Effect of Forced Use of the Upper Extremity on Functional Outcome in Hemiplegic Cerebral Palsy Children

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ABSTRACT

Purpose: *The purpose of this study was to determine the effectiveness of forced use therapy on functional outcome in hemiplegic cerebral palsy children.* ***Subjects:*** *Thirty children with hemiplegic cerebral palsy were included in the study. Their age ranged from 9 to 14 years old. Patients were assigned into two equal groups.* ***Procedures:*** *Group I received forced use therapy (immobilization of the unaffected arm while engaging in repetitive task practice and behavioral shaping with the affected hand) with Neuro-Developmental Treatment (NDT), while group II received Neuro-Developmental Treatment only for 90 minutes three times per week for eight weeks. Patients were assessed before and after the treatment. Functional outcome were assessed using the Action Research Arm Test, the manual hand dynamometer, the Motor Activity Log and the Barthel Index.* ***Results:*** *The results revealed that patients in forced use therapy group showed significant improvement in functional performance than patients in Neuro-Developmental Treatment group.* ***Discussion and conclusion:*** *This study provides evidence of greater improvements in functional outcome of daily activities after forced use therapy in addition to NDT treatment in hemiplegic cerebral palsy children.*
Key words: *Cerebral palsy, Forced use therapy, Neuro-Developmental Treatment.*

INTRODUCTION

Cerebral palsy (CP), defined broadly as a non progressive motor impairment syndrome caused by a problem in the developing brain. Children with hemiparesis or substantially greater deficit in one upper extremity than the other comprise a significantly large group of those with CP[13]. Children with hemiplegia have sensory motor problems similar to those of adults with hemiplegia[3]. These children demonstrate early poverty of movement in the affected side, often with fisting of the affected hand[11].

The recovery process of upper extremity function is often slower than the recovery process of lower extremity function[12]. According to the theory of "learned nonuse", repeated disappointment in attempts to use the affected arm can lead to negative reinforcement of using the affected arm.

Increasing use of the unaffected side becomes even more apparent with toy manipulation, and this is often accompanied by associated reactions, or increasing spasticity in the affected limb, during periods of use of the unaffected arm. Neglect of the affected side also becomes more pronounced with increasing use of the unimpaired arm and hand[11]. The motor and sensory deficits of children with hemiplegia significantly affect the coordination of reaching and grasping, including the timing of movement and the coordination of muscle forces during precision movement[17,21].

Rehabilitation methods have been developed in which patients were either forced to use the affected arm, by means of immobilization of the unaffected arm (forced use) or strongly encouraged to do so by a therapist who constantly corrected the patient when he/she tried to use the unaffected arm (constraint induction)[19].

It has been suggested that constraint-induced movement therapy may be used to overcome the learned non-use phenomenon and improve functional performance of the affected arm of hemiplegic patients[6,16].

Forced use technique had been shown to be highly effective in improving upper limb function in adults following stroke, but there is only a limited literature on the use of this intervention in children[11].

So, the purpose of the present study was to determine the efficacy of forced use of the upper extremity (extended, intensive training of the more affected arm for many hours a day over a period of consecutive weeks and restraint of less- affected arm for that period) on functional outcome in hemiplegic children with cerebral palsy.

MATERIAL AND METHOD

Subjects

Thirty children with hemiplegic cerebral palsy of both sexes (males and females) participated in the study. The patients were referred from the out-clinic of the faculty of physical therapy, Cairo University. Their age ranged from 9 to 14 years old with the mean age of (11.51 ± 2.32). Patients were included according to the following criteria: the degree of spasticity was determined according to the modified Ashwarth's Scale within range of 1 to 2 grades[4]. The upper limb was free from any structural deformities. They were free from any associated disorders other than spasticity. All of them can follow command. The patients were divided randomly into two groups of equal number: study group (G I) and control group (GII).

Evaluation procedures

Both groups were subjected to follow up protocol for 8 weeks. Pre-test measures were performed before initiation of the treatment. Post test assessments were done after 8 weeks to assess effectiveness of the treatment and to determine impact on functional outcome.

1- The Action Research Arm Test:

Dexterity was assessed by means of the action research arm (ARA) test[15], which is an observational test consisting of 19 items focusing on grasping objects of different shapes and sizes, and gross movements in the vertical and horizontal planes. The performance of each motor task is rated on a 4-point scale, ranging from 0 (no movement possible) to 3 (movement performed normally)[22]. The scores on the individual items are added, yielding an overall sum score; the maximum obtainable sum score is 57 points. The validity and reliability of the ARA test have been found to be high in several studies[15,22].

2- The Motor Activity Log (MAL):

Amount of use (AOU) and quality of movement (QOM) of the affected arm were assessed by means of the Motor Activity Log (MAL), a questionnaire evaluating 25 specific activities on a 6-point scale. This is an adapted version of the MAL used by Taub et al.,[19] which consisted of 14 items. The AOU scale ranges from 0 (never use the affected arm for this activity) to 5 (always use the affected arm for this activity), and the QOM scale also ranges from 0 (inability to use the affected arm for this activity) to 5 (ability to use the affected arm for this activity). The sum of the ratings on the MAL was divided by the number of specified daily activities that the patient actually performed, resulting in a mean score per item. The patients also rated a Problem Score for the 3 most important activities they themselves selected from the MAL. These scores range from 0 (no problem) to 6 (a very big problem), and the maximum sum score is 18.

3- Manual hand dynamometer (Model No. 1528, made in U.S.S.R):

This equipment provides reading about hand grip strength. For hand grip strength: From sitting position on a chair with the forearm rested on a table in the midline. Each patient was asked to hold the dynamometer by his hand then squeeze it as maximum as he can for the affected and non the affected hand then therapist asked him to relax taking the dynamometer and see red detector.

4- Barthel index[7]: For assessment of patient independence in ADLs. It consists of 10 items. The sum points for all items give total score of 0-100.

Treatment procedures

Patients in the study group received NDT and forced use therapy consisted of two main elements: (1) restriction of movement of the unaffected hand by placement in a mitt for 6 hours per day. Hours of mitten wearing per day were recorded by the patients and confirmed by the caregivers under the supervision of the treating therapist. (2) Intensive training of the affected arm for 30 minutes in a form of shaping. Shaping involved presenting interesting and useful activities in ways that provided frequent and repetitive rewards for the child’s efforts and increasing functional use of the more impaired extremity. Tasks such as reaching, grasping holding, manipulating an object, picking up marbles, flipping cards, stacking blocks, combing hair, writing and other activities similar to those performed in daily life plus NDT for 30 minutes per session , three times per week for 8 consecutive weeks.

Group II children received NDT only (one hour for each session) three times per week for 8 consecutive weeks which include: stretching/weight bearing by the affected arm and strengthening exercises for upper and lower limbs, approximation, balance, fine motor dexterity training, functional task practice when possible. Symmetry of posture and inhibition of inappropriate "synergistic" movements were emphasized.

Statistical analysis

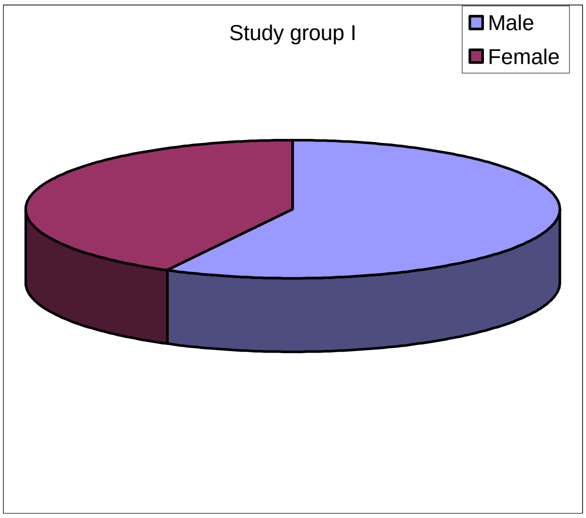
The arithmetic mean and standard deviation of the mean, the student paired t-test (to determine level of significance in one group pre and post treatment), and unpaired t-test between two groups (to determine level of significance between two groups). Level of significance was assumed at 0.05 for all analysis.

RESULTS

The results of the present study before starting treatment revealed that there were no significant differences in all chronological variables (age, sex, side of affection, weight, and height) between both groups (GI and GII). These results ensured matching between the patients in both groups. Therefore, it provided basis for comparison between results obtained as shown in table (1) and fig. (1a,b).

Table (1): The general characteristics (age, weight, height) of both groups.

	Study group (G I)	Control group (G II)	t-value	P-value
	Mean±SD	Mean±SD		
Age	11.78±2.15	11.24±2.5	1.677	0.101
Weight	35.3±2.7	36.71±2.5	1.215	0.231
Height	125.3±3.6	126.2±4.1	1.221	0.229



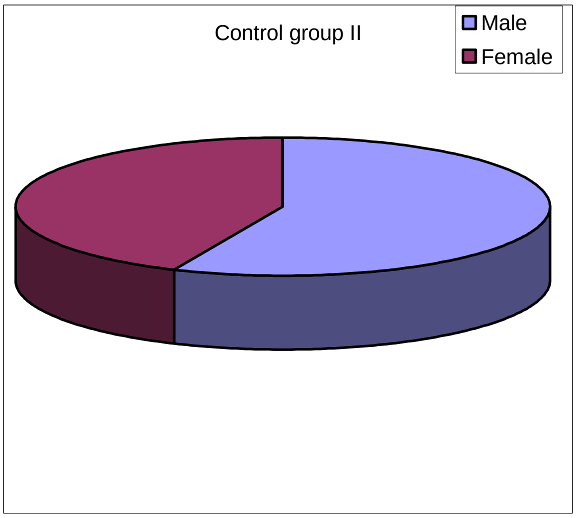
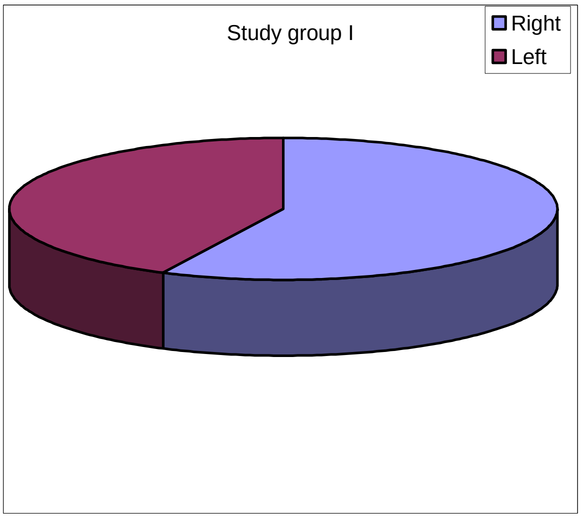


Fig. (1a). Sex distribution in both groups.



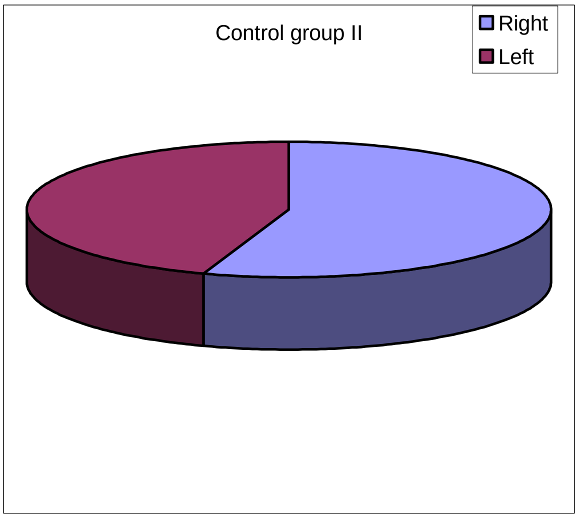


Fig. (1b). Sides of affection in both groups.

In regarding to the results shown in table (2) and fig. (2), there were more significant improvement of the Action Research Arm Test scores in G (I) than in G (II).

Table (2): Effect of treatment procedures within each group and between the two groups on ARA.

Group	Pre	Post	t-value	P-value
	Mean±SD	Mean±SD		
Study Group I	33.2±10.4	47.78±11.34	4.238	0.0001*
Control Group II	32.9±11.32	40.3±11.11	2.086	0.0437*
t-value	0.2036	2.107		
P-value	0.8397	0.0418*		

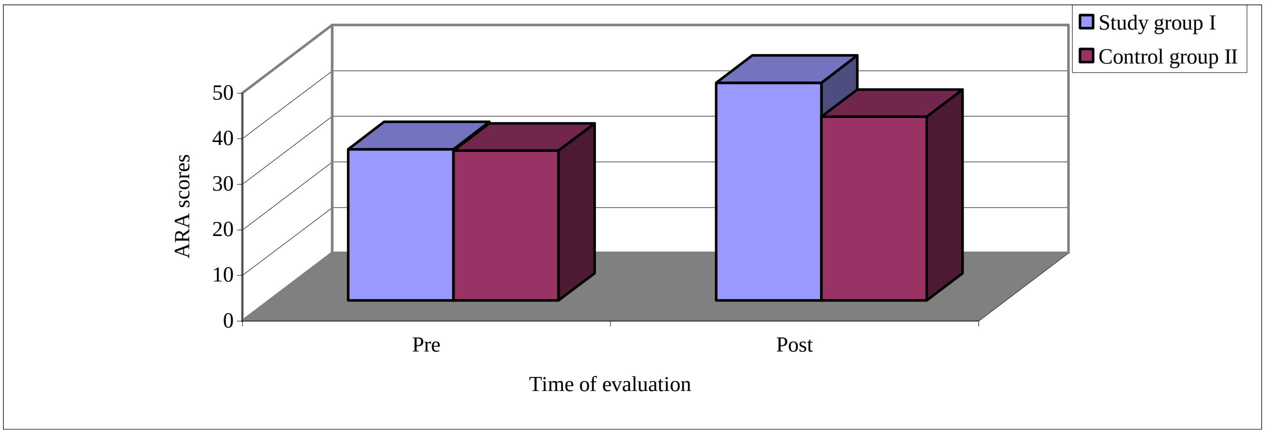


Fig. (2). Comparison between mean values of ARA scores of (GI) and (G II).

Concerning the results shown in table (3) and fig. (3), there were more significant improvement of the hand grip measures in G (I) than in G (II).

Table (3): Effect of treatment procedures within each group and between the two groups on hand grip.

Group	Pre	Post	t-value	P-value
	Mean±SD	Mean±SD		
Study Group I	0.9±0.37	1.8±0.34	8.010	<0.0001*
Control Group II	1.0±0.44	1.5±0.39	3.803	0.0005*
t-value	0.7779	2.593		
P-value	0.4414	0.0134*		

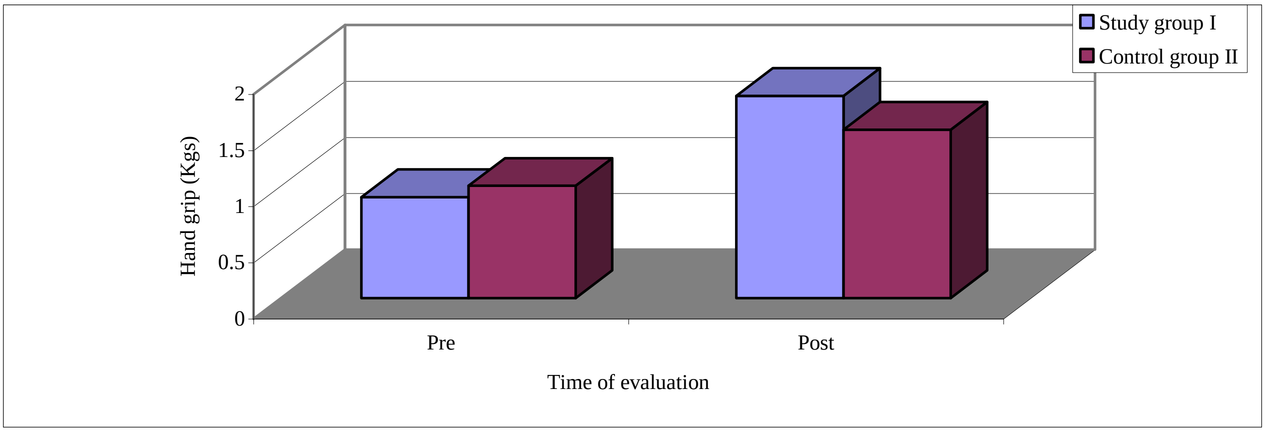


Fig. (3). Comparison between mean values of hand grip measures of (GI) and (G II).

There was significant difference in MAL (AOU) post-treatment between G I and G II (t=2.198, P =0.0341). For MAL (QOM) the results showed more improvement in G I than in G II (t =2.106, P=0.0419).

The results showed that there were significant differences in the Barthel Index scores between G (I) and G (II) (t =5.03, P<0.0001) as shown in table (4) and fig. (4).

Table (4): Effect of treatment procedures within each group and between the two groups on Barthel index.

Group	Pre	Post	t-value	P-value
	Mean±SD	Mean±SD		
Study Group I	44.3±18.2	76.4±22.3	4.987	<0.0006*
Control Group II	38.5±19.5	51.2±21.6	2.895	0.0063*
t-value	0.601	5.03		
P-value	0.5514	<0.0001*		

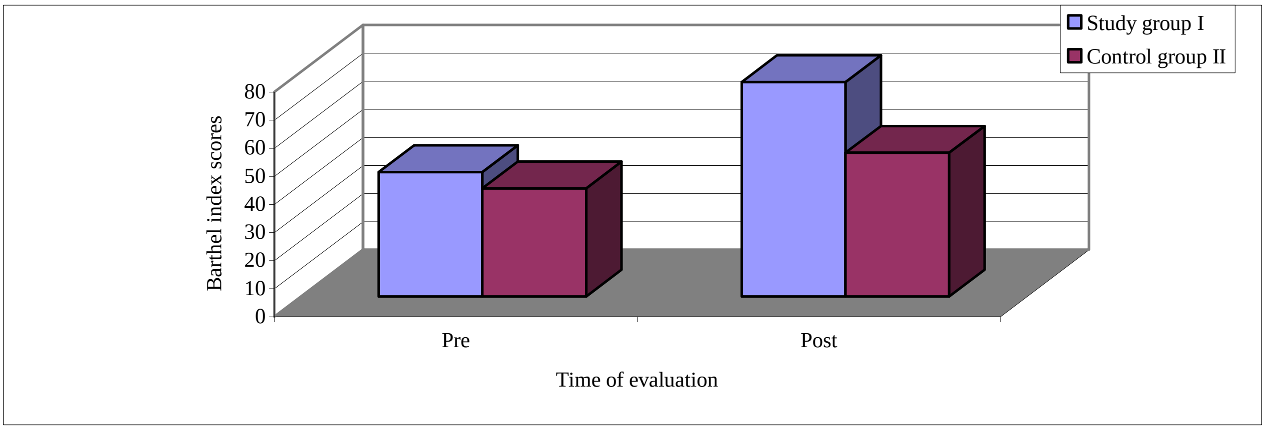


Fig. (4). Comparison between mean values of Barthel Index scores of (GI) and (G II).

DISSUSION

As children with hemiplegia develop mobility, they usually avoid use of the affected arm; for example avoiding supporting themselves on that side when prone, or while moving in and out of sitting or crawling[11]. Despite the substantial evidence of motor function improvement after constraint-induced (forced use) therapy, it remains unclear whether and how these treatments may affect motor control during the performance of functional dexterous tasks[1].

This study provides experimental data addressing the changes that occurred in both functional performance of daily activities and motor control of upper extremity in children with hemiplegia following participation in an eight-weeks forced use therapy program.

In our study, the forced use therapy protocol emphasized intensive practice and use of functional tasks to train the affected arm. Intensive practice of the affected arm might provide sufficient proprioceptive and visual feedback to develop the internal models for feedforward control of movement. Thus, after forced use therapy, patients were able to replan motor patterns more efficiently and primarily used the feedforward control strategy to perform movement. This explanation comes in agreement with Desmurget and Grafton, 2000[9].

Regarding the post treatment results of our work, the intervention (forced use) produced a large improvement in the use of the more affected extremity. This comes in agreement with Blanton and Wolf, 1999[2] and Taub and Wolf, 1997[18] who indicating improvement in adults with hemiplegia following stroke, through constraint of the unaffected limb (forced use), intensive and repetitive shaping of movement in the affected limb, and / or some combination of the two. They postulated that the constraint portion of forced use therapy addresses the behavioral issue of learned non-use, while the intensive shaping facilitates effective movement of the impaired limb. Similarly the results was supported by Charles et al., 2001[8] who reported the use of constraint induced therapy on hand function in three children, ages eight, 11, and 13, with hemiplegic cerebral palsy. Children were constraint for six hours per day for 14 consecutive days. Following treatment there was an improvement in hand function in two children and an improvement in two-point discrimination for all three children.

These findings contrast with Hakim et al., 2005[14], who showed decreased hand opening after constraint-induced movement therapy. This inconsistency might be due to differences in the level of hand function between the study participants. Patients with different levels of impairment of hand movement may have differential responsiveness to the intervention of forced use therapy.

Concerning the improvement in the post treatment mean values of group (II) could be explained by the effect of NDT program which focuses on inhibiting abnormal movement patterns and facilitating automatic patterns of movement and the foundations for normal functional movement. This findings comes in agreement with Glover et al., 2002[11] who stated that neurodevelopmental therapy in children with hemiplegia is directed at increasing mobility, strength, and frequency of use of the affected arm, as well as decreasing spasticity.

Forced use therapy patients reported larger improvements in the use and function of their affected arm, as measured by the Motor Activity Log, than did NDT patients. These findings are consistent with Bonifer, et al., 2005[5] and Brogårdh, and Sjölund, 2006[11].They suggested that the learned non-use phenomenon can be better overcome through forced use therapy than traditional rehabilitation. This comes also in agreement with Taub et al., 2004[20] who found that constraint induced (forced use) therapy in children with hemiparesis leads to rapid and large changes in motoric function.

The forced use therapy group demonstrated greater improvement of Barthel Index scores than did the NDT group, suggesting that forced use therapy patients achieved better functional performance of daily activities. These findings are inconsistent with those of the Dromerick et al., 2000[10], who showed non-significant differences in most aspects of the Functional Independence Measure between the constraint-induced movement therapy and control groups in stroke patients.

From previous results and explanations, we can conclude that the forced use of upper extremity in combination with NDT are effective in improving functional outcome of hemiplegic cerebral palsy children.

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الملخص العربي

تأثير الاستعمال الإجباري للطرف العلوي على النتيجة الوظيفية للأطفال المصابين بالشلل النصفي الدماغى

أجريت هذه الدراسة بهدف دراسة تأثير الاستعمال الإجباري للطرف العلوي على النتيجة الوظيفية عند الأطفال المصابين بالشلل النصفى الدماغى .اختير لهذه الدراسة 30طفلا من المصابين بالشلل النصفي وتراوحت أعمارهم ما بين 14 إلى 9 سنة ، قسموا إلى مجموعتين متساويتين ، المجموعة الأولى وهي مجموعة الدراسة وقد عولجت عن طريق الاستعمال الإجباري للطرف العلوي المصاب بالتقييد المستحث للحركة واستخدام الممارسة التكرارية والتشكيل السلوكي باليد المتأثرة بالإضافة إلى البرنامج التقليدي للعلاج بينما عولجت المجموعة الثانية وهي المجموعة الضابطة باستخدام برنامج العلاج الطبيعي التقليدي . واستمر البرنامج العلاجي لمدة ثمانية أسابيع بواقع ثلاث مرات أسبوعيا . تم تقييم المرضى قبل وبعد العلاج عن طريق استخدام اختبار بحث العمل للذراع والديناموميتر وسجل النشاط الحركي ودليل بارثيل . وأظهرت النتائج تحسن ذو دلالة إحصائية في النتيجة الوظيفية لصالح مجموعة الدراسة . مما سبق فإنه يفضل استخدام الاستعمال الإجباري للطرف العلوي مع العلاج التقليدي في علاج مثل هذه الحالات .