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Original Article

Effects of Neurodevelopmental Therapy on Gross Motor Function and Postural Control in Children with Spastic Cerebral Palsy: A Randomized Controlled Trial

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ABSTRACT

Cerebral palsy (CP) is one of the most prevalent childhood-onset causes of permanent disability affecting gross motor functioning and postural control ability. **Objective:** To determine the effects of neurodevelopmental treatment on the gross motor function postural control among children with spastic CP. **Methods:** A single-blinded randomized controlled trial was carried out at Sher e Rabbani Hospital, Department of Pediatric Rehabilitation, Sheikhupura. 66 children fulfilling the inclusion criteria were recruited using the non-probability sampling technique. Participants were divided into two groups, Group A which received beurodevelopmental techniques along with routine physical therapy while Group B received only routine physical therapy treatment. To collect data, Gross motor function measure scale (GMFM-88) and posture and postural ability scale (PPAS) were employed as outcome measures. **Results:** Repeated measure *ANOVA* and an *independent t-test* were executed for parametric data after assuming normality. Pairwise comparison of both groups demonstrated that gross motor function was significantly improved from baseline to 4th, 8th, and 12th week after applying NDT treatment *(p-value≤ 0.05)*. Pairwise comparison of both groups revealed that postural ability post NDT treatment and significant improvement was observed after 12 weeks in comparison to baseline. While within-group comparison at different follows up for gross motor function measure and postural control also expressed *p≤ 0.05* as significant. **Conclusions:** Children with spastic CP who received Neurodevelopmental Therapy along with conventional physical therapy treatment showed significant improvements in gross motor function and postural control as compared to the control group..

INTRODUCTION

One of the most prevalent childhood-onset causes of the physical disability that is permanent and found in one child out of 500 newborns and impacting 17 million individuals globally is cerebral palsy (CP) [1,2]. As a neurodevelopmental disorder, CP is characterized by abnormalities in the development of the muscles, the capacity to walk and move, and the ability to do other motor tasks. Even though indicative signs and symptoms may be present at a younger age, the clinical aspects of this entity change and the particular CP syndrome may not be recognized until 3–5 years of age [3,4]. With a global prevalence of 2.1/1000 live births, Spastic CP is a frequent physical impairment among children [5,6]. A basic concern is whether these children would benefit from being diagnosed earlier and getting early specialized interventions [6,7]. The neurodevelopmental treatment technique is an intensive therapy method used by trained occupational therapists to help children with Spastic CP regain their independence [8]. Using and regulating the central nervous system's neural-based motor responses is the goal of the NDT method. The NDT method is still evolving, and it is currently referred to as an approach rather than a method. It outlines the principles of delivering a normal mobility experience to CP children in order to reduce motor-sensory disruptions and increase

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functional independence through tasks. It also emphasizes the child's own growth and cognitive qualities, among other key milestones [9,10]. The primary objective of the neurodevelopmental therapy method (NDT-Bobath) for children with CP is to give them as much independence as possible. The prevention of aberrant motor functions and the enhancement of normal motor synergy during functional activities of daily living are secondary goals of NDT. NDT has been shown to benefit children with CP in a variety of studies [11,12]. Neurodevelopmental therapy was provided to a first group (n=15) with a mean age of 4.9 years and a second group (n=13) with a mean age of 4.4 years in a quasi-experimental design carried out by Labaf and colleagues in 2015. All individuals were assessed using the GMF Measure. It took three months of weekly one-hour sessions to complete the course of treatment. We found substantial differences between baseline and post-treatment values in at least two of the groups [9]. Children with spastic diplegic CP had their trunk control, gross motor function, and balance tested in a recent research by Sah et al., based on neurodevelopmental therapy (TOA-NDT) principles. (SDCP). In the TOA-NDT group, all of the above outcomes were improved [13]. Tekin et al., published a study in 2018 which evaluated the effects of an 8-week postural and balance training session based on Neurodevelopmental Treatment principles over postural control and balance. All subjects demonstrated statistically significant gains in gross motor function after the treatment session (p-value≤ 0.05). Balance and independence in doing everyday tasks improved statistically significant for the subjects (p-value≤ 0.05) [14]. It is the purpose of NDT to promote normal patterns and inhibit aberrant patterns in motor disturbances caused by injury to the central nervous system in order to improve posture and motions performed with abnormal muscle tone [15-17]. It was the goal of this research to examine the effects of Neurodevelopment Therapy on gross motor function and postural control in children with spastic CP. Whereas NDT is a 'problem-solving hands-on approach used to manage and treat children having functional limitations, mobility issues or postural control problems as a result of damage to their central nervous system [18]. GMF is defined as the skills that prerequisite whole-body movement involving body's major muscles to conduct daily tasks like standing, walking, sprinting, and jumping. However, postural control is the ability to maintain, acquire, or restore a state of equilibrium during any position or activity [19].

METHODS

This Randomized Controlled Trial (RCT) was conducted at Sher e Rabbani Hospital's pediatric Rehabilitation Department in Sheikhupura, Pakistan after obtaining the consent of participants. The trial was started on June 17, 2021, and was completed on December 15, 2021. After considering a 20% dropout rate, a total sample size of 33 was estimated for each group using GMF as an outcome measure. The sample size was identified using the WHO sample size calculator (Figure 1).

Sample Size for Comparoing Two Means Input Data			
Confidence Interval (2-sided)		95%	
Power		80%	
Ratio of sample size (Group 2/Group 1)		1	
	Group 1	**Group Difference***	
Mean	90.1	86.3	3.8
Standrad devision	6.62	3.93	
Variance	43.8244	15.4449	
Sample size of Group 1	33		
Sample size of Group 2	33		
Total sample size	66		

Figure 1: Sample Size Power Analysis

A purposive Convenient Sampling Technique was used. Participants aged 2–6 years, both female and male children who were diagnosed with Spastic CP (Spasticity level I) having no other severe abnormalities like seizures were included. Those who received botulinum toxin injections, orthopedic correction surgery, or were mentally retarded, or had a learning handicap were all ruled out of the research. Participants without these conditions were allowed to participate.

Outcome Measures:

GMFM-88: In the GMFM, there are five categories: laying and rolling, sitting, crawling and kneeling, standing, and running. A four-point score scale is used for each category. Reliability, interrater, intra-rater, and internal reliability of the GMFM-88 have all been shown to be high (all >0.99) in independent studies. The correctness of both the material and the framework is also praised as being great.

PPAS: Assessment of postural competency in four different postures is assessed using this seven-point ordinal scale. There are six things in the sagittal and frontal planes that may be used to evaluate the quality of one's posture. There was a significant difference in construct validity and median scores *(p-value≤ 0.05)* between GMFCS levels. A high level of internal consistency (alpha = 0.95-0.96; item-total correlation = 0.55-0.91) and great inter-rater reliability (kappa score = 0.77-0.99) were found in the study [20].

Blinding: The study was single-blinded. The assessor was unaware of the treatment given to both groups.

Randomization: Subjects were randomized into two groups using the lottery method.

Interventions: Group A: Three months of

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neurodevelopment therapy were given to the treatment group (3sessions per week). In addition to passive stretching of the hamstring and gastro-soleus muscles, NDT therapy includes efforts to alleviate spasticity and promote near-normal movement patterns while focusing on motor skills. During each session, the physical therapist supported the patients in different postures, including sitting, crawling, semi-kneeling, and standing, until tone reduction was achieved. Balance and reflex correction were encouraged with the use of a CP ball and tilt board. Group B: For the control group, physical therapists prescribed stretching, passive range-of-motion exercises, and active range-of-motion activities.

Procedure and Follow-up: The participants were assessed on the baseline for comparable variables and then randomly assigned to two groups. Assessment tools used for the purpose were Gross Motor Function Measure-88 and Posture & Postural ability Scale. Data was collected at baseline, 4th week, 8th week, and 12th week. SPSS Version 24(SPSS Inc., Chicago, USA) was used for executing data analysis. The mean and standard deviation (SD) were used to represent numerical data, such as age. There was a frequency distribution for categorical data like gender group (Percentage). Shapiro Wilk and Kolmogorov Smirnov tests were used to check the normality of the data variables at baseline. Gross Motor Function Measure and Posture & Posture Ability Scale mean differences between groups were determined using an independent sample t-test at baseline weeks 4th, 8th, and 12th. Repeated measure *ANOVA* was applied to compare Gross Motor Function Measure (GMFM-88) and the Posture & Posture Ability Scale (PPAS) at three different time points: baseline week 4, week 8, and week 12(Considering *(p-value≤ 0.05)* as significant).

Ethical Concerns: In accordance with IRB-UOL-FAHS/882/2021, the University of Lahore's ethical review board gave its permission. The study was conducted in accordance with the ethical guidelines established by the ethical review board of the The University of Lahore, and all participants' rights were upheld. All participants were required to provide their express written permission, which was included in the consent form. There was no disclosure of any information or data gathered. The trial was registered at *clinicaltrials.gov* as well under ID: NCT05231538.

RESULTS

For both groups (Treatment and Control), the age of patients is shown in Table:1. The treatment group had a mean age of 3.96 years, whereas the control group's average age was 3.84 years, ranging from 2 to 6 years old.

Age of patients (Years)		
Treatment Group	Mean	3.96
	Std. Deviation	0.79
	Minimum	2.0
	Maximum	6.0
Control Group	Mean	3.84
	Std. Deviation	0.90
	Minimum	2.0
	Maximum	6.0
Gender		
Female	N	36
	%age	54.55
Male	N	30
	%age	45.55

Table 1: Demographics of Patients

Table 2 shows that Shapiro Wilk and Kolmogorov-Smirnov tests were conducted to check the normal distribution of data at baseline in both groups. The values of coefficient of alpha for all variables at baseline showed (p-value≤ 0.05).

Variables (Baseline)	Study group	Kolmogorov-Smirnov test		Shapiro-Wilk	
		Statistics	p-value	Statistics	p-value
Score of gross motor measure	NDT	0.089	0.200	0.964	0.336
	Routine therapy	0.100	0.200	0.980	0.782
Total score of posture and postural ability measure	NDT	0.089	0.200	0.964	0.336
	Routine therapy	0.100	0.200	0.980	0.782

Table 2: Normality Test

Repeated measure ANOVA was applied to observe pairwise comparison as demonstrated in Tables 3 and 4. p ≤ 0.05 was considered significant.

(I) GMFM	(J) GMFM	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
1	2	.606*	.106	.000	.286	.926
	3	.545*	.138	.004	.1291	.9622
	4	1.667*	.155	.000	.200	.134
2	1	-.606*	.106	.000	-.926	-.286
	3	-.0611	.144	.000	-.495	.3731
	4	.061*	.130	.000	.668	.453
3	1	-.545*	.138	.004	-.962	-.129
	2	.0611	.144	.000	-.373	.4951
	4	.121*	.155	.000	.653	.590
4	1	-1.667*	.155	.000	-2.134	-1.200
	2	-1.061*	.130	.000	-1.453	-.668
	3	-1.121*	.155	.000	-1.590	-.653

Table 3: Pairwise Comparison of Gross Motor Function in Treatment Group

Pairwise comparison of both groups demonstrated that the GMF Measure score and postural ability score were improved after NDT treatment after 4 weeks and much

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improvement was observed after 12 weeks as compared to baseline.

(I) GMFM	(J) GMFM	Mean Difference (I-J)	SE	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
1	2	-1.636*	.361	.000	-2.652	-.621
	3	-3.333*	.6861	.000	-5.263	-1.403
	4	-5.424*	.064	.000	-8.417	-2.431
2	1	1.636*	.361	.000	.621	2.652
	3	-1.697*	.388	.001	-2.788	-.606
	4	-3.788*	.763	.000	-5.935	-1.641
3	1	3.333*	.686	.000	1.403	5.263
	2	1.697*	.388	.001	.606	2.788
	4	-2.091*	.4141	.000	-3.254	-.927
4	1	5.424*	.064	.000	2.431	8.417
	2	3.788*	.763	.000	1.641	5.935
	3	2.091*	.414	.000	.927	3.254

Table 4: Pairwise Comparison of Postural Ability after NDT Treatment

An independent sample t-test was used to analyze the within-group difference at the baseline and subsequent follow-ups (4th, 8th & 12th weeks) for both variables i.e. GMFM & PPAS. The p-value<0.001 showed significant improvement in both measures as compared to baseline (Tables 5 and 6).

Follow-up Intervals	t-test for Equality of Means						
	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Score of Gross Motor Function Measure(Baseline)	2.00	64	.04	2.87	1.43	.00	5.75
Score of Gross Motor Function Measure(4th week)	.09	64	.92	.15	1.58	-3.01	3.31
Score of Gross Motor Function Measure(8th week)	-1.49	64	.13	-2.75	1.84	-6.43	.91
Score of Gross Motor Function Measure(12th week)	-2.19	64	.03	-4.84	2.20	-9.26	-.43

Table 5: Independent t-test for Gross motor function measure

Follow-up Intervals	t-test for Equality of Means						
	T	df	Sig. (2-tailed)	Mean Difference	SE Difference	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Total Score of PPAS (Baseline)	2.00	64	.04	2.87	1.43	.00	5.75
Total Score of PPAS (4th week)	.09	64	.92	.15	1.58	-3.01	3.31
Total Score of PPAS (8th week)	-1.49	64	.13	-2.75	1.84	-6.43	.91
Total Score of PPAS(12th week)	-2.19	64	.03	-4.84	2.20	-9.26	-.43

Table 6: Independent t-test for Postural Ability Measure

DISCUSSION

This research examined the effects of neurodevelopment therapy and normal physiotherapy on gross motor function and postural abilities in spastic children aged 2 to 6 years. Children with CP had their gross motor function assessed using the gross motor function scale (GMFS). There are five different levels of movement assessed by the GMFM: laying down and rolling over to kneeling to standing to walking to running. Assessment of postural control was carried out with the Posture and Postural Ability Scale (PPAS). Postural competency in standing, sitting, supine and prone postures may be assessed on an ordinal scale of zero points. The quality of posture in the frontal plane is assessed using six items, while the quality of posture in the back is assessed using the additional item. Shapiro Wilk and Kolmogorov-Smirnov tests were used to ensure that the data in both groups were normal. The null hypothesis was accepted and the alternative hypothesis was rejected because the coefficients of alpha for all variables were greater than 0.05. In a pairwise assessment of gross motor function in the control group, p-value≤ 0.05 is statistically significant. There were substantial improvements in gross motor function from baseline through week 4, week 8, and week 12, according to a pairwise comparison of both groups. In this research, postural control comparisons across groups were shown to be statistically significant at numerous follow-ups. In a pairwise comparison of both groups, postural ability improved considerably after four weeks of treatment and after 12 weeks of treatment compared to baseline. However, the neurodevelopment approach had much better results than normal physiotherapy in terms of

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improving postural control. Iran's Ebnesina Rehabilitation Clinic in Tehran conducted a three-month research on CP youngsters in which NDT was employed as a therapy and the patients were monitored. There was a significant improvement after applying the neuro-development therapy method, according to the study's findings [21]. Ketelaar et al., performed an experimental study after applying Neuro-development techniques to CP children, and the results indicated that sitting, rolling, and kneeling positions changed. These results are in accordance with what was found in the research [22]. More research on the Neurodevelopment therapy approach for children with CP has shown that this strategy has outstanding effects on children who have spastic CP. 'Children's GMFM-88 and TUG scores improved considerably between the first and final measures of the NDT intervention, and this improvement was maintained for one month. Because of this, neurodevelopmental treatment has been shown to be effective in increasing gross motor function and postural ability in the present investigation [23]. There was an 8-week NDT treatment research conducted in Turkey on children with CP. According to the results, CP children's gross motor function and balance improved considerably (p 0.05) in the course of treatment (p-value≤ 0.05). The postural control measure score improved significantly after NDT was used on patients (p-value≤ 0.05). The findings of this study were relevant to current studies [24]. Neurodevelopmental therapy's impact on trunk control, balance, and gross motor function in children with spastic diplegic CP was examined by Sah AK et al., in a randomized controlled trial in 2019. (SDCP). When it comes to increasing trunk control, balance, and gross motor function, NDT principles outperformed typical physical therapy methods, according to the research. According to the findings of the present research, NDT treatment results in better outcomes than regular physical therapy [9]. Researchers reported comparable outcomes, with statistically significant improvements in motor function, functional independence, and balance scores after eight weeks of Bobath treatment. Functional motor abilities, daily living independence, and balance are all improved in children with CP with Bobath treatment [25]. Gross motor skills in the youngsters treated by Turker et al., improved as well. Gross motor skills, daily living independence, and health-related quality of life all improved in CP patients who underwent treatment. With neurodevelopmental therapy (NDT) alone or with typical rehabilitation therapies, postural alignment was improved (i.e. joint mobility, muscular strengthening, and mobility activities) [25]. The neuro-developmental therapy for children with spastic CP improves all elements of rough motor function. However, additional randomized controlled studies on rehabilitation strategies are required [25]. The outcomes of this study are undeniably favorable, but further research is required to repeat the findings and to investigate other concerns associated with the treatment's effectiveness. Investigators found it difficult and time-consuming to acquire and analyze all of this data, which is a fault in the study's design. The interpretation of the GMFM final score has also proved problematic. COVID-19 restrictions hampered researchers' ability to reach patients directly and showed a number of communication barriers and non-compliance issues that need to be addressed in future studies.

CONCLUSIONS

In conclusion, children with spastic cerebral palsy who received both neurodevelopmental treatment and regular physical therapy had improvements in their gross motor performance and postural control. Neurodevelopmental therapy outperformed the standard of care group in terms of improvement. There was a significant variation in the gross motor function test's

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different elements. The ability to lie, sit, crawl, roll, kneel, and stand were all much improved, but the ability to walk, run, or leap remained unchanged.

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