Efficacy of Dual Task Specific Training on Upper-Extremity Function of Hemiplegic Cerebral Palsy

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ABSTRACT

Background and Purpose: *Spastic hemiplegia is a type of cerebral palsy which considered one of the most devastating calamities in the field of neuropediatrics. The present study was conducted to determine the effect of dual task specific training on upper-extremity function of hemiplegic cerebral palsy.* ***Subjects:*** *Thirty patients suffered from spastic hemiplegia, (19 female and 11 male) with age ranging from 10 to 16 years were invited from faculty of Physical Therapy. The sample was divided into two groups, the control group (GI) and study group (GII).* ***Methods:*** *in addition to the designed program of treatment for upper limb given to the control group, the study-group received dual task specific training, every patient in the study group must wear a sling in the unaffected arm during each session in the first month. Training was given daily for eight weeks.* ***Measure:*** *The upper limb outcomes were evaluated using the Rivermead Motor Assessment Scale, Fugl-Myer Assessment Scale. Gross Manual dexterity of Hand was measured with the box and block test (BBT).Also the power of wrist extension and Hand grip were measured by dynamometer.* ***Results:*** *There was a highly significant improvement in the study group than control group.* ***Conclusion:*** *The use of dual task specific training is more effective in improving functional outcome of hemiplegic cerebral palsy.*

Key words: *Dual task, Cerebral Palsy, Functional Training, Hemiplegia.*

INTRODUCTION

Cerebral palsy is: "an umbrella term covering a group of non progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in early stages of its development"[31]. The major problem facing hemiplegic children is the inability to use hands for reach, grasp and manipulation which affect in their daily life activities[12].

The upper-extremity function of hemiplegic cerebral palsy lags behind their lower extremity functioning. That is, child with cerebral palsy (CP) can walk fairly well using their affected lower extremities, but they seldom use their affected hands because of more affected motor function and sensory deficits than in the leg[34]. The hand is a very special organ, with unique functions and versatility in the human body. Hands are pivotal in manipulating our environment, receiving feedback from our surroundings and communicating our unspoken words by gestures[19]. Learned nonuse is thought to develop after a central nervous system (CNS) lesion[37]. As a result, the nonuse of the affected limb is negatively reinforced by the results of these attempts, such as a failure to accomplish the intended goal. The learned nonuse continues, and the patient does not use that limb to the full extent of its true potential[36].

There were many studies on the effective therapeutically methods for improving of hand functions in spastic hemiplegic cerebral palsy patient[24], but the benefits of these treatment are temporary and evidence of their effectiveness are minimal. Effective treatment for patient with cerebral palsy requires a careful analysis of the behavior taking into consideration the complex issue of using the hands. In addition, it was important that the treatment was grounded in well-defined theories and methods[14]. Muscle imbalance and poor control of movement can have an impact on the daily occupational functioning of patient with cerebral palsy when one side of the body functions better than the other, patient will often prefer to use the less-involved upper extremity for completion of play and self-care activities because they have learned that the other hand dose not function effectively[7,10].

Dual task performance is also known as "concurrent performance" and involves the execution of a primary task, which is the major focus of attention, and a secondary task performed at the same time[29]. During many activities of daily living, people need to perform more than one task at a time. The capacity to do a second task (dual task performance) is needed during daily living because it allows for communication, transportation of objects from one location to another, and monitoring of the environment[1]. It is the method used to measure task automaticity, by determining the attentional costs of a given task or skill[41]. If tasks are automated and hence require little attention, multiple tasks can be performed concurrently without negatively impacting on performance, as they will not exceed the overall attention capacity[26]. So, the aim of this study was to investigate the effect of dual task specific training on upper-extremity function of hemiplegic cerebral palsy.

MATERIAL AND METHOD

Subjects

Thirty patients with spastic hemiplegic cerebral palsied {17 right sided and 13 left sided} ranging in age from 10 to 16 with the mean age of {13.43±1.97} years, were selected from both sexes {19 female and 11 male} from the out-patient clinic of the Faculty of Physical Therapy, Cairo University. The patients enrolled in this study fulfilled to the following criteria; The degree of spasticity was determined according to the modified Ashwarth's Scale within range of 1 to 2 grades. 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 patient with severe spastic paralysis of the hemiplegic side or with cognitive dysfunction which unable good cooperation during testing were excluded from the study.

The patients were equally divided into the control group (GI) and study group (GII). Evaluation was carried out for all patients before and after eight weeks of the treatment program.

Evaluation procedure

1- Hand held dynamometer: This equipment provides reading about hand grip strength & wrist extensor strength which are predictors for hand function. 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 & non the affected hand then therapist asked him to relax taking the dynamometer & see red detector.

For wrist extensors strength: From sitting position on a back supported chair with the head maintained in mid-position, and the elbow flexed, each patient was allowed to place his forearm in a pronated position, with the wrist free off the table. The dynamometer was attached to the hand. Each patient was then asked to move his/ her hand without moving the forearm, and the wrist extension strength was measured in Kilograms (Kg.).

2- Functional activities assessment: Rivermead motor assessment scale (RMA)[23]. The patients were instructed to complete a series of functional movements of the upper limb, in which the activities were arranged in a difficult orders according to the patients abilities. The patients had no feedback of whether the movement correct or not, score 1 for patients who could performed the task, and score zero for patients who failed three trials to perform the task. Total scores were collected for each patient to be compared with reevaluation scores.

3- Motor function of the affected arm was evaluated using upper extremity motor section of the Fugl-Meyer assessment scale (FMA)[13,16]. It assesses impairment in the sensorimotor function. It measures the ability to move the affected arm out side the synergistic pattern on a 3-point scale (two point for the detail being performed, one point for the detail being performed partially and zero for the detail not being performed) with a maximum motor performance score of 66 points[13].

4- Gross manual dexterity was measured with the Box and Block test. This test consists of moving, one at a time in a 60-seconds period, the maximum number of wooden blocks from one side to the other side of a box separated into the middle[11,32].

Therapeutic procedures

The control group received a designed physical therapy program. While the study-group received dual task specific training in addition to the exercise program given to control group, every patient in the study group must wear a sling in the unaffected arm during first four weeks training. Treatment was carried out daily for eight weeks.

Designed exercise program including the following:

- Neuro development treatment program, using proximal and distal key points of control for the upper limbs, lower limbs and trunk.
- Stretching exercises for all the muscles liable to be tight, namely wrist flexors, pronators, elbow flexors, iliotibial band, hip flexors, knee flexors and tendo-Achilles.
- Approximation for the upper limbs, lower limbs, head and trunk from different positions.
- Facilitation of righting, equilibrium and protective reactions, from different positions.
- Electrical stimulation for weak muscles.
- Proprioceptive neuromuscular facilitation techniques for the upper and lower limbs.
- Occupational therapy.

Dual Task Specific Training: every patient in the study group must wear a sling in the unaffected arm during each session in the first month. While Practicing a bimanual activity in the second month of training.

1- Training of cognitive task:

It was conducted by use of RehaCom system (Computer-assisted cognitive rehabilitation, manufactured by Schuhfrted, model No454v, D-14482 potsdam, Karl. Liepkencht, Austra). It was used for training of cognition (attention and concentration program) Training with RehaCom can be carried out using a special panel, the computer keyboard, the mouse or a touchscreen. RehCome system is composed of patient panel, a mouse and central processing unit CPU compromising software of several programs. Special input panel with a very simple keyboard, big and robust design of the reaction keys enables a safe operation also for clients with restricted or unpracticed manual motor skills. The child seated in good comfortable position in front of a screen and receive explanation about the procedures.

Task description:

* The screen in front of the child was divided into two parts; one part contains one separate picture of an object. The other represent a matrix of pictures which contains:

- 3 pictures (1 by 3 matrix)
- 6 pictures (2 by 3 matrix)
- 9 pictures (3 by 3 matrixes) according to level of difficulty.

* The separate picture is to compare to the matrix of pictures. The one picture resembling it in every detail is to be chosen.

* The child had to recognize the picture shown separately and select it from the matrix, by means of the big buttons on the patient panel.

* When using such big buttons, an orange frame marks a picture in the matrix and by means of these buttons the child can move the frame to the picture him or her choosed, then the selection is confirmed by pressing OK button on the panel.

* After selection a picture, the procedure evaluate the choice and lights up a green sign {CORRECT} or a red sign {INCORRECT}.

* The performance bar changes according to the reaction quality.

* These procedures continue until the child failed to achieve three correct choices at certain level, at this moment the level of the child's attention, concentration and reaction time will be recorded on the performance bar.

* The level of difficulty is adapted automatically.

2- Training of motor task:

Each patient trained on tasks such as reaching, grasping, holding, manipulating an object, bearing weight on the arm. Also making hand gestures which divided into small component skills, which were worked on individually and later chained together to complete a target activity. including eating, grooming, dressing and using the toilet, also each patient was asked to get coins out of his/her other hand, while at the same time asked to do secondary tasks {Counting back ward by two, threes-Subtract or add number to letter-Remembering things (e.g. telephone numbers)- Spell the word backward- Name any words start with letter (A–K), (L–X)}.

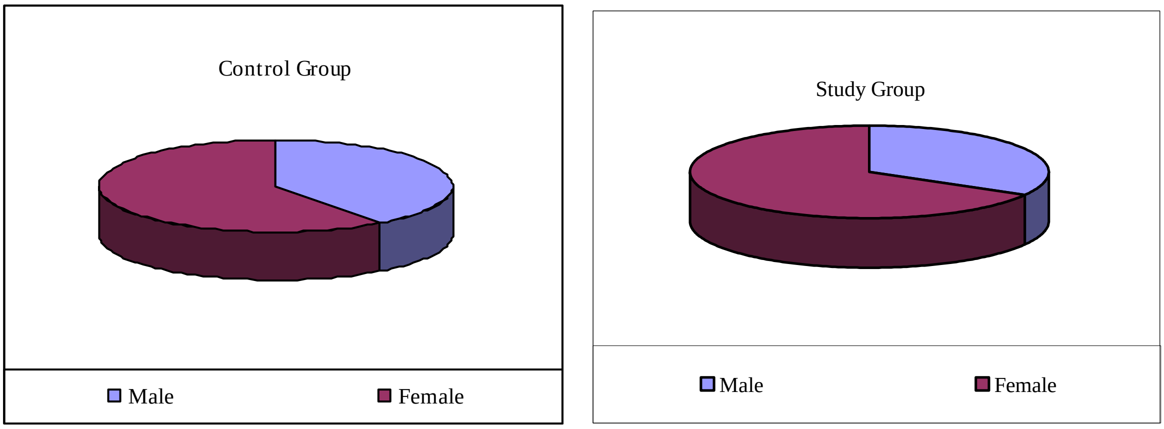
Functional occupational therapy (OT) started with concrete therapeutic goal setting[4] during the therapy session. Different tools of occupational therapy such as cubs, and blokes, with different geometric shapes. therefore each patient is asked to perform motor task while as a same time perform the secondary cognitive task.

Statistical Analysis

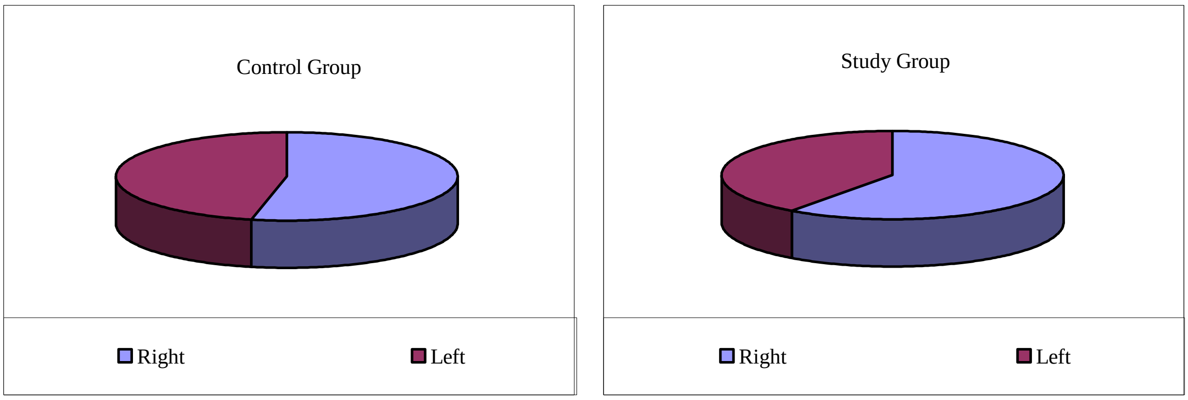
The arithmetic mean and standard deviation of the mean, the student paired t-test (to determine level of significance in one group pre and post treatment), and unpaired t-test between two groups (to determine level of significance between two groups). Level of significance was assumed at 0.05 for all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

RESULTS

The current study was designed to investigate the influence of dual task specific training on upper-extremity function of hemiplegic cerebral palsy. 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) between both groups (GI and GII) as shown in fig. (1). These results ensured matching between the patients in both groups. Therefore, it provided basis for comparison between results obtained. Mean value of age in G(I)= 13.8±1.86and G(II) = 13.2±1.95years.



Sex Distribuation in Both groups



Sides of Affection in Both groups

Fig. (1): General characteristics of subject between the two groups.

Concerning the result of hand grip and wrist extensors strength, statistical analysis revealed that there was a significant improvement in both groups but in favour of G (II) which showed a highly significant improvement (P<0.0001) as shown in table (1) and fig. (2).

Table (1): Effect of treatment procedures between the two groups on hand grip and wrist extensors strength.

Group	Control (I)				Study (II)			
	Mean ± SD		t-value	P value	Mean ± SD		t-value	P value
	Pre	Post			Pre	Post		
Hand Grip	5.09±0.81	6.01± 0.97	4.086	0.0011**	4.87±0.86	7.31±0.75	11.678	0.0001***
Wrist Extensors Strength	3.31±0.43	4.15± 0.96	3.997	0.0013**	3.48±0.71	5.59±0.89	10.843	0.0001***

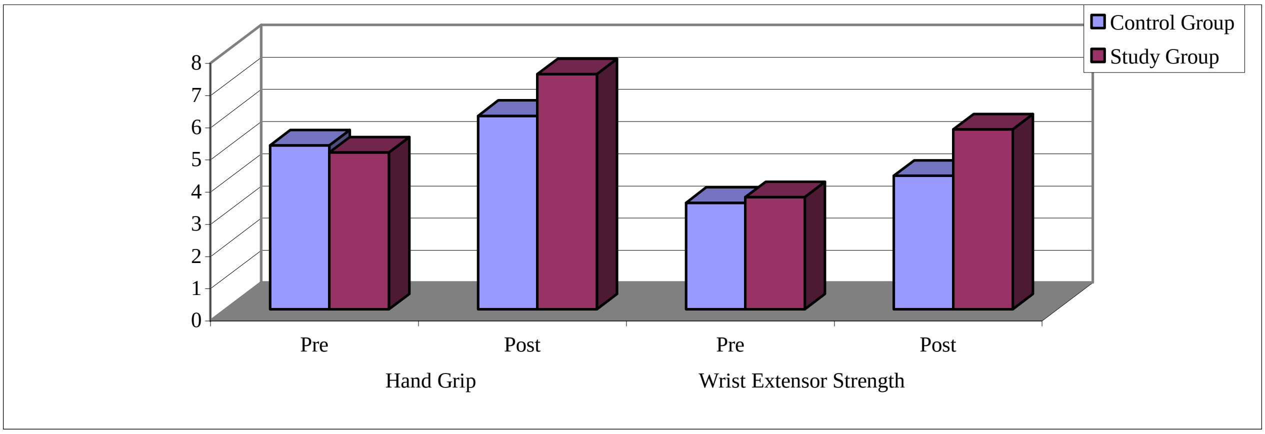


Fig. (2): Effect of treatment procedures between the two groups on hand grip and wrist extensor Strength.

Concerning the result of FMA, BBT and function activities, statistical analysis revealed that there were a significant improvement in both groups but in favour of G (II) which showed a highly significant improvement (P<0.0001) as shown in table (2) and fig. (3).

Table (2): Effect of treatment procedures between the two groups on function activities, FMA and BBT.

Group	Control (I)				Study (II)			
	Mean ± SD		t-value	P value	Mean ± SD		t-value	P value
	Pre	Post			Pre	Post		
Function Activities	4.6±0.63	5.67±1.95	2.615	0.0204*	4.4±1.06	11.07±1.87	24.672	0.0001***
FMA	27.47±2.07	31.13±6.52	2.843	0.013*	25.67±3.26	48.2±3.59	33.728	0.0001***
BBT	9.53±2.5	11.4±4.56	2.656	0.0188*	9.2±2.73	14.93±1.22	12.395	0.0001***

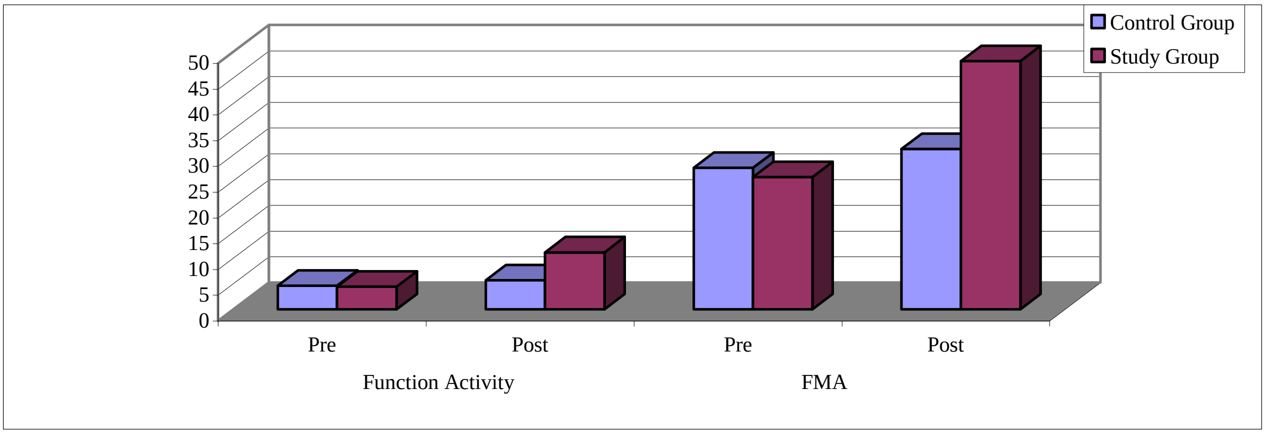


Fig. (3): Effect of treatment procedures between the two groups on function activity and FMA.

DISCUSSION

The current study aim to investigate the influence of dual task specific training on upper-extremity function of hemiplegic cerebral palsy. Following hemiplegia. Muscle weakness arises from two sources: primarily from the lesion itself, as a result of a decrease of descending inputs converging on the final motor neuron, and hence a reduction in the number of motor units available for recruitment. Since skeletal muscle adapts to the level of use imposed upon it, secondary sources of weakness arise as a consequence of lack of muscle activity and immobility .Contrary to previous opinion, weakness in agonist muscles is not due to spasticity (reflex hyperactivity) in an antagonist muscle group, but is a direct result of reduction of descending motor commands, compounded by disuse and adaptive muscle changes[27].

The hemiplegic problem is not only a lack of muscles power, but also the patient become unable to control resulted or voluntary components of the pattern. Also inadequate recruitment of motor units resulting in an inability to generate significant forces is considered as an important reasons for poor motor performance in hemiplegic patient[3,17]. Thus forcing the use of the paretic arm was developed to help patients overcome the learned nonuse of their paretic arm[18]. The current study constraining the unaffected limb, coupled with practice of functional movements of the impaired limb improvement motor impairment for hemiplegic child.

The result of this study revealed that dual tasks training enhanced the learning process. The improvement in performance generalized to new task combinations demonstrated benefits in both reaction time and accuracy for dual-task practice. Therefore, it appears that training can substantially improve dual-task processing skills[30]. Explained that there is relationship between cognitive function and motor abilities. In normal circumstances, the concomitant execution or motor and cognitive tasks is common, and in such situations, motor activities are performed "automatically", that is, no effort of conscious attention are required[8]. Such autonomous stage of performance of a motor ability is achieved trough a process of motor learning in which practice and its variability bring about the formation of action programs[33].

The most evidence in support of constraint plus intensive motor relearning and meaningful exercise and practice comes from studies of brain reorganization after stroke. Studies showed that there is association between increased use of the affected limb, improved motor performance and brain reorganization[2].

The result of this study showed improvement upper limb function and this can be explained by active participation of patient and cognitive training provide more activation of brain area resulting in improvement in cerebral blood flow, the increase of blood flow in a particular area of the brain is taught to reflect a greater activity which result in increase of synaptic activity within that region[38]. It is assumed that repetitive practice of a particular movement may drive brain reorganization by which appears to be a process of motor learning. a process that strengthens existing pathways and may lead to new functional or structural changes (neuroplasticity). This result was in agreement with the study applied by Sung et al. (2005)[35] who reported that discourage the use of the unaffected arm combined with a conventional rehabilitation program appears to be more effective than a rehabilitation program alone in improving affected hand function in children with hemiplegic CP. This improvement is due to forcing the use of the affected arm and intensive rehabilitation treatment could facilitate motor function and brain reorganization[40].

The result of this study were supported by Carr and Shepherd, (2003) who said that, following a brain lesion affecting the motor system, an immediate need is to help the patient regain the ability to activate paretic muscles and generate force. Task training involves many repetitions under constrained conditions as a means of increasing muscle contractility, strength, and coordination. Repetitive exercise may be as critical to motor relearning following stroke as it is for healthy[6].

There is much controversy concerning the recovery mechanism of the injured CNS, as well as the mechanism and therapeutic effects of rehabilitation treatment. In monkeys with injuries in the brain region that is responsible for motor control of the arm, intensive treatment of the affected hand both improved hand function and induced structural changes in the brain. This suggests that intensive rehabilitation treatment could facilitate motor function and brain reorganization[28].

Liepert et al. (2000) claimed that before treatment, the representation area of the non-paretic muscles in the unaffected hemisphere was significantly larger than the motor representation of the paretic muscles in the affected hemisphere. This reflects a reduced excitability of the motor cortex in the affected hemisphere. This is probably due to reduced use of the paretic hand before therapy or may be the result of the infarct itself. The complete reversal of this abnormally took place after physical therapy treatment[22]. This observation agreed with Cramer and Crafton who reported to that after lesion reduced affected - hemisphere activity and increased non-affected hemisphere activity[9]. Mudie and Matyas, (2000) in their study developed a theoretical model proposing that bilateral simultaneous movement promotes interhemispheric disinhibition to allow reorganization by sharing of normal movement commonds from the undamaged hemisphere. Disinhibition may also encourage recruitment of undamaged neurons to construct new task-relevant neural networks[25].

A more recent study done by Carey et al. (2005) found that the upper limb function was linearly correlated with task related changes in regional cerebral blood flow. Therefore better motor recovery was correlated with reduction in contralesional activity and increased in the ipsilesional primary sensorimotor cortex[5].

Feys et al. (1998) pointed out that training repetitive movements without any problem solving activity limits generalization to functional performance. That is more complex and skillful activities are required to attain a certain degree of muscle recruitment and control. This is accomplished by addressing skillful and goal directed movements to obtain a maximal generalization toward function[15]. Practicing bilateral movements in synchrony (and in alterations) may result in a facilitation effect from non-affected upper extremity to the affected upper extremity. For example, when bimanual movements are initiated simultaneously, the arms act as a unit that supersedes individual arm action indicating that both arms are linked together as a coordinated unit in brain[20]. Studies have shown that learning a novel motor skill with one arm will result in a subsequent bilateral transfer of skill to the other arm[21]. Both single- and dual-task conditions is necessary to optimize functional independence and reduce falls in elderly people[39]. Dual task training improve Attention skills, Working memory, Self confidence, Self control, Mental processing speed,and quality of life for optimum performance.

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الملخص العربي

فاعلية تدريب محدد ثنائي المهام على المحصلة الوظيفية للطرف العلوي لمرضى الشلل النصفي الدماغي

يهدف هذا البحث إلى دراسة تأثير تدريب محدد ثنائي المهام على المحصلة الوظيفية للطرف العلوي لمرضى الشلل النصفي الدماغي . اشترك في هذا البحث ثلاثون مريضا (11 من الذكور و 19 من الإناث) يعانون من شلل نصفى طولي تقلصي . تم تقسيمهم إلى مجموعتين متساويتين . المجموعة الأولى (مجموعة الضابطة) وتشتمل على خمسة عشر مريضا عولجت ببرنامج العلاج الطبيعي التقليدي فقط . بينما عولجت المجموعة الثانية (المجموعة الدراسة) والتي شملت خمسة عشر مريضا عولجت عن طريق برنامج تدريب محدد ثنائي المهام للطرف العلوي بالإضافة إلى برنامج العلاج التقليدي ، وأستمر البرنامج العلاجي يوميا ولمدة ثمانية أسابيع . تم تقييم المرضى قبل وبعد العلاج عن طريق قياس الوظيفة الحركية للطرف العلوي وقياس وظائف اليد عن طريق تحديد قوة اليد وقوة العضلات لمفصل الرسغ بالإضافة إلى قياس الإتقان اليدوي . وقد أظهرت النتائج تحسن ذو دلالة إحصائية في كلا المجموعتين وكان التحسن أكثر وضوحا في المجموعة الدراسة . مما سبق فانه يفضل استخدام تدريب محدد ثنائي المهام على المحصلة الوظيفية للطرف العلوي لمرضى الشلل النصفي الدماغي لعلاج هؤلاء المرضي .