The effectiveness of intensive versus standard physical therapy for motor progress in children with spastic cerebral palsy

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Background

Cerebral palsy (CP) remains the most common cause of physical disability in children that results from a static brain lesion during pregnancy or early life. Although the brain lesion is static, the physical manifestations and medical issues may progress, leading to altered motor patterns.

Objective

The aim of the study was to assess gross motor progress in children with spastic (quadriplegic and diplegic) CP treated with intensive physical therapy (PT) as compared with a matched group treated with a standard PT regimen.

Patients and methods

Out of 45 patients with spastic CP aged 2-6 years, 25 patients were assigned to an intensive therapy group (group A), whereas 20 patients were assigned to standard therapy (control group B). Patients were classified according to the gross motor function classification system. The intervention program was administered for 16 weeks, with sitting and walking as the treatment goal. The gross motor function measures 88 and 66 (GMFM-88 and GMFM-66) and gross motor performance measure (GMPM) were used for assessment at baseline, at 8 weeks, and at 16 weeks after intervention.

Results

At baseline, there were no statistically significant differences between the two groups. After 8 weeks, there were significant differences between the two groups as regards the total scores of GMFM-88 and GMPM ($P < 0.05$). However, highly significant differences for GMFM-88 ($P < 0.001$) and only significant differences ($P < 0.05$) for GMPM were observed after 16 weeks. No statistically significant differences were found between the two groups as regards GMFM-66 scores after 8 weeks, and significant differences were found only after 16 weeks ($P < 0.05$). After 16 weeks, all dimensions of GMFM-88 were significantly increased in both groups ($P < 0.001$). Only sitting showed no statistically significant difference in group B ($P > 0.05$).

Conclusion

Intensive PT regimens were more beneficial than standard therapy in spastic CP, especially in children with a low functional level.

Keywords:
cerebral palsy, intensive physical therapy, neurodevelopmental therapy, spastic cerebral palsy

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Introduction

Cerebral palsy (CP) represents a group of permanent disorders in the development of movement and posture, causing activity limitation attributed to nonprogressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior. Secondary musculoskeletal disorders involving the muscle, tendons, bones, and joints are common as a result of spasticity, muscle weakness, and immobility [1].

CP is divided into three groups on the basis of the predominant neuromotor abnormality: spastic (unilateral and bilateral), dyskinetic (dystonia and choreoathetosis), or ataxic [2].

The gross motor function in children with CP has been conceptualized as having two main features: function and performance. Function indicates the ability to accomplish certain motor activity. Performance refers to the quality of motor activity or how well the child performs a certain activity [3]. The gross motor function classification system (GMFCS) was developed in response to having a standardized system for describing and classifying the severity of movement disability among children with CP [4]. The classification system is widely used among healthcare professionals to establish goals, give prognosis, and make decisions [2].

There is no compelling evidence on the type and length of therapy for children with CP. It was found that a high-frequency physical therapy (PT) regimen, regardless of the type of intervention, enhances treatment results [5].

PT plays a central role in managing the condition; it focuses on function, movement, and optimal use of the child's potential. PT uses approaches to promote, maintain, and restore physical, psychological, and social well-being and also teaches parents on how to handle their child at home with respect to feeding, bathing, dressing, and other activities. Previous reviews have addressed the effectiveness of PT interventions in children with CP, focusing on neurodevelopmental therapy (NDT) [6], strength training [7], conductive education [8], and orthotic devices [9].

It is important to determine the effects of interventions on motor function with reliable and valid tests. Several evaluation measures are available to assess gross motor development in children with CP, such as the gross motor function measure (GMFM), which is the best known and most frequently used instrument worldwide. The original version of the GMFM is the GMFM-88, consisting of 88 items that have been categorized into five dimensions of gross motor function [10]. The scores for each dimension are expressed as a percentage of the maximum score for that dimension, and the total score is obtained by adding the scores for all dimensions and dividing by 5 (the total number of dimensions). The GMFM total scores can range from 0 to 100. The reliability, validity, and responsiveness of the GMFM scores are documented for children with CP [11].

Objective

The aim of the study was to assess gross motor progress in children with spastic (quadriplegic and diplegic) CP treated with intensive PT as compared with a matched group treated with a standard PT regimen.

Patients and methods

Forty-five children with spastic quadriplegic and diplegic CP were recruited from the Conductive Education School for Special Needs, Kuwait. They comprised 25 girls and 20 boys, aged between 2 and 6 years. They were classified as per the GMFCS, a five-level classification system with particular emphasis on sitting, walking, and wheeled mobility. Level I includes children who can walk without limitations and level II includes children with limitations in walking long distances and balancing. Children in level III can walk using a hand-held mobility device (canes, crutches, or walkers), and children in level IV are more likely to be transported in a manual wheelchair or to use powered mobility. In level V, individuals have severe limitations in head and trunk control and require extensive assisted technology and physical assistance [4]. They were then classified according to the method adopted by Yokochi *et al.* [12], who used a three-level system of mild, moderate, and severe as follows: levels I and II GMFCS were considered as mild CP, level III was considered as moderate CP, and levels IV and V were considered as severe CP. Mild indicates that the child walks without assistive aids, moderate indicates that he or she walks with assistive aids, and severe indicates no independent functional mobility.

All patients were divided into three groups:

Group 1 included 18 patients with mild CP (eight quadriplegic and 10 diplegic); group 2 included 17 children with moderate CP (six quadriplegic and 11 diplegic); and group 3 included 10 children with severe CP (six quadriplegic and four diplegic).

Exclusion criteria

Children with seizure, mental delay, progressive neurological diseases, blindness, or deafness were excluded, in addition to children who had undergone surgical procedures or had received botulinum toxin type A injection within the previous 6 months.

Intervention programs

Patients were randomly assigned to two treatment groups: group A and group B.

In group A (the intensive PT group) the treatment program consisted of five sessions weekly, of a duration of 1-h per session, for 16 weeks. In group B (the standard PT group or the control group) the children received standard NDT twice weekly, of a duration of 1-h per session, for 16 weeks.

Each intervention session combined three components, as proposed by Bower *et al.* [13]:

(1) The manual treatment component, which used sensory techniques guiding the child's movement by means of graded stimulation, as practiced with the NDT approach [14].
(2) The training exercise component, which focused on helping the child to perform development-related functions such as rolling, sitting, and standing.
(3) The management component, which consisted of guidance for the parent or assistant on handling and positioning within the scope of daily activities at home.
(4) The rehabilitation program of all children also included occupational therapy, for 1 h once weekly, which focused on upper-extremity functions, hand–eye coordination tasks, and perceptual training.

Assessment

(1) *The GMFM-88* [15]: This consists of 88 items grouped into five dimensions:
(a) Lying and rolling (17 items),
(b) Sitting (20 items),
(c) Crawling and kneeling (14 items),
(d) Standing (13 items), and
(e) walking, running, and jumping (24 items). Items were scored on a four-point scale.
A score of 0 indicates that the child does not initiate the movement, a score of 1 indicates that the child initiates but completes less than 10% of the movement, a score of 2 indicates that the child partially completes the movement, and a score of 3 indicates that the child successfully completes the movement. The measure was applied to both groups three times at baseline, and at 8 and 16 weeks.
(2) *The GMFM-66*: This is the most recent version as it contains 66 of the original 88 items [11]. The goal was to be more responsive for children with major functional limitations and for those with minor functional limitations.

To improve reliability and validity, 22 items were deleted and an interval scale was created. Of the 22 items, 13 were from the lying and rolling dimension, five were from the sitting dimension, and four were from the kneeling and crawling dimension.

(1) *The gross motor performance measure (GMPM)*: The GMPM is composed of 20 items selected from the GMFM for assessing the quality of movement in children with CP [16]. Three of the 20 items are static, such as standing, whereas the remaining 17 are dynamic, such as hopping on one foot. For each GMPM item, three out of the five possible attributes (alignment, coordination, dissociated movement, stability, and weight shift) are determined to be assessed. Alignment refers to the adjustment of parts or segments of the body in relation to each other. Coordination is defined as the smooth and controlled use of movements in motor performance. Dissociated movements refer to isolated movements such as extension of the hip with flexion of the knee. Stability refers to the active maintenance of a body position in the presence of disturbing forces. Finally, weight shift is defined as movement involving the transfer of the body's center of gravity. We assessed each attribute by using a five-point scale ranging from severely abnormal (1) to consistently normal (5). We scored all three attributes for each item simultaneously, based on the average performance in three trials.

Statistical methods

IBM SPSS statistics (V. 22.0, 2013; IBM Corp., Chicago, Illinois, USA) was used for data analysis. Data were expressed as mean ± SD for quantitative parametric measures. The following tests were performed:

(a) Comparison between two independent mean groups for parametric data using the Student *t*-test;
(b) Comparison between more than two patient groups for parametric data using analysis of variance.

Results

Forty-five children with spastic quadriplegic and diplegic CP were included in this study, divided into two treatment groups.

Group A included 25 patients (10 mild, nine moderate, and six severe CP) with a mean age of 3.1 years.

Group B included 20 patients (eight mild, eight moderate, and four severe CP) with a mean age of 3.4 years.

The general characteristics of both groups are presented in Table 1. At baseline, there were no statistically significant differences between the two groups. After 8 weeks, there were significant differences between the two groups as regards the total scores of GMFM-88 (P < 0.05). Highly significant differences (P < 0.001) were observed after 16 weeks. All dimensions of the GMFM-88 were increased in both groups, as shown in Tables 2 and 3. Only sitting showed no significant differences after 16 weeks in group B. No statistically significant differences were found between the two groups as regards the GMFM-66 after 8 weeks (P > 0.05), whereas significant differences were found after 16 weeks (P < 0.05) (Table 4). There were highly significant differences in total scores of GMPM after 16 weeks in both groups (Tables 5 and 6). On comparing the total scores of GMFM-88 and GMPM in both groups, we found significant differences after 8 weeks and highly significant differences for GMFM-88 (P < 0.001) and significant differences (P < 0.05) for GMPM after 16 weeks (Table 7).

Table 1 Comparison of the general characteristics of the two groups

The characteristic	Group A (n = 25)	Group B (n = 20)	P-value
Age (mean ± SD) (years)	3.1 ± 1.1	2.8 ± 0.94	>0.05
Females/males	14/11	11/9	>0.05
Quadriplegic/diplegic	12/13	8/12	>0.05
Mild spasticity [n (%)]	10 (40)	8 (40)	>0.05
Moderate spasticity [n (%)]	9 (36)	8 (40)	>0.05
Severe spasticity [n (%)]	6 (24)	4 (20)	>0.05

There were no statistical significant differences between the two groups at baseline; P > 0.05, nonsignificant.

Table 2 Comparisons of mean scores of all dimensions of the gross motor function measure-88 in group A at baseline, at 8 weeks, and at 16 weeks

Dimensions	Group A				
	Baseline	8 weeks	*P*-value between baseline and 8 weeks	16 weeks	*P*-value between baseline and 16 weeks
Lying and rolling	66.86 ± 10.2	78.2 ± 9.8	<0.01	87.5 ± 11.4	<0.001
Sitting	31.6 ± 11.6	65.5 ± 12.6	<0.001	77.7 ± 11.4	<0.001
Crawling and kneeling	34.5 ± 8.5	64.82 ± 14.7	<0.001	80.42 ± 20.5	<0.001
Standing	33.8 ± 10.2	55.91 ± 14.6	<0.001	75.6 ± 16.4	<0.001
Walking, running and jumping	30.2 ± 10.4	44.85 ± 15.2	<0.01	62.55 ± 16.9	<0.001
Total score	39.39 ± 12.5	61.85 ± 18.2	<0.01	76.75 ± 12.5	<0.001

Highly significant differences can be seen between baseline and at 8 and 16 weeks in group A after intervention; $P < 0.001$, highly significant.

Table 3 Comparisons of mean scores of all dimensions of the gross motor function measure-88 in group B at baseline, at 8 weeks, and at 16 weeks

Dimensions	Group B				
	Baseline	8 weeks	*P*-value between baseline and 8 weeks	16 weeks	*P*-value between baseline and 16 weeks
Lying and rolling	64.9 ± 11.4	70.24 ± 10.5	>0.05	75.8 ± 13.2	<0.05
Sitting	33.3 ± 12.4	36.7 ± 16.2	>0.05	42.2 ± 15.5	>0.05
Crawling and kneeling	36.3 ± 12.6	55.3 ± 15.7	<0.01	62.75 ± 22.4	<0.001
Standing	32.5 ± 14.2	44.8 ± 14.9	<0.05	65.3 ± 15.7	<0.001
Walking, running and jumping	31.42 ± 14.2	42.85 ± 16.8	>0.05	55.2 ± 20.1	<0.001
Total score	39.68 ± 14.5	49.97 ± 20.2	>0.05	60.25 ± 14.8	<0.001

$P < 0.05$, significant; $P > 0.05$, nonsignificant; $P < 0.001$, highly significant.

Table 4 Comparison of changes in mean total score of gross motor function measure-66 in both groups at baseline, at 8 weeks, and at 16 weeks

The GMFM-66	Group A	Group B	*P*-value
At baseline	53.85 ± 12.2	52.5 ± 14.3	>0.05
After 8 weeks	68.9 ± 13.7	64.2 ± 14.5	>0.05
After 16 weeks	79.35 ± 14.9	68.8 ± 15.9	<0.05

Significant differences in GMFM-66 between both groups were only found after 16 weeks; ANOVA, analysis of variance; GMFM, gross motor function measure; $P > 0.05$, nonsignificant; $P < 0.05$, significant.

Table 5 Comparisons of mean changes in gross motor performance measure in group A at baseline, at 8 weeks, and at 16 weeks

The GMPM	Group A			
	Baseline	8 weeks	16 weeks	*P*-value
Alignment	38.46 ± 15.2	78.4 ± 15.2	88.8 ± 14.8	<0.001
Coordination	37.59 ± 11.5	59.6 ± 11.5	72.3 ± 18.2	<0.001
Stability	40.5 ± 13.6	62.3 ± 13.6	76.8 ± 16.2	<0.001
Weight shift	38.7 ± 15.4	56.8 ± 15.4	66.3 ± 16.4	<0.001
Dissociated movement	38.75 ± 17.1	60.2 ± 17.1	74.5 ± 14.9	<0.001
Total scores	38.8 ± 15.2	63.46 ± 20.2	75.74 ± 18.4	<0.001

There were highly significant differences in mean total scores of gross motor performance measure (GMPM) after 16 weeks in group A; $P < 0.001$, highly significant.

After 8 weeks only crawling and kneeling and standing showed significant differences. After 16 weeks only sitting showed no significant differences. Lying and rolling showed significant differences, whereas other dimensions showed highly significant differences.

No significant differences were found between the two groups at baseline. Significant differences were observed after 8 weeks, whereas after 16 weeks differences were highly significant for GMFM-88 and significant for GMPM.

Discussion

CP is a disorder of movement and posture secondary to an insult to the developing brain. The insult is static and permanent and may be the consequence of different factors, including both genetic and

Table 6 Comparisons of mean changes in gross motor performance measure in group B at baseline, at 8 weeks, and at 16 weeks

The GMPM	Group B			
	Baseline	8 weeks	16 weeks	*P*-value
Alignment	41.22 ± 10.2	58.45 ± 17.2	64.85 ± 18.4	<0.001
Coordination	39.11 ± 16.4	49.25 ± 14.8	60.2 ± 18.2	<0.001
Stability	42.51 ± 13.4	53.35 ± 14.9	61.8 ± 20.4	<0.001
Weight shift	38.72 ± 16.7	44.82 ± 20.5	56.38 ± 16.2	<0.05
Dissociated movement	40.10 ± 13.7	60.2 ± 17.2	74.5 ± 18.8	<0.001
Total scores	40.33 ± 17.8	53.21 ± 16.5	63.54 ± 16.9	<0.001

There were highly significant differences in total scores of gross motor performance measure (GMPM) in group B after 16 weeks; $P < 0.001$, highly significant; $P < 0.05$, significant.

Table 7 Comparisons between the two groups as regards mean total scores of gross motor function measure-88 and gross motor performance measure at baseline, at 8 weeks, and at 16 weeks

The Total score	Mean total score of GMFM-88			Mean total score of GMPM		
	Group A	Group B	*P*-value	Group A	Group B	*P*-value
At baseline	39.39 ± 12.5	39.68 ± 14.5	>0.05	38.8 ± 15.2	40.33 ± 17.8	>0.05
After 8 weeks	61.85 ± 18.2	49.97 ± 20.2	<0.05	63.46 ± 20.2	53.21 ± 16.5	<0.05
After 16 weeks	76.75 ± 12.5	60.25 ± 14.8	<0.001	75.74 ± 18.4	63.54 ± 16.9	<0.05

GMFM, gross motor function measure; GMPM, gross motor performance measure; $P > 0.05$, nonsignificant; $P < 0.05$, significant.

environmental causes. Although the insult is static, the consequent symptoms are variable and may change over time [17].

Our study showed that the NDT interventions administered for 16 weeks in children with spastic CP had improved their gross motor function as measured with the GMFM-88 and GMFM-66. This improvement was significant for both groups as all dimensions of GMFM-88 were significantly increased in both groups ($P < 0.001$). Only sitting showed no statistically significant difference in group B ($P > 0.05$) after 16 weeks. Further, the intensive NDT intervention had a greater effect on children's motor function and performance than did the standard intervention.

Tsorlakis *et al.* [18] examined the effect of NDT treatment and differences in its intensity on the gross motor function of 34 children with CP, of a mean age of 7 years (age range 3–14 years), with mild to moderate spasticity and hemiplegia ($n = 10$), diplegia ($n = 12$), and tetraplegia ($n = 12$). Patients were assigned randomly to two groups: group A underwent NDT twice a week, whereas group B underwent NDT five times a week for 16 weeks. The outcome measure used was the GMFM-66, which assessed the performance of the children before and after intervention. The differences between the initial and final measurements for group A revealed significant differences in GMFM-66 scores with a mean change score of 1.18, whereas group B showed a mean change score of 2.36. Results revealed that the gross motor function of children from both groups improved significantly after intervention. Children in group B performed better and showed significantly greater improvement than those in group A. Therefore, as initially hypothesized, NDT intervention had a significant positive effect on gross motor function in the children of both groups.

A randomized controlled study was conducted by Shamir *et al.* [19] to assess sitting and gross motor progress in infants with CP who were treated with intermittent intensive PT as compared with a matched group treated with a standard PT regimen. Ten infants aged 12–22 months were studied; five were assigned to the intensive intermittent therapy group and five to the control group. After 4 weeks of baseline intervention, the intervention program was administered to the experimental group for 8 weeks and the regularly scheduled weekly program to the comparison group, targeting sitting as the treatment goal. In baseline phase A, a 90-min treatment was administered to each infant once a week for 4 weeks, and in the intervention phase B group E received one therapy session for 4 consecutive days in 1 week followed by a 3-week rest period during which no intervention was administered. The same schedule was repeated during the second 4-week period (B2). At the end of each month an assessment using GMFM 66 and 88 (dimension B) was made. During this period (B, B2), the comparison group C was treated for 8 weeks once a week (A1, A2) and evaluated with the same measurement tools applied in group E. The intermittent intensive regimen yielded a mean improvement of 7.8% as compared with 1.2% with the standard treatment. However, these results were attributed to infants with a low functional level only.

Another study conducted by Bower *et al*. [13] aimed to determine whether motor function and performance is better enhanced by intensive physiotherapy in children with CP. Participants comprised a sample of 56 children with CP classified at level III or below on the GMFCS, aged between 3 and 12 years. To compare the effects of routine amounts of physiotherapy with intensive amounts following the 6-month treatment period there was a further 6-month period of observation. Changes in motor function and performance were assessed by using the GMFM and the GMPM at 3-month intervals. There was no statistically significant difference in the scores achieved between intensive and routine amounts of therapy.

A study done

In the study by Deppe *et al*. [20] 47 children with unilateral CP aged 3.3–11.4 years were randomly assigned to either a modified CIMT or intensive bimanual training. Patients in the modified CIMT group received 60 h of modified constraint induced movement therapy (CIMT) and 20 h of bimanual training over 4 weeks. Patients in the bimanual treatment group received 80 h of bimanual training over 4 weeks. This was the same number of hours of training given to our patients but over a period of 16 weeks. Modified CIMT provided a significantly better outcome for isolated motor functions of the paretic arm compared with the bimanual training. Children with greater disability showed greater improvement than those with less disability and age did not affect the treatment outcome.

Conclusion

Intensive PT regimens are more beneficial than standard therapy in spastic CP, especially in children with a low functional level.

Acknowledgements

Conflicts of interest

None declared.

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