Physiotherapy and Occupational Therapy Journal
Volume 6 Number 4, October - December 2013

Original Article

Effect of Unaffected Upper Extremity Strengthening on Motor Performance of Affected Upper Extremity in Spastic Hemiplegic Cerebral Palsy

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Abstract

Introduction: In Cerebral Palsy the areas of the brain affected are those associated with the motor systems, which when damaged, impair control of movement. The difficulties of a child with Cerebral palsy are caused with either damage to or faulty development of the motor areas of the brain that disrupts the brain's ability to control movement and posture producing poor coordination, poor balance, or abnormal movement patterns. Over the decades, studies related to intermanual transfer have been performed in normal subject. The main objective of this study is "to find out the effect of strengthening of unaffected upper extremity on motor performance of affected upper extremity in spastic hemiplegic cerebral palsy". **Methodology:** 20 spastic hemiplegic CP subjects aged 5-15 years, IQ > 60 were taken and divided in two groups. Control group was given Conventional exercises for affected upper extremity and experimental group was given strengthening and co-ordination training to unaffected upper extremity while affected limb received the same treatment as control group. Intervention was given for three days a week for 3 weeks.The subjects were assessed using Purdue Pegboard test and Abilhand assessment tool before and after the intervention. **Results:** The experimental group showed significant effect on purdue pregboard task and abilhand tool after the training. **Discussion:** Intermanual transfer of training does exist in patients with spastic hemiplegic CP leading to improvement in motor performance.

Keywords: Spastic CP; Inter manual transfer; Pegboard task; Abilhand assessment tool.

Introduction & Background

Cerebral Palsy is a motor disorder that appears in children before the age of three. The condition is generally believed to be caused by damage or trauma to the brain before it is has fully developed. In Cerebral Palsy the areas of the brain affected are those associated with the motor systems, which when damaged, impair control of movement. The difficulties of a child with Cerebral palsy are not caused by problems with their muscles or nerves, but rather with either damage to or faulty development of the motor areas of the brain that disrupts the brain's ability to control movement and posture producing poor coordination, poor balance, or abnormal movement patterns.[1] Among various physical impairments, loss of hand functions has a profound effect on the individual's life.[2] *In the entire upper limb the percentage of functional importance of wrist and hand is 60%.*

Contractures of the elbows, for example, may interfere with the ability to position the hands in space. Mild to moderate wrist contractures may interfere with grasp and release and limit use of the affected hand as an assisting hand. The ability of an individual to accomplish everyday activities depends on the anatomical integrity, sensation, co-ordination and strength of his hands.[2] Many therapeutic strategies such as NDT, MRP, and PNF have been used to improve hand function. These strategies focus on the impaired segment to facilitate its recovery.

A few known Neuropsychological theories/ models suggest transfer of training from one

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hand to the other hand, which are known as Inter manual transfers.

It is well known that practice of novel movements with one hand affects subsequent performance of the other hand.[3]

However, over the decades, studies related to intermanual transfer have been performed in normal subject, there is no published evidence suggesting effectiveness of intermanual transfer in patients of hemiplegic cerebral palsy. But the theories suggesting intermanual transfer are strong enough to explore their effectiveness in patients with hemiplegic CP. Hence we decided on this particular concept.

Bert Steenbergen, Jeanne Charles and Andrew M. Gordon examined unimanual and bimanual fingertip force control during grasping in children with hemiplegic cerebral palsy (CP). Participants lifted, transported and released an object with one hand or both hands together in order to examine the effect on fingertip force control for each hand separately and to determine whether any benefit exists for the affected hand when it performed the task concurrently with the less-affected hand. They observed close synchrony of both hands when the task was performed with both hands, despite large differences in duration between both hands when they performed separately.[4] Hanajima R, *et al* investigated interhemispheric interactions between the human hand motor areas using transcranial cortical magnetic and electrical stimulation. A magnetic test stimulus was applied over the motor cortex contra lateral to the recorded muscle (test motor cortex), and an electrical or magnetic conditioning stimulus was applied over the ipsilateral hemisphere (conditioning motor cortex). They investigated the effects of the conditioning stimulus on responses to the test stimulus. These results were compatible with surround inhibition at the motor cortex.[5]

Objective

In spite of the fact that intermanual training being a well-established theory, there are no studies supporting/ refuting its use in patients of hemiplegic CP. If found effective, intermanual training can have significant therapeutic implications in patients with hemiplegic CP. Hence the study was planned. The main objective of this study is "to find out the effect of strengthening of unaffected upper extremity on motor performance of affected upper extremity in spastic hemiplegic cerebral palsy".

Hypothesis

Null hypothesis

There will not be any statistically significant effect of strengthening of unaffected upper extremity on motor performance of affected upper extremity in spastic hemiplegic cerebral palsy.

Alternate hypothesis

There will be a statistically significant effect of strengthening of unaffected upper extremity on motor performance of affected upper extremity in spastic hemiplegic cerebral palsy.

Methodology

20 spastic hemiplegic cerebral palsy subjects, aged 5-15 years were taken from a special school located in Delhi.

Inclusion Criteria

1. Hemiplegic Cerebral Palsy
2. Age 5-15 yrs.
3. I.Q. > 60
4. Full range of motion in upper limb (within normal limits).
5. Ashworth's scoring ≤ 1
6. Unaffected upper limb with MMT Grade 5

Exclusion Criteria

1. Any associated cardiac disease
2. Use of orthotic device in affected limb.
3. Sensory impairment in upper limb.

Procedure

After selection of subjects as per the inclusion criteria, the subjects were divided in two groups of 10 subjects each: Control group (group) and Experimental group (group).

For the control group the conventional Physiotherapy regime was given to affected extremity for duration of 3 weeks (3days a week). Therapy consisted of Passive stretching, PROM, Active stretching, Electrical stimulation to hand Muscles, PNF techniques-Hold Relax, Contract Relax, Agonist Inhibition and ADL Activities using Motor Relearning Program (MRP).

Experimental group was given Physiotherapy intervention for both the extremities. Affected upper extremity was given same regimen as the Control group. Unaffected extremity was given strengthening exercises using clay(putty), theraband, rubber bands, Hand gripper and squeezing ball and co-ordination exercises using movements of finger to nose, finger to finger, finger to therapist's finger, piano playing Movements, making circle with thumb and each finger one-by-one.

The hand function assessment of both the groups was taken before and after the intervention of 3 weeks by using the:

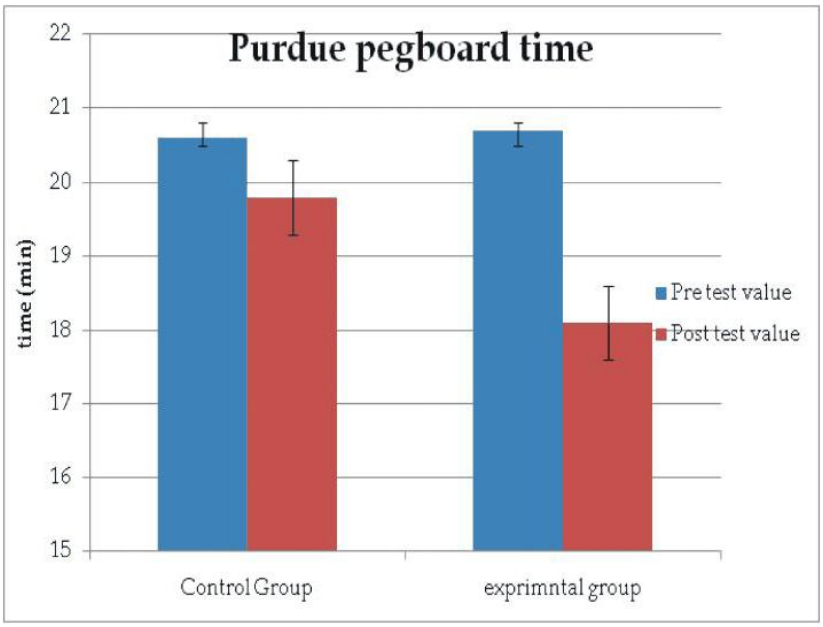
i) Peg board Test: It consisted of 6 different shapes, with 5 blocks of each shape, making it a pegboard of 30 blocks. Children were asked to lodge and dislodge with affected hand.Time was noted (in approximate minutes).

ii) Abilhand Assessment Tool: It is a Manual Ability Measure Scale, consisting of 21 tasks, which the parents were asked to fill and categorize whether the child did the particular task with ease, difficulty or impossible to do. The no. of activities done with ease were noted before and after the intervention.

Data Analysis & Results

The result for comparison "Between Pre-test & Post-test values of Control Group" using Paired t-Test showed no statistically significant difference in the values of time taken to complete the pegboard task. The pre test time was 20.6 min and post test time was 19.8 min. The result for comparison "Between Pre-test & Post-test values of Experimental Group"

Figure 1: A Child Performing the Pegboard Task



showed significance at 0.05 level of Paired t-Test. The pre test time was 20.7 min and post test time was 18.1 min.

Abilhand assessment tool showed increase in the number of tasks which can be done with ease before and after the intervention in two groups. Prior to intervention, children were able to do 11 tasks with ease in both the groups. However, after intervention, 8 out of 10 children in control group were able to do 15 tasks with ease and 9 out of 10 children in experimental group were able to do 18 tasks with ease.

Discussion

The main objective of this study was to find out the "effect of strengthening of unaffected upper extremity on motor performance of affected upper extremity in spastic hemiplegic cerebral palsy".

We used a variant of the pegboard task which is widely used in Neuropsychology for examination of motor functions.[6,7] Although this task is associated with a variety of functions, it is definitely a specific response. Previous Neuroimaging studies have shown that motor tasks triggered or guided by visual cues evoked strong cortical activation bilaterally in the ventral and dorsal premotor cortex(vPMC and dPMC), in the left sensorimotor (M 1 & S 1), in the left supplementary motor cortex(SMA), bilaterally in the inferior lobe, in the right inferior cerebellum. And in the left ventro lateral thalamus.[8-11] These findings highlight the fact that the pegboard task is most likely accompanied by distributed activation in bilateral fronto parietal network., the cerebellum, the basal ganglia and the thalamus. The distributed activation requires time consuming intrahemispheric and interhemispheric transfer of information and also time consuming process within each node of this network. The results of our study can be analyzed against the backdrop of this information.

The unaffected hand in the experimental group was subjected to 9 training sessions of 20 minutes each. There was significant reduction in the mean time taken to complete the pegboard task from 20.7min. to 18.1min. Therefore one might assume that some kind of interhemispheric transfer had occurred.

As mentioned, the pegboard task is a typical visuomotor task most likely accompanied by neural activities bilaterally in the vPMC and dPMC. The critical part of the task is not the movement itself, which is controlled by the

primary motor cortex, but rather the adjustment of movement parameters (eg. Distance between the holes, size of the pegboard) by means of visual information. According to the above mentioned brain imaging data, it is known that visual information associated with motor functions is transferred from the visual cortex bilaterally via the dorsal stream to the dPMC. Thus if say, in the right hand when the pegboard task is performed unimanually (causing strong activations with the left dPMC and left M 1), the right dPMC and possibly the adjacent right M 1 is also activated. Learning to perform the pegboard task the right hand will therefore automatically lead to an improvement of visual motor associations in both hemispheres, in which case performing the motor task with the untrained hand will rely on improved visual motor associations.There also may be further process such as training program located in M 1 or PMC or the interhemispheric exchange of information between both PMCs which are also stimulated.

In the control group, there was a no statistically significant difference in the mean time taken to complete the task i.e. the mean value reduced from 20.6min. to 19.8min. Though statistically insignificant, the difference in the mean time between initial and final reading could be due to conventional PT regimen and familiarization of the task.

As the results observed for the experimental group are statistically significant, therefore we can deduce that just being familiar with the task or the conventional PT regimen could not have been sufficient to improve task performance so significantly.These results demonstrate that the intermanual task performance exists in the patients with spastic hemiplegic cerebral palsy. It is essential to have training period and just familiarization with a task alone is not sufficient to improve performance in the affected upper extremity.

Future Research

The concept of intermanual transfer has been well established in normal subjects but there is little evidence supporting its use in patient's population. This study can be carried forward by conducting related studies in different neurological patient's population. A study also needs to be conducted to evaluate transfer of training from subdominants to weak/impaired dominant hand. Studies can also be conducted by varying the treatment duration, nature of task, complexity, to name a few.

Relevance to Clinical Practice

The results of the study can be applied in clinical settings to improve performance of the affected upper extremity in patients with spastic hemiplegic cerebral palsy.

Conclusion

The "Null hypothesis" is rejected and the results of the study indicate the following:

1. Training on the pegboard task improves task performance.
2. Intermanual transfer of training does exist in patients with spastic hemiplegic CP.
3. Familiarization of the task performance on the affected hand may not be clinically significant.

Limitations of the Study

1. The total sample size in the study is small.
2. The total duration of the study is very short.
3. The study is done on the students of DWSMR only. This makes the sample source very limited and confined.

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