, Coimbatore. The study was conducted for a period of 1 year and In the 1 year study duration intervention was given for the period of 10 weeks. Fifteen subjects who fulfilled inclusion, Age group 4 to 6 years, Sex Both boys and girls, Children under Gross motor function classification system level of I- III, Children with Spastic diplegic CP and able to understand the commands were selected and underwent functional strength training program. Children with Instable seizures, Mental retardation, Children underwent surgery, Children under Botox injection, other type of CP, GMFCS level IV- V were excluded. 15 subjects were selected based on the selection criteria and their gross motor function was measured by GMFM before the intervention. The parents were informed about the assessment, intervention and risk of participation of the study. After 10 weeks of functional strength training program posttest assessment was done.

Functional strength training

After finishing the pretest assessment the exercises were selected for each child based upon gross motor limitations observed by the therapist. The functional strength training exercises were given to strengthen lower limb muscles, improve segmental control of lower limbs and improve balance. The intervention was given 4 times per week. Each session lasts for 60-90 mins. Each session started with a warming up and cooling down period of 10 mins. During the warm up period muscle stretching, gentle massages for major muscles and aerobics given. The training session was carried out with a practice of loaded sit to stand, forward step ups, lateral step ups, leg press and half knee exercises. Sit to stand exercise was performed in the following manner. The child move the trunk by flexion of the hips until the

shoulders are above the knee joints and then the child should stand up. The child should stay in that position for 5 sec. Standing with as much symmetrical hip strategy as possible to defined position. This is achieved by simple overhead activities.

The main strategy followed for the step up was, the child should place the right foot on the step next to the left foot and extend the knees as much as possible. Keep standing with both legs for 1 sec. Then place the right foot down then left with 8 repetition of same exercise. Then the exercise was carried for the other side also. The same procedure was followed for lateral step up exercise. Rest period 2 min in between each exercises. The leg press exercise was carried out in the leg press machine. The repetition of leg press during the overall circuit training was less because it is not a functional one. The half knee exercise was carried out in the floor and the weight bearing mainly carried out in leading leg during the transmission. The therapist was standing in front of the child to provide support while coming up from the half kneeling posture. In each activity one stand up and one return was considered as 1 repetition. Orthosis were used in some children who were having tight tendo- achilles to maintain the heel contact.

The exercises were carried out in circuit manner. Exercises were performed intensively with 8 repetitions in order to promote motor learning and improve muscle strength and endurance. The training was completely individualized and exercises were given with attention to each child to get correct performances of the exercises. The exercises were given through goal directed game like activities with little fun to get maximum active participation from the child and to make the child enjoy the session. The resistance was given by the means of weight cuffs and weight vest. The parents kept a diary to record all the exercises performed during the session. Remaining 2 days of the week parents are instructed to make the child to do those exercises without resistance excluding on Sunday. The exercises were progressed by increasing the number of repetitions and exercise difficulty. After 10 week functional strength training program posttest assessment was done (Table 1).

Measurement Procedure

It is a standardized observational instrument tests activities in 5 dimensions lying and rolling, sitting, crawling and kneeling, standing and walking, running, jumping. In this study dimension D, (i.e.) standing, dimension E (i.e.) walking, running, and jumping were selected as goal areas. According to the scoring sheet activities were scored as 0, 1, 2, 3, NT by observing the child's performance with higher rating represents the better performance. During each activity the level of support, balance reactions, weight transmission and the type of assistances all were noted.

S.NO	INTERVENTION	REPETITION	DURATION
I	**WARM UP:** Streching Hamstrings Quadriceps Tendoachilles Adductors of Hip	 Hold 10 Sec × 5 rep Hold 10 Sec × 5 rep Hold 10 Sec × 5 rep Hold 10 Sec × 5 rep	 5-7 Min
II	**EXERCISE:** Leg Press Loaded sit to stand Forward step up Right Left Lateral step up Right Left Half knee Rise Right Left	 8 reps 8 reps 8 reps 8 reps 8 reps 8 reps 8 reps 8 reps	 8-10 min 8-10 min 8-10 min 8-10 min 8-10 min 8-10 min 8-10 min 8-10 min
III	**COOL DOWN:** Stretching (or) Walking	-	5-7 min

Table 1: Functional strength training drills.

Results

A number of subjects for the study was 15 (n=15). The subjects were involved for the pretest assessment by GMFM. Treatment was given for period of 10 weeks 4 sessions per week. Regarding the dependent variable dimension D (i.e.) standing, dimension the calculated't' value is 4.818 which is higher than the table value is 2.977.at 0.005 level. Hence the calculated't' value is more than table value, the above value shows that there is significant difference in standing after functional strength training. In dimension 'E' (i.e.) walking, running, and jumping of GMFM, the calculated 't' value is 18.14 which is greater than the table value 2.977 at 0.005 level. Hence the calculated't' value is more than table value, the above value shows that there is significant difference in walking, running and jumping following functional strength training.

When analyzing both dimensions there is significant improvements in both dimension D&E of GMFM. Therefore the results show that the functional strength training having significant effects in gross motor function among preschool age spastic diplegic children. Hence we accept alternate hypothesis and reject null hypothesis (Tables 2-4).

Discussion

Spastic children having particular type of brain damage that inhibits the proper development of UMN function impacting the motor cortex, cortico spinal tract and basal ganglia. Due to these areas involvement mainly the spastic diplegic children often more impairments in the movement than the sensory areas. In this study 15 children were selected based on the criteria and pretest was done at 0 week. The

s.no	characteristics	n
1	Walks without restrictions	**15**
2	Walks with assistive device	**5**
3	Children under Gross motor function classification system level of I- III	**I-7** **II-4** **III-4**
4	Male	**10**
5	Female	**5**
6	Age 4	**4**
7	Age 5	**7**
8	Age 6	**4**
9	Regular to school	**10**
10	Irregular to school	**5**

Table 2: Data analysis of dimension d of GMFM': Socio demopgraphics of 15 children with cerebral palsy and their families.

Intervention	Mean	Mean Difference	SD	Paired 't' Value
Pre Test Post Test	63.51% 84.95%	17.43	28.86	4.818

Table 3: Dimension D-Standing: shows mean value, mean difference, standard deviation and paired 't' value between pretest and post test scores of dimension D in functional strength training.

Intervention	Mean	Mean Difference	SD	Paired 't' Value
Pre Test Post Test	30.73% 44.68%	13.93%	2.971	18.14

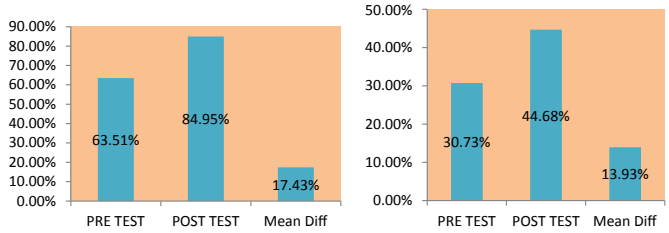
Table 4: Dimension E-walking, running and jumping: shows mean value, mean difference, standard deviation and paired 't' value between pretest and posttest score of dimension E of GMFM in functional strength training.

functional strength training was given for the period of 10 weeks based on the prescribed protocol. The findings in our study show that a 10-week functional strength training programme which is focused on the lower extremities improves walking ability. However l5 participants in this study could walk with or without walking aids and they all walked in a very typical way, with flexion, internal rotation and adduction in their hips and flexion in their knees. The antagonist muscles, hip abductors, and hip extensors are thus not normally activated and it could be assumed that they are weaker than in individuals with a normal walking pattern [22-25]. In many respects, functional strength training should be thought of in terms of a movement continuum. As humans, we perform a wide range of movement activities, such as walking, jogging, running, jumping, lifting, pushing, pulling, bending, twisting, turning, standing, starting, stopping, climbing and lunging. All of these activities involve smooth, rhythmic motions in the three cardinal planes of movement-sagittal, frontal and transverse. The functional strength training enhances the coordinated working relationship between the nervous and muscular systems. The task specific functional strength training yields long lasting cortical reorganization which is specific to the area of brain being used with a task. Training to improve functional strength involves more than simply increasing the force-producing capability of a muscle or group of muscles [26].

After finishing the pretest assessment, the calculated mean pretest score of dimension 'D' was 55.89 %. After the 10 week intervention programme the post test scores were measured and the mean value of the post test score was 66.49%. The mean difference of dimension D (standing) of GMFM is 10.59. So there was 10.59% increase in the dimension D (standing) of gross motor function measure due to the 10 week functional strength training. In dimension E (walking, running, jumping) the assessed mean pretest score was 29.43 and the posttest mean score was 38.79 [27-28]. By these we found that there was significant improvement in walking, running and jumping up to 9.35%. Therefore from the above analysis we could found the significant changes in overall gross motor function after 10 weeks functional strength training in the children with spastic diplegic cerebral palsy (Figure 1).

Conclusion

An experimental study was conducted to investigate the effectiveness of functional strength training in improving gross motor function among preschool age children with spastic diplegic CP. 15 children with age limit of 4-6 years were selected based on the selection criteria and they were treated with functional strength training exercises and gross motor function was measured by GMFM before and after the intervention. The statistical results show that there is an improvement in gross motor function in particular standing, walking, running and jumping after 10 weeks of functional strength training program.



Mean difference in dimension 'D' is 17.43 mean difference of in dimension 'E' is 13.93%.

Figure 1: Graphical representation of pretest mean and post-test mean scores of dimension D (standing) and E (walking, running, and jumping) of GMFM.

Limitations

1. Short duration study.
2. Sample size was small, which might have affected the generalization of the study
3. Age group between 4 to 6 was only selected for the study.
4. Spastic diplegic type of cerebral palsy was only considered.
5. The study only assessed short term progress of the patient. Long term follow-up is needed to evaluate the difference in the condition of the patient from current status.

Suggestions

1. Further study can be conducted with more sample size.
2. Further study can be done in other types of cerebral palsy including hemiplegic, athetoid and ataxic cerebral palsy.
3. Long term follow-up is needed to evaluate the difference in the condition of the Patient from current status.
4. Further study is suggested with Strength training can be given in progressive method.
5. Further study is needed to systematically determine the most efficacious protocol for each patient

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