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Original Research Paper

Occupational Therapy

EFFECT OF TASK RELATED CIRCUIT TRAINING ON WALKING SPEED AND ENDURANCE OF CHILDREN WITH SPASTIC HEMIPLEGIC CEREBRAL PALSY.

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ABSTRACT **Design:** Pre-test/post-test experimental design **Setting:** Inpatient and outpatient of Department of Occupational Therapy, NILD, Kolkata **Participants:** Total 30 children with spastic hemiplegic cerebral palsy were randomly allocated into two groups i.e. control group (n=15) and experimental group (n=15). **Interventions:** Task-related circuit training in group along with conventional occupational therapy was provided to experimental group and only conventional occupational therapy was provided to control group. **Outcome Measures:** 6 minute walk test (6MTW) and 10 meter walk test (10MTW) **Result:** The experimental group demonstrated significant improvement compared with the control group in walking speed and endurance (p = 0.00). **Conclusion:** The result of the study provides evidence, that task related circuit training can be used to improve the walking speed and endurance in children with hemiplegic cerebral palsy than Conventional Occupational Therapy.

KEYWORDS : Spastic Cerebral Palsy, Hemiplegic Cerebral Palsy, Walking Speed, Endurance, Circuit Training

INTRODUCTION

Cerebral palsy (CP) is a non-progressing chronic neurological condition that affects movement and muscle control, often resulting in spasticity and weakness and loss of selective motor control. It touches the lives of 2.11 in every 1000 newborns worldwide [1,2]. Treatment focuses on task-oriented training, which helps children improve their daily functions through consistent activities and environmental adaptations. Unlike traditional rehabilitation, which can be unengaging, task-oriented training involves the child actively and rewards progress[3,4].

Circuit training is an efficient and cost-effective way to strengthen muscles and enhance endurance. It rotates different exercises to give muscles time to rest, benefiting conditions like MS and stroke [5,6]. Studies highlight significant improvements with intensive practice, better therapist time management, and group support. Such training builds strength, endurance, and cardiovascular health [5,2]. It combines low-resistance, high-repetition exercises aimed at improving muscular endurance with exercises that increase flexibility and cardiovascular fitness.

Task-oriented circuit class training demonstrates three fundamental attributes crucial for effective physical rehabilitation. Firstly, it employs multiple workstations to facilitate meaningful and progressive exercises tailored to individual patient needs. This method not only engages patients in active practice but also optimizes therapist time and reduces staff-to-patient ratios. Secondly, the incorporation of group dynamics, including peer support and social interaction, significantly improves class attendance and exercise adherence. This environment fosters psychosocial benefits such as increased confidence and enhanced mood. Thirdly, the training comprises challenging and progressively adapted tasks that necessitate active participation, thus promoting the development of motor skills and the formulation of solutions to motor function challenges[3,4].

In the literature, studies have been conducted to investigate the effect of task-related circuit training on stroke, spastic diplegic cerebral palsy, and other conditions [3,4,5]. There are very few studies conducted to find out the effect of task-related circuit training on hemiplegic cerebral palsy. Thus, this study is aimed at investigating the effect of task-related circuit training in children with hemiplegic cerebral palsy.

METHOD

This study was a randomized pre test and post test control group design. Based on the inclusion criteria, 30 medically diagnosed subjects with spastic hemiplegic cerebral palsy were selected for the study from outpatient Occupational Therapy Department and indoor rehabilitation ward of National Institute for Locomotor disabilities (Divyangjan) and subjects were excluded based on the presence of other pathologies as found from the medical report and exclusion criteria. Informed consent was obtained from all the patients before inclusion in the study. Inclusion criteria were as follows; Age of children – 6-12 yrs, Gender- both, Gross motor functional classification levels-I to II, Children diagnosed with hemiplegic cerebral palsy according to topographical distribution. Exclusion criteria were: Cognitively impaired children, Children who are non-ambulatory. History of newly developed neurological problems, musculoskeletal disorders, or botulinum toxin injections in the past six months. Severe adductor spasticity (more than 2 according to Modified Ashworth Scale). Diplegic CP. Visual, Orthopedic or medical condition that would prevent them from carrying out the intervention. As per baseline assessment the subjects were randomly allocated into 2 groups of 15 each both in experimental group and control group. The experimental group participated in the task related circuit training program for a session of 45 minutes in the department. The control group received conventional occupational therapy in the department. Both the groups received therapy for 3 days/week for 12 weeks. 6 minute walk test and 10 meter walk test were used as outcome measures.

Procedure

Prior to participation in the study, informed consent was obtained from all children's parent or guardian. Based on the inclusion criteria, 30 medically diagnosed subjects with spastic hemiplegic cerebral palsy were selected for the study and subjects were excluded based on the presence of other pathologies as found from the medical report and exclusion criteria. After taking the informed consent, a general evaluation for spastic hemiplegic cerebral palsy was done including demographic data, history and functional outcome of subjects with hemiplegic cerebral palsy. Baseline evaluation was done using the outcome measures 6 minute

walk test and 10 meter walk test. As per baseline assessment the subjects were allocated into 2 groups of 15 each both in experimental group and control group, randomly using simple random method for the study. The experimental group participated in the task related circuit training program for a session of 45 minutes in the department.

Table 1: Treatment Protocol for Experimental Group

No. of task	Name of task	Duration of task in minutes
1	Sit to stand from appropriate seat height	5
2	Stepping up and down	5
3	Stair climbing	5
4	Heel raise and lower	5
5	Over ground forward walking	5
6	Walking side ways	5
7	Walking backward	5

The control group received conventional occupational therapy in the department. Both the groups received therapy for 3 days/week for 12 weeks. Post intervention both the groups were evaluated for all the outcome measures.

RESULTS

SPSS version-26 was used for statistical analysis. Sample t - test was used to determine to find out whether there was significant difference between the pre scores and post scores of outcomes measure within the two groups. Level of significance was set at p p<0.05 with 95% confidence interval. Data were presented as arithmetic means +/- standard deviation(X+/-SD).

Table 2. Shows the Distribution of Children with Spastic Hemiplegic Cerebral Palsy in Both Experimental and Control Group.

SL. NO	BASELINE CHARACTERISTICS	EXPERMENTAL GROUP	CONTROL GROUP
1.	No. Of children	15	15
2.	Age range	6-12	6-12
3.	Mean age (SD)	7.86(1.64)	8.26(2.34)
4.	Sex (male/female)	9:6	8:7
5.	Side (right/left)	9:6	8:7
5.	Mean 10MWT (SD)	0.23 (0.10)	0.25(0.05)
6.	Mean 6MWT (SD)	78.06 (9.51)	74.26 (5.72)

The 10MWT shows significant improvement in walking speed in children with spastic hemiplegic cerebral palsy in experimental group (p = 0.000) upon within group analysis by Independent t test. One pre test and one post test were done using the 10MWT. The table shows significant increase in walking speed in post test (0.93±0.04) in experimental group. The control group shows insignificant increase in walking speed in post test (0.29±0.06) (p = 0.03). This shows that increase in walking speed was more in experimental group than in control group.

Table 3. Within Group Analysis of Experimental and Control Group –(10MWT)

Outcome measures	Group	PRE (mean±SD)	POST (mean±SD)	t	P
10MWT	experimental	0.23±0.10	0.93±0.04	-20.43	.00
	control	0.25±0.05	0.29±0.06	-2.40	.03

The 6MWT shows significant improvement in walking endurance in children with spastic hemiplegic cerebral palsy in experimental group (p = 0.000) upon within group analysis by Independent t test. One pre test and one post test were done using the 6MWT. The table shows significant increase in walking endurance in post test (103.06±17.80) in experimental group. The control group shows insignificant increase walking endurance in post test (76.86±9.11) (p = 0.095). This shows that increase in walking endurance was more in experimental group than in control group.

Table 4. Within Group Analysis of Experimental and Control Group –(6MWT)

Outcome measures	Group	PRE (mean±SD)	POST (mean±SD)	t	p
6MWT	experimental	78.06±9.51	103.06±17.80	-5.62	.00
	control	74.26±5.72	76.86±9.11	-1.78	.09

The 10MWT shows significant difference between the experimental (0.93±0.04) and the control group (0.29±0.06) in the post test 10MWT (p = 0.00), which shows that walking speed in experimental group is improved more than the control group which was treated with conventional occupational therapy. The 6MWT shows significant difference between the experimental (103.06±17.80) and the control group (76.86±9.11) in the post test 6MWT (p = 0.00) which shows that walking endurance in experimental group is improved more than the control group which was treated with conventional occupational therapy.

Table 5. Between the Group Analysis of 10MWT

Experimental (mean±SD)	Control (mean±SD)	T	P
0.93±0.04	0.29±0.06	30.05	.00

Table 6. Between the Group Analysis of 6MWT

Experimental (mean±SD)	Control (mean±SD)	T	P
103.06±17.80	76.86±9.11	5.07	.00

DISCUSSION

There is a growing body of evidence that supports task-oriented circuit training as beneficial for children with hemiplegic cerebral palsy[1,2,3]. The purpose of this study was to see the effect of task – related circuit training on walking speed and endurance of children with spastic hemiplegic cerebral palsy, based on the evidence, that resistance training improves walking ability of hemiplegic cerebral palsy patient and added purpose to exercise or tasks, designed to improve strength can have a positive effect on walking ability in hemiplegic cerebral palsy. The result supports the efficacy of task-related circuit training for this study. In this study, the task related practice (with at least body weight or weight of a limb as resistance), as in repeated standing up and sitting down, helped in increasing muscle strength of lower extremity (increased force generating capacity). Increased muscle strength occurs due to improved firing and synchronization of motor units and improved agonist antagonist and synergic coordination. Task related exercises have therefore the potential to increase the control of movement and functional performance of the everyday actions which are the focus of the exercise [Carr JH, Shepherd RB, 1988]. The sit to stand task helped in improving muscle strength of Hip and knee extensors, Ankle Dorsiflexors and repeated sitting to standing helped in improving the length of the Soleus muscle [J.H. Carr and R.B. Shepherd,2002]. During ascent (stair climbing task) stance phase, weight acceptance is initiated with middle to front portion of foot, pull up occurs through the extensor activity at the knee, ankle, primarily concentric contraction of vastus lateralis and soleus and in forward continuance phase ankle generates forward and lift forces. In swing phase, foot clearance is activated through activation of dorsiflexors and activation of hamstrings which flex the knee. The Rectus femoris contracts eccentrically to reverse the motion by mid swing. The swing leg is brought up and forward through activation of hip flexors of the swing leg and motion of the contra lateral stance leg. Final foot placement is controlled by hip extensor and ankle dorsiflexor. Decent (walking down stairs) is achieved through eccentric contraction of Knee extensors and planter flexors [J.H. Carr and R.B. Shepherd,2002]. Step up and step down task trains hip, knee and ankle extensors to work together both concentrically and eccentrically, to raise and lower the body mass. Step up exercises also train ankle dorsiflexors. Heel raise and lower task helped in improving the planter flexor strength which is the major power generator during the gait cycle during push off [1,6]. The hip abductors improved in

power due to side wise walking task and walking backward task strengthens hip extensor activity particularly hamstrings [Damayanti Sethy et al, 2018, Richards CL, 2004]. The walking speed and endurance are increased in the children with hemiplegic cerebral palsy measured by 6MWT and 10 MWT following task- related circuit training, which indicates that task-related circuit training may be beneficial in increasing walking speed and endurance in the children with hemiplegic cerebral palsy functional reserve, thus making daily activities less fatiguing. The results are supported by the study done by White et al. [L.J. White et al, 2004]. This overall improvement in muscle strength, endurance and reduced fatigue helped in improving gait velocity and the ability to walk after task related circuit training, which is supported by the study of Dean et al. [7] with stroke patients. The increase in speed may be due to increase in strength of ankle planter flexor, hip extensor and flexors. Planter flexor and hip flexors is the major power generator for push up and pull-up during propulsion [7, 9]. There is increasing evidence that the effects produced by strengthening programs may generalize to higher gait speeds, increased gait endurance and improved Activities of daily living [7]. Added purpose of task related circuit training can enhance performance compared to rote exercise [8]. In addition it found in other studies by Richards et al., and Dean et al. that training programs in which patients are subjected to high repetitions of functional activities are more likely to improve in function than conventional strengthening of lower limb [9]. The hypothesis of this study is that task – related circuit training is effective in improving walking speed and endurance of children with spastic hemiplegic cerebral palsy as compared to conventional occupational therapy. The hypothesis has been proved, as the results show significant difference in the walking speed as measured by 10MWT ($p = 0.00$) and walking endurance as measured by 6MWT ($p = 0.00$). The study findings indicate that task-related circuit training significantly improved walking speed as measured by 10MWT and walking endurance as measured by 6MWT. Circuit training is distinct from the concept of group therapy, which is defined as therapy involving more than two patients, undertaking the same tasks at the same time under the direction of therapist with little or no individual tailoring or progression of activities. Circuit training comprises a set of core activities, individually adapted, task specific and graded in time. Its physiological approach is based on integrated functional exercises targeting specific impairments in strength, balance, endurance. A therapist provides supervision and verbal feedback during circuit training; however, the majority of feedback is provided by setting up each task such that it provides a concrete goal and intrinsic feedback regarding its correct completion [10]. The mechanisms behind the circuit training eliciting similar degrees of improvement in lower-extremity motor control, balance, walking competency and basic ADL are uncertain, but there is evidence of a dose-response relation in the amount of early physical therapy after stroke and recovery of function. Several studies have proposed that although circuit training provides less opportunity for direct supervision and assistance, the total time spent in circuit training program is greater than in individual physical therapy, and that circuit training is highly effective at increasing the amount of time spent by subjects in active rehabilitation practice [10]. The result of the present study are in agreement with the finding Blundell et al (2003) who suggest that the task specific exercise program focused on lower limb strength, and functional performance, in the form of group circuit training resulted in improved functional performance that was maintained over time in children with hemiplegic cerebral palsy.

CONCLUSIONS

The result of the study provides evidence, that task related circuit training can be used to improve the walking speed and endurance in children with hemiplegic cerebral palsy than Conventional Occupational Therapy. Use of tasks helped improving muscle strength of lower limb and endurance thereby improving the walking speed and endurance. Thus, the study concludes that task related circuit training is more effective than Conventional Occupational Therapy.

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