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Dr. Shruti Chaudhari
Assistant Professor, Dr. Ulhas Patil College of Physioyherapy, Jalgaon, Maharashtra, India

Dr. Rachana Shetty BV
Associate Professor, Kempegowda Institute of Physiotherapy, K.R. Road, VV Puram, Bengaluru, Karnataka, India

Corresponding Author:
Dr. Shruti Chaudhari
Assistant Professor, Dr. Ulhas Patil College of Physioyherapy, Jalgaon, Maharashtra, India

A study to compare the effect of task oriented training versus functional progressive resistance exercise strength training on gross motor functions in spastic diplegics

Dr. Shruti Chaudhari and Dr. Rachana Shetty BV

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Abstract
Cerebral palsy is a disorder of the development of movement and posture, causing activity limitations. Spastic Diplegic CP is the commonest and it occurs due to the brain damage inhibits the proper development of UMN function impacting the motor cortex, the basal ganglia and the corticospinal tract. 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. Improvement in mobility has been primary goal in treatment of cerebral palsy. This interventional study was conducted to compare the effect on gross motor function in spastic diplegics treated with task oriented training and spastic diplegics treated with functional progressive resistance exercise strength training. Sixty subjects with spastic diplegics were assessed for the inclusion and exclusion criteria and equally divided into two groups group - A received task oriented training and Group - B received functional progressive resistance exercise strength training five times a week for 5 weeks. The outcome measures were taken on GMFM88 (Dimension D and E) and Mobility Questionnaire on day 1 and at the end of 5th week. The result showed statistically significant improvement in Gross motor function in both the groups after 5 weeks of treatment, But Group A treated with task oriented training shows better improvement in outcome measures as compared to group B treated with functional progressive strength training.

Keywords: Cerebral palsy (CP), UMN (upper motor neuron) gross motor function measure (GMFM), gross motor function classification system (GMFCS), task oriented training, functional progressive resistance exercise strength training

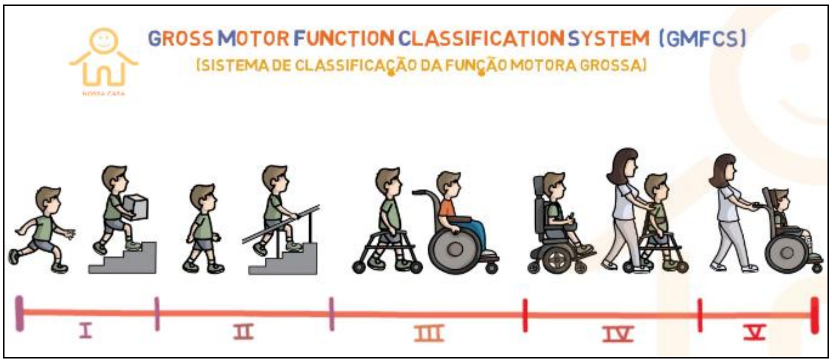
Introduction

Cerebral palsy (CP) is defined as "a group of disorders of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain [1].

The range of severity may be from total dependency and immobility to abilities of talking, independent self-care and walking, running and other skills, although with some clumsy actions [2].

Cerebral palsy is the most common motor disability of childhood, affecting approximately 3.6 per 1,000 school-age children with at least 8,000 new cases each year in the United States. The population of children with CP may be increasing due to premature infants who are surviving in greater numbers, higher incidence in normal-weight term infants, and longer survival overall. The proportion of CP that is most severe is also increasing, with as much as a third of all children with CP having both severe motor impairments and mental retardation [1]. The prevalence of CP expressed by gestational age was highest in children born before 28 weeks' gestation (111.80 per 1000 live births) [3].

Clinical diagnosis of cerebral palsy is made by an awareness of risk factors, regular developmental screening of all high risk babies and neurological examination [4]. The Gross Motor Function Classification System for cerebral palsy is based on self-initiated movement with particular emphasis on sitting (truncal control) and walking. When defining 5 levels Classification System, primary criterion was that the distinctions in motor function between levels must be clinically meaningful [5].



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. 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. These impairments may limit the performance of gross motor, fine motor with limitations of participation in daily life [6].

Although school age children with mild spastic CP can walk independently, their walking abilities are worse than their peers without disability, and may get worse with age, resulting in a loss of their ability to walk. Therefore, an effective intervention for children with mild CP to preserve or improve their motor ability at school age is very important [7].

A recent study has shown that muscle weakness showed a stronger association with mobility limitations in children with CP than spasticity. Strength training for these children is, therefore, expected to improve or maintain their mobility. To be successful, strength training must be individualized, and involve a progressive increase in intensity, thereby stimulating strength gains that are greater than those associated with normal growth and development (i.e. ‘overload’). This is known as progressive resistance exercise (PRE).To stimulate strength progression, the amount of resistance should be increased as strength increases [8].

Improvement in mobility has been primary goal in treatment of cerebral palsy. Modern concept of motor learning indicate that training is most effective when the training task is specific to the intended outcome as improvement in function involves practice task-specific activities. These concept of motor learning have shifted current rehabilitation approaches from traditional inhibition/facilitation techniques to more dynamic task oriented training. It involves practice of activities that are specific to intended outcomes as well as meaningful to the person [9].

Therapy should be challenging and meaningful to the child and involve the integration of the skills learned into functional and cognitively directed skills for carryover. Movement task should be goal oriented and interesting to maintain motivation. Children with CP are able to perform concrete perceptuomotor tasks much more readily than abstract ones, even if the same movements are involved, because more information is available from environment to direct the task [6].

There are very few studies available where in the efficacy of “task oriented training” and “functional strengthening” over routinely used to improve gross motor function hence mobility in cerebral palsy child. Hence, this comparative study is undertaken to evaluate the effect of task oriented training verses functional progressive resistance exercises strength training on gross motor function in children with cerebral palsy child.

Methodology

Study design: Comparative study

Study setting: Kempegowda Institute of Physiotherapy, V.V. Puram, Bangaluru.

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Duration of study: 12 months

Sample size: 60

Sampling technique: A stratified random sampling method

Method of data collection

The study was conducted on 60 subjects who were diagnosed with spastic diplegic cerebral palsy fulfilling inclusion and exclusion criteria. The intervention was explained to the subject and their parents in the language understood by the subject/family members. Written informed consent was taken from the parents.

Subjects included in the study were divided in to 1 of the 2 intervention groups by stratified random sampling method. Group A: task oriented training group (n=30) & Group B: functional progressive resistance exercise strength training exercise group (n=30). For both the groups treatment was given 5 times a week for 5 weeks and pre and post treatment evaluation was taken with GMFM 88 scale and Mobility questionnaire.

Intervention

Following the pre-interventions evaluation the subjects/ parents were explained about the procedures and written consent was taken.

Group A: This group consists of 30 patients were given task oriented training which includes:

1. Walking activities which include walking forward, backward, sideways and walking through an obstacle course.
2. Walking up and down stairs.
3. Stepping forward, backward, sideways onto block
4. Standing balance activities such as reaching in different directions or picking up an objects placed outside the stability limit (beyond arm length) to promote weight shifting and loading of the lower extremities including object placed on floor.
5. Standing up from chair.
6. Performing single leg stance.
7. Kicking a ball.

Group B: This Group consists of 30 patients, were given functional progressive strength training (with body vest loaded with weight). During the training, intensity was progressively increased, based on repeated estimation of the eight-repetition maximum (8RM).

Training load: The training load for the exercises was established according to the individual 8 RM test. The predicted 8 RM is based on the child's body weight, according to GMFCS specific guidelines.

GMFCS level:

I 35% of the body weight

II 30% of the body weight

III 25% of the body weight

The 8 RM test procedures was initiated after the children became familiar with the training program, and when they performed the exercises correctly.

If a child performed less than 6 or more than 10 correct repetitions, a 5 to 10% load was either reduced or added, respectively. After a 3 minute rest, the trial was repeated until the child performed 7–9 repetitions, but no more. For loading material used was weight vest with weight bags in different weights, ranging from 0.5 kg-3 kg. The load in the weight vest was equally divided between the front and the back and between the left and right side.

Training program included three functional exercises loaded with vest weight:

1. Sit to stand: Bilateral exercise

Initial starting position:	Position: sitting on chair Hands: on waist or across the chest (with assistance: in hands of trainer). Trunk: erect Hips: 90° flexion (hips and knees leveled thigh is parallel to the floor) Knees: 105° flexion (full extension is defined as 0°) Feet: parallel, as flat on the floor as possible. (Adaptations: Same as above, but decrease knee flexion to 100° - 120° hips slightly higher than knees by raising the seat of the chair.)
Chair:	Type: no armrests, no backrest Height: Adjusted to the initial starting position
Instruction:	"Stand up slowly. Stand still, then sit down again slowly. Do not use hands or support (if possible)"
Trainer:	Trainer stands beside or in front of the child. Support may be given for balance.
Strategy:	Move the trunk forward by flexion of the hips until the shoulders are above the knee joints. Stand up. Stay standing up for 1 second. Sit down. Repeat 8 times
Speed:	One stand-up per two to three seconds. One sit-down per two to three seconds.
Correct trial:	Standing up with as much symmetrical hip strategy as possible to the defined standing position, which requires the subject's trunk and lower extremities to being fully extended
Incorrect trial:	Losing balance.Standing up with an obviously asymmetrical posture during the test (i.e. head of child leans over one or both knees)Unable to maintain a standing position for two seconds after standing up swaying the trunk back and forth several times to initiate the task of standing up. Sitting down abruptly without good control.

2. Lateral step- up: (Target: Lt leg)

Initial starting position:	Position: standing at about 10cm besides or in front of the step Hands: on waist / across the chest or alongside body (with assistance: in hands of trainer) Trunk: erect Hips: neutral (as neutral as possible) Left leg: flexed in hip and knee, foot placed on step Right leg: hip and knee extended (as far as possible, full extension is defined as 0°), foot on floor, with heel contact, or as flat on the floor as possible. (Adaptations: If the child has contractures or wears a rigid orthosis, heel contact is not possible.)
Step:	Height: GMFCS I & II : 20 cm GMFCS III: 10 cm
Instructions:	"Step up slowly. Stand still, and step down again slowly. Do not use hands or support (if possible)"
Trainer:	Trainer stands in front of the child. Support may be given for balance.
Strategy:	Step up: place right foot up on the step, next to the left foot. Extend the knees as much as possible. Pause: keep standing with both feet on the step for 1second. Step down: place right foot down on the floor, leave left foot up on the step. Repeat 8 times
Speed:	One step-up per one to two seconds. One step-down per one to two seconds.
Correct trial:	Stepping up and down with good balance, without tripping and without pulling up using the arms of the trainer.
Incorrect trial:	Losing balance. Unable to maintain a standing position for one second on the step. 'Pulling' up using arms of trainer.

3. Half knee raise: (Target: Right leg)

Initial starting position:	Position: on floor (or mat) in half-kneeling position on left knee. Hands: on waist, on knee (with assistance: in hands of trainer). Trunk: erect or slightly forward. Hips: Left: may range from 20° flexion to neutral (as long as buttocks are clear of lower legs / weight bearing surface); Right: range from 70° - 110 ° flexion Knees: Left: on floor in 90° - 130° flexion (full extension is defined as 0°); Right: range from 70° - 90° flexion. Feet: Left: on floor; Right: as flat on floor as possible, preferably heel contact (Adaptations: If the child has contractures or wears a rigid orthosis, heel contact is not possible.)
Instructions:	"Stand up slowly. Stand still, and slowly kneel down again on the left knee. Do not use hands or support (if possible)"
Trainer:	Trainer stands in front of the child. Support may be given for balance.
Strategy:	Stand up: Move the trunk forward by flexion of the hips until the shoulders are above the right knee joint. Stand up while keeping weight on the leading leg. If possible: place the left foot next to the right (otherwise, do not move the foot, simply remain in lunge position) Pause: Keep standing for 1 second. Sit down: Return to half-knee position. Repeat 8 times
Speed:	One stand-up per two to three seconds. One return per two to three seconds.
Correct trial:	Standing up through half-kneeling position while keeping the weight on the leading leg to the defined standing position which requires the child's trunk and lower extremities to be fully (maximally) extended, and slowly return on half knee
Incorrect trial:	Losing balance. Standing up with an obviously asymmetrical posture during the test. Unable to maintain a standing position for two seconds after standing up swaying the trunk back and forth several times to initiate the task of standing up. Sitting down abruptly without good control.

Outcome measures
All subjects were evaluated pre and post intervention using the following outcome measures:

1. Gross motor function measure 88(GMFM-88)
The Gross Motor Function Measure (GMFM) is a clinical measure to design to evaluate change in gross motor function in children with cerebral palsy. Tool that has been developed to assess change in gross motor function in children with cerebral palsy aged 5 months to 16 years of age. The tool measures capacity (what a person can do in a standardized, controlled environment) rather than performance (what a person actually does do in his/her daily environment). The assessment typically takes 45 to 60 minutes to complete and only requires 'usual therapy equipment'. GMFM 88 consist items each scored on a 4-point ordinal scale of 0 to 3, where 0 indicates that the child does not initiate the task; 1 indicates that the child initiates the task (completes < 10% of the activity); 2 indicates that the child partially completes the task (completes from 10 to 99% of the activity); 3 indicates that the child completes the task (100%). The 88 items are grouped into five dimensions: 1) lying and rolling, 2) sitting, 3) crawling and kneeling, 4) standing, and 5) walking, running and jumping. A maximum of three trials is allowed for each item and the best trial is recorded. In this study to assess GMFM 88, dimension D, (i.e.) standing, dimension E (i.e.) walking, running, and jumping is selected as goal areas [6].

2. Mobility Questionnaire (MobQues)
The MobQues was designed to measure mobility limitations in children with CP, as rated by their parents. The instrument directly addresses the degree of difficulty these children experience in executing mobility activities. The instrument tested in the present study addresses 47 mobility activities experienced in everyday life, such as 'get up from a chair', 'go down stairs', and 'run on asphalt'. The parents of children with CP are asked to indicate how difficult it is for their child to perform these mobility activities in the usual way (with the use of assistive devices if needed) without the help of others. There are nine response options, ranging from 'impossible without help' to 'not difficult at all, which is scored as: impossible without help (score 0); extremely difficult, very difficult, and difficult (score 1); moderately difficult and somewhat difficult (score 2); slightly difficult and very little difficulty (score 3) and not difficult at all (Score 4) [7].

Results
Data was analyzed using the statistical package SPSS19.0 (SPSS Inc., Chicago, IL) and level of significance was set at $p<0.05$.

1. Descriptive statistics was performed to find out the mean and standard deviation of the respective groups.
2. To assess the effectiveness of Task oriented training in children with spastic diplegics paired t test was used.
3. To assess the effectiveness of functional progressive strength training in children with spastic diplegics paired t test was used. To compare the effect of Task oriented training with functional progressive resistance exercise strength training t test was used.

Table 1: Age comparison of the study participants

	Mean	SD
Group A	10.1	1.46
Group B	10.3	1.39

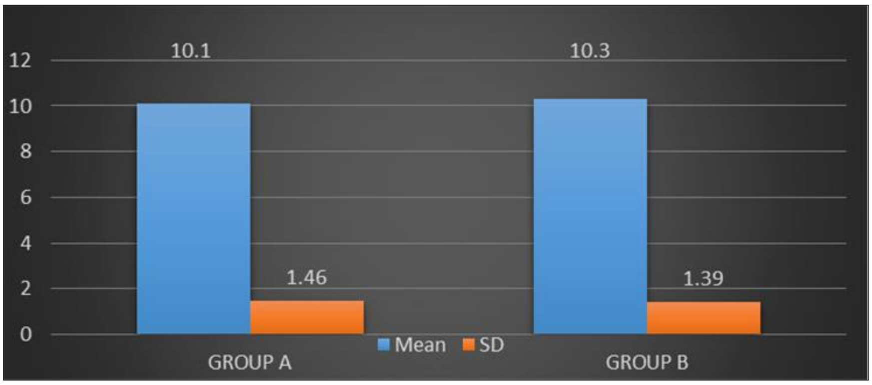

Fig 1: Age of the participants

Table 1 and figure 1 shows the mean value of age with standard deviation in each group. The higher mean age was observed in Group B (10.3) compared to Group A (10.1).

Table 2: Gender comparison of the study participants

	Male		Female	
	Number	**Percentage**	**Number**	**Percentage**
Group A	19	64	11	36
Group B	17	57	13	43

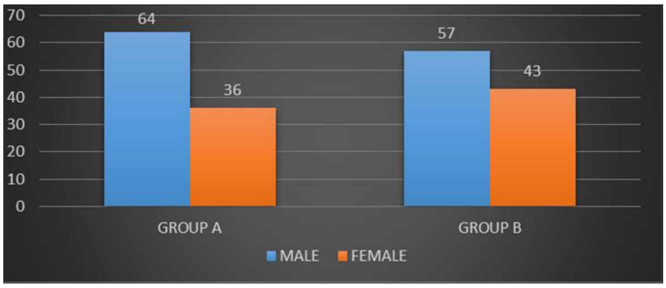

Fig 2: Gender comparison of the participants

Table 2 and figure 2 shows percentage distribution of males and females. In group A consist of 19 male (64%) and 11 female (36 %) and in group B consist of 17 male (57%) and 13 female (43%).

Table 3: GMFCS Level

	I	II	III
Group A	7(24%)	12(40%)	11(36%)
Group B	9(30%)	11(36%)	10(34%)
P value	0.93		

$p>0.05$

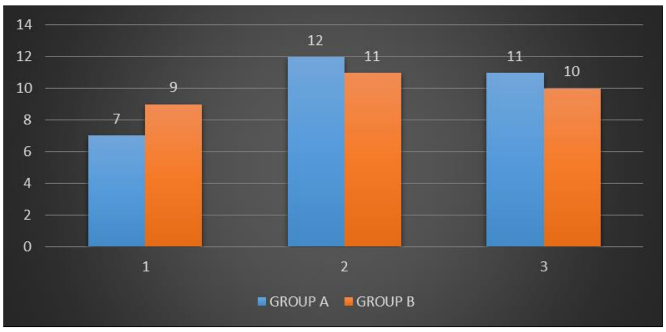

Fig 3: GMFCS Level

Table 3 and figure 3 shows percentage distribution of GMFCS Level. In group A 7 subjects (24%) are in GMFCS I, 12 subjects (40%) are in GMFCS II level, 11 subjects (36%) are in GMFCS III level. In group B 9 subjects (30%) are in GMFCS I level, 11 subjects (36%) are in GMFCS II level, 10 subjects (34%) are in GMFCS III level.

Table 4: Comparison of GMFM (D Standing) scale between the group

		Group A		Group B		P value
		Mean	**SD**	**Mean**	**SD**	
	Pre	53.75	5.72	54.7	5.13	0.50
	Post	65.72	6.22	63.51	5.61	0.15
	Diff	11.96	2.61	8.81	2.72	0.0001*
P value (within group)		0.0001*		0.0001*		
% reduction		22.3%		16.1%		

<0.05 is statistically significant (unpaired t test)

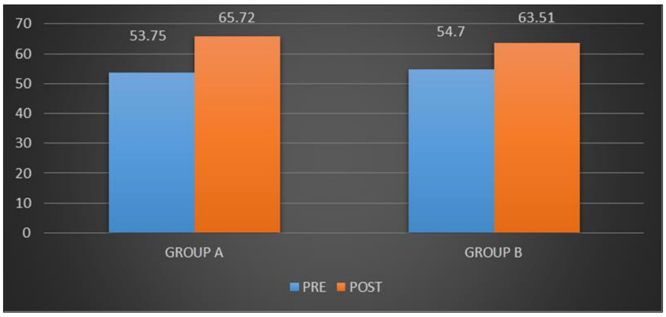

Fig 4: Comparison of GMFM (D Standing) scale between the group

The result showed that there is a significant difference present regarding GMFM (D-standing) between the A group (task oriented training) and Group B (functional progressive resistance exercise strength training) on gross motor function in spastic diplegics $p<0.05$.

Hence we reject the null hypothesis and accept the alternate hypothesis that task oriented training did better than functional progressive resistance exercise strength training on gross motor function in spastic diplegics. (22.3% vs 16.1%). Within group analysis showed the two methods have significantly improved on gross motor function in spastic diplegics ($p<0.05$).

Table 5: Comparison of GMFM (E Walking) scale between the group

		Group A		Group B		P-Value
		Mean	**SD**	**Mean**	**SD**	
	Pre	33.86	3.24	33.7	3.26	0.84
	Post	40.62	3.48	38.48	3.57	0.02*
	Diff	6.75	1.56	4.78	0.90	0.0001*
P value (within group)		0.0001*		0.0001*		
% reduction		19.9%		14.1%		

<0.05 is statistically significant (unpaired t test)

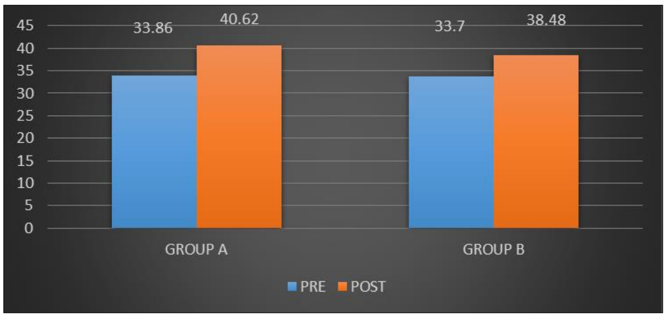

Fig 5: Comparison of GMFM (E Walking) scale between the group

The result showed that there is a significant difference present regarding GMFM (E-walking) method between the group A (task oriented training) and group B (functional progressive resistance exercise strength training) on gross motor function in spastic diplegics. $p<0.05$

Hence we reject the null hypothesis and accept the alternate hypothesis that task oriented training did better than functional progressive resistance exercise strength training on gross motor function in spastic diplegics. (19.9% vs 14.1%). Within group analysis showed the two methods have significantly improved on gross motor function in spastic diplegics ($p<0.05$)

Table 6: Comparison of Mobility questionnaire between the group

		Group A		Group B		P value
		Mean	SD	Mean	SD	
	Pre	44.14	5.92	43.96	5.17	0.90
	Post	56.75	8.02	50.35	5.12	0.0005*
	Diff	12.33	2.89	6.38	0.82	0.0001*
P value (within group)		0.0001*		0.0001*		
% reduction		27.9%		14.5%		

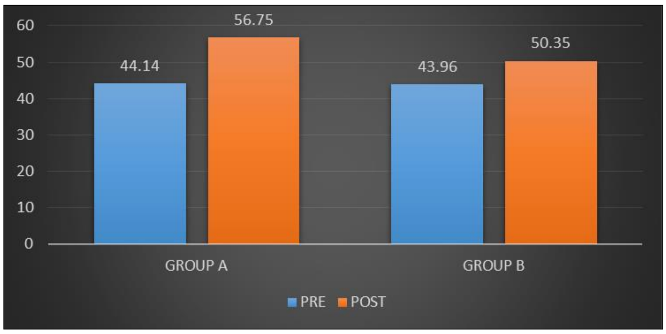

Fig 6: Comparison of Mobility questionnaire between the group

The result showed that there is a significant difference present regarding Mobility questionnaire between the group A (task oriented training) and Group B(functional progressive resistance exercise strength training) on gross motor function in spastic diplegics $p<0.05$.

Task oriented training did better than functional progressive resistance exercise strength training on gross motor function in spastic diplegics (27.9% vs 14.5%). Within group analysis showed the two methods have significantly improved on gross motor function in spastic diplegics ($p<0.05$).

Discussion

This study was conducted to compare the effect of task oriented training versus functional progressive resistance exercise strength training on gross motor functions in spastic diplegics. In this interventional study, 60 subjects with spastic diplegic cerebral palsy who fulfilled the inclusion criteria were selected, with age ranging from 8 to 13 years of both genders.

The results of this study support the efficacy of task oriented training as compared to functional progressive resistance exercise strength training for improving gross motor function. The study findings indicate that task oriented training significantly improved standing and walking performance as measured by GMFM and mobility according to Mobility questionnaire.

Our findings are in agreement with those of Ahl *et al*. (2005) [11] examined the effects of a 5-month functional training program in fourteen children with cerebral palsy which included practice of functional activities used in everyday activities and results showed that functional training significantly improved GMFM scores and ability to perform daily activities. A decrease in caregiver assistance was also noted in mobility tasks following the training program.

Morton JF (2003) study on strength training of lower limb on children with cerebral palsy showed that there is decrease in muscle tone, improvement in standing (D) and walking, running, and jumping (E) goal areas of the gross motor function measure and walking speed and step rate has been increased.

When compared to Task oriented training which is given to group-A, group B trained with Functional progressive resistance exercise strength training showed lesser change in GMFM component D and E, and also on mobility according to Mobility questionnaire. So, despite the current popularity of strength training, the evidence from current protocol given to group B with functional progressive resistance exercise strength training is less effective than task oriented training to improve mobility in children with spastic diplegic. Possible explanation for lesser mobility improvement in Group B might be though there is improvement in strength of targeted lower limb it was too small to improve mobility and also could be the number of individual muscles gaining strength was too limited. The measure for muscle strength was not included in this study.

Vanessa a Scholtes *et al*. (2010) [8] in their study stated that daily activities require only a certain amount (e.g. lowest threshold) of muscle strength. Increase in above these lowest threshold values may be accompanied by increase in mobility, but there might also be a point (e.g. highest threshold) at which further strength increases provide no additional advantage in mobility improvement. In that case, strength training would not be the appropriate choice of treatment when the aim is to improve mobility.

Here, other components, such as balance and coordination, might influence mobility improvement to a greater degree than muscle strength alone. In addition, the lack of effectiveness on mobility improvement found in group B might also be explained by the lack of variation in task contexts and individually tailored exercises.

Even though group B training contained functional exercises that resembled mobility activities of daily living (e.g. rising from a chair), the actual context of these exercises (i.e. chair height) remained unchanged throughout the training period. This is supported by the study conducted by Papavasiliou AS *et al*. (2009) [13] which concluded that selection of individually tailored mobility exercises with a more goal-oriented approach might improve the effectiveness of strength training on mobility outcomes. The lack of effectiveness on mobility improvement might also be explained by the non-individual specificity of the exercises.

Salem Y *et al*. (2009) [14] states that optimal training needs to be task-specific and also one of the major challenges in the management of children with cerebral palsy is enhancing motivation to practice throughout the day. The motivation to participate in activities is closely linked to improvement in acquisition of motor abilities. The task-oriented activities used in this study were similar to those the participants used in everyday tasks and play; these activities may have been beneficial in motivating the children and optimizing practice and repetition throughout the day.

In this study conducted, task-specific training was a key feature of the intervention in the task-oriented group. The intervention activities used in the task-oriented group were designed to mimic how the lower limb muscles are used in everyday activities taking into consideration normal biomechanics, strength, balance, and lower limb function. The intervention activities included repetitive practice of functional activities used in everyday activities. The training parameters used in this study have similar characteristics of those found normally in many functional activities with respect to strength, balance, and coordination. The training parameters also ensured that the muscle targeted, the force generated, the lower limb support, and the balance and propulsion required were directly related to the functions being trained. Such training may refine movement and result in more efficient motor patterns required for functional performance. Evidence supports that task-specific training that focused on practice of task-specific motor activities, in comparison to traditional approaches, resulted in significant and long-lasting cortical reorganization specific to the corresponding areas being used during practice. The improvements in mobility function may be related to the specificity of training used in this study.

Conclusion

The study of 5 weeks of intervention with exercise programme was conducted on 60 subjects of spastic diplegics to assess and compare the effectiveness of task oriented training and functional progressive resistance exercise strength training on gross motor function on in 2 groups of 30 subjects each. Subjects of both the groups showed statistically significant improvement in their gross motor function but subjects of group A with task oriented training has clearly showed a better improvement in GMFM 88 (component D, E) and Mobility Questionnaire against Functional progressive resistance exercise strength training of Group B subjects with the $p \leq 0.05$ Concluding that results of the study has shown that though both groups showed statistically significant improvement, Task oriented training in spastic diplegics has given a better improvement in functional activities and mobility than with subjects given Functional progressive resisted exercise strength training. This suggesting that focusing on task specific training programs gives a better functional performance and mobility than the traditional resistance exercise programme in spastic diplegics.

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