Effect of Cross Education on Learning A Motor Skill in Hemiplegic Cerebral Palsied Children

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ABSTRACT

The purpose of this study was to investigate the effect of cross education training on supination skill of the affected upper extremity in hemiplegic cerebral palsied children. Twenty four hemiplegic cerebral palsied children participated in this study. Their ages ranged from 7 to 9 years ($\overline{X}$ 7.4). They were randomly divided into two groups of equal number A and B. The supination range and the performance time were measured before and after the treatment in the affected upper extremity using a modified axial rotation gravity geniometer, stop watch and videotapes. Subjects in group A received unilateral training of supination skill in their affected upper extremity, while subjects in group B underwent of bilateral training of supination skill in both forearms simultaneously. Treatment program was conducted for three months for both groups A and B , 4 days / week. Collected data at the end of treatment indicated significant changes in mean values of all measuring parameters in group A (P < 0.05). However, results of group B showed valuable improvements which were statistically highly significant in relation to corresponding mean values of group A (P < 0.001). It could be concluded that the cross education training might be used in conjunction with traditional physical therapy program in the habilitation of upper extremity in hemiplegic cerebral palsied children.

INTRODUCTION

Cerebral palsy (CP) is one of the most common neurological problems of children referred to paediatric physical therapists[7]. Hemiplegia is the commonest form of spastic CP accounting for 30% to 40% of the total number[18]. The affected upper limb is maintained in flexion and internal rotation of shoulder, and the scapula is adducted. The elbow is flexed with pronation of forearm. The wrist is flexed with some ulnar deviation, the thumb and fingers are flexed and adducted[6].

Motor skill learning is one of the greatest challenges that physical therapists often face during their rehabilitation programs for patients whose motor skills are considered absent, insufficient, impaired or abnormal. Several previous attempts have been conducted and focused on what variables and conditions of practice that facilitate, enhance and promote this learning[13]. Practice is essential for motor learning and the development of motor programs. Without practice, learning is impossible, with effective structuring of practice, learning is enhanced[17]. Practice of related or similar movement skills may improve performance in other desired skills. This has been termed transfer of learning and can be a useful strategy in promoting learning[21]. Practice of one part of the body in performing a skilled act increases

the ability of bilaterally symmetrical part in the same act. This phenomena has been called cross education[2], bilateral transfer[17] or intermanual transfer[2], contralateral transfer of training[19], cross exercise[8], excitation overflow[19] and interlimb transfer of training[8].

supination skill of the affected forearm in spastic hemiplegic cerebral palsied children compromises a major problem that hinders them from practicing most of their affected upper extremity daily living activities. So the improvement of this motor skill may improve the functional activities of it. So the purpose of this study was to investigate the effectiveness of cross education technique on supination skill in hemiplegic cerebral palsied children.

SUBJECTS, INSTRUMENTS AND PROCEDURES

Subjects

Twenty four hemiplegic cerebral palsied children participated in this study (18 right and 6 left sided). They were selected from the out patient clinic of the Faculty of Physical therapy, Cairo University (13 boys and 11 girls). Their ages ranged from 7 to 9 years ($\overline{X}$ 7.4) who met the following criteria:

- Degree of spasticity ranged from 1 to 2 grades according to modified Ashworth scale[3].
- All subjects were right hand dominant and having limitation in the supination range in the affected upper limb.
- All patients had the ability to follow instructions and they were free from any visual and auditory impairment.

The subjects included in this study were divided randomly into 2 groups of equal number, group (A) and group (B), 12 patients each.

Instruments:

- A modified axial rotation gravity geniometer, the validity of this geniometer was verified by medical engineering department, Faculty of Engineering, Cairo University[1].
- A portable video camera (WV - 3030 IV) and video tapes.
- Colour television and video set.
- Digital stop watch.
- Preston equipment for rehabilitation and special educator, model no. PC 5291, 2000, fig (1). This apparatus consists of a metal arch, which is fixed on a wooden base and is arched enough to allow full range of supination and pronation movement, a movable piece that moves through the metal arch.

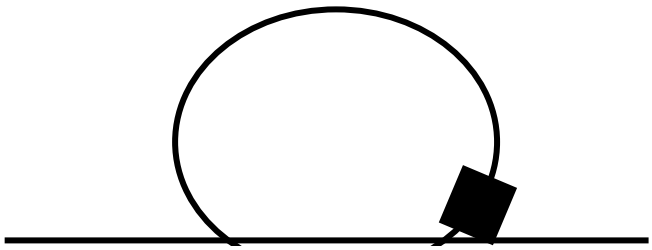

Fig. (1): Supinator Equipment.

Procedures

A. Evaluation

Each child sat and firmly fixed by straps to the back of the chair. The modified geniometer was fixed at the edge of the table on the side of the affected arm. The table height was adjusted to permit child to hold the handle while his/her forearm was in full pronation and 90° flexion elbow. Three reflected dots were fixed at the following three bony prominences: the greater tubercle, the lateral epicondyle of the humerous and the ulnar styloid process. Then each child in both groups was asked to supinate the affected forearm from full pronation as far as he/she could. The time utilized for accomplishment of the performed supination range was recorded by digital stopwatch. The evaluation procedure was repeated 3 times and the average value of them for both range of motion (ROM) and time were recorded. All of the previous steps were recorded on videotape[1]. Throughout the measurement, care was taken that the child's elbow was bent at approximately 90° to prevent additional rotation from the shoulder joint and his fingers must be closed tightly around the handle of geniometer to prevent additional rotation in his hand.

B. Treatment

Subjects in group (A) used one apparatus, fig. (1) to allow full range of supination and pronation in their affected forearm (unilateral use). While subjects in group (B) used two apparatus to allow full range of supination and pronation in both forearms simultaneously (bilateral use).

Each child in both groups was asked to grasp the movable piece of the apparatus that was supported on the table. The table was adjusted until the child could grasp the movable piece while his/her forearm 90° flexion elbow. Each child in both groups (A & B) was asked to move the movable piece to the end of the metal arch of the apparatus. The child who was unable to complete the task, was actively assisted by the therapist's hand to complete the task. All Children in both groups performed the task for 40 times in every treatment session with rest between two successive trials to reduce fatigue and distraction[1].

Subjects in both groups received a traditional program of physical therapy, including: positions for postural control and stability; neurodevelopmental technique; sensory stimulation as taping, approximation, weight bearing and prolonged stretch for affected upper limb. Stretching was used for affected pronators and wrist flexors.

Treatment was conducted 3 months, 4 days/week for both groups.

RESULTS

In the present study the effects of cross education training on supination range of affected upper extremity as well as the time needed of the performance of supination skill were evaluated in hemiparetic cerebral palsied children. Comparison of mean values of all measuring variables in both groups A and B before starting treatment indicated non-significant difference ($P > 0.05$). As revealed from table (1), fig. (2) a significant change was observed in the mean values of supination range in affected upper extremity for group A at the end of treatment as compared with the corresponding mean values before treatment ($P < 0.05$). A highly significant improvement in mean values of supination range for affected upper extremity in group B has been shown at the end of treatment as compared with the corresponding mean values before treatment ($P < 0.001$).

Table (2) and fig. (3) shows a significant reduction in mean values for time of performance supination range in affected upper extremity after suggested period of treatment for group A ($P < 0.05$). A highly significant change has been observed for mean value in time of performance supination skill of group B at the end of treatment as compared with corresponding mean value before treatment ($P < 0.001$). As indicated from table (3) a percentage of improvement in supination range for affected upper extremity was 18.5 % for group A and 27.5% for group B. Also percentage of improvement of time of performance supination range was 20.2% for group A and 28.9% for group B.

Table (1): Shows mean values of the supination range for affected forearm before and after treatment for both groups A and B.

		Group A	Group B
Pre	$\overline{X}$	32.64°	32.54°
	SD	± 4.34	± 4.29
Post	$\overline{X}$	38.69°	41.43°
	SD	± 4.77	± 5.47
	MD	6.05°	8.89°
	t	3.36*	4.5**

* Significance ** Highly Significance

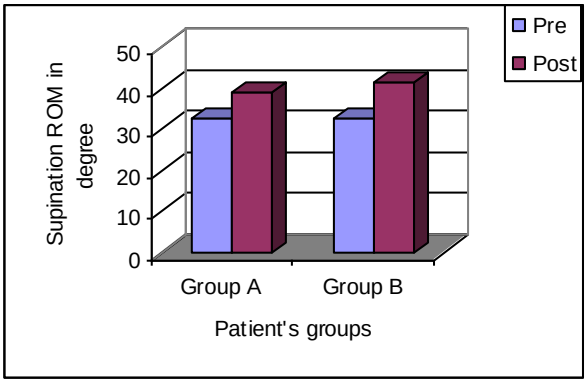

Fig. (2): Supination range for affected forearm before and after treatment for both groups A and B.

Table (2): Shows mean values for time of performance supination range in affected forearm before and after treatment for both groups A & B.

		Group A	Group B
Pre	$\overline{X}$	29.9	29.55
	SD	± 5.26	± 5.05
Post	$\overline{X}$	23.86	20.99
	SD	± 4.1	± 3.34
	MD	6.04	8.56
	t	3.09*	4.83**

* Significance ** Highly Significance

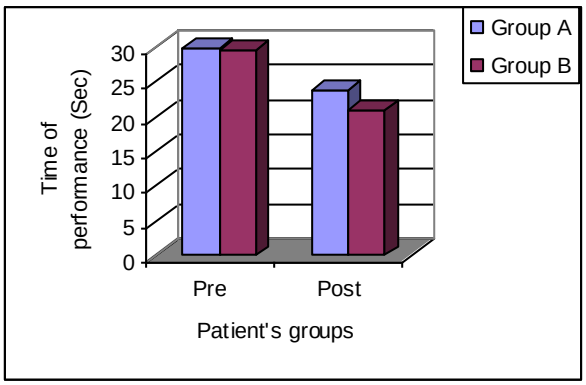

Fig. (3): Time of performance of supination range for affected forearm before & after treatment in both groups A & B.

Table (3): Show percents of improvement after suggested period of treatment in both groups A & B.

Patient's groups	Percents of improvement	
	Supination ROM	Time of performance
Group A	18.5 %	20.2 %
Group B	27.5 %	28.9 %

DISCUSSION

Hemiplegic cerebral palsied children frequently have limitation of supination range in their affected forearms[17].

The forearm supination skill is one of the motor skills which is frequently included in most of upper limb activity. This skill is

impaired or limited in the affected upper limb in hemiplegic children. Thus physical therapy interventions concerning with learning of this skill is important for those children.

Regarding to the results of the present study, there was a significant deficiency in mean values of supination range in affected upper extremity in both groups A & B before starting the treatment. The pretreatment results came in agreement with O'sallivan (1995)[17] who stated that cerebral palsied children have problem with praxis process of supination skill, which is impaired and affected by the presence of spasticity and the lack of practice. In case of hemiplegia, there is abnormal muscle tone which results primarily from the presence of the spasticity and secondary from changes in the intrinsic properties of the muscle fibers themselves[4]. Results of group A at the end of the suggested period of treatment indicated significant improvement in mean values of supination range for affected upper extremity. Also, there was a significant decrease in the mean values of the time (in seconds) needed for accomplishment of the performed range. These findings came in agreement with the findings of Abd El Kafy (2000)[1].

Results of group B at the end treatment revealed highly significant improvement in mean values of supination range in hemiparetic upper limb and a highly significant decrease in mean values of the time needed to complete the supination range. These results confirmed by the concepts and explanations of Pink, (1995)[19], Fujiwara et al., (1999)[8], Mohamed et al., (2001)[15], Jackson and Turner (2003)[10]. They stated that, transfer effects also can be incorporated into treatment by having the patient practice the desired movements using the contralateral extremities. In hemiplegia the more normal extremities can be engaged in practice of the desired movement patterns first. This enhances formation of the necessary motor programs, which can be used to control the movements in the opposite involved extremities.

Electromyographic activity was recorded in the nonexercised extremity while the contralateral upper extremity underwent to proprioceptive neuromuscular facilition (PNF). These results could be used in planning a treatment program for patients are unable to exercise one of their upper extremities and who could benefit from the contralateral effects of upper extremity PNF patterns[19].

The influence of non paretic leg movement on muscle action in paretic leg of hemplegic patients was evaluated by Fujiwara et al., (1999)[8]. They stated that, among patients with severe hemiplegia isometric knee flexion in the non-involved side maybe useful for facilitating the paretic rectus femoris and tibials anterior muscular activities.

The intermanual transfer of a new writing in young adults was examined by Andree and Matra (2002)[2]. They suggested that activities comprising tasks previously learned by one hand would be more effective in facilitating improved performance by the other hand.

In other work, prolonged muscle vibration on maximal voluntary knee extension performance in both ipsilateral and contralateral limb in man was evaluated by Jackson and Turner (2003)[10]. They stated that the findings of this study have implications for rehabilitation of patients with an immoblised limb.

The explanations for cross education could be summarized as following:

1- The presence of 2% undecussated portion of anterolateral corticospinal tract[20].
2- Bilateral activation of motor cortex during unilateral movement[11].

3- Diffusion of motor impulses from practiced to unpracticed side via irradiation[17].
4- The effect of repetitions, transfer can be improved if the number of repetitions of the contralateral extremities is increased and actual training of those limbs is promoted[17].
5- Reorganization of motor output in the non affected hemisphere5,16.
6- The presence of cognitive elements in motor skill acquisition and performance, If the task is complex with highly independent parts or if the learner has a limited memory or attention, learning can be enhanced through this method of practice[14].
7- Combination of many of the above explanations.

The findings of Lagasse (1974)[12]; Housh and Housh (1992)[9] contradicted with the results of this study who examined the effect of unilateral training on strength of the ipsilateral and contralateral limbs. Their results showed a non significant increase in strength in the contralateral untrained muscles.

Conclusion

The results obtained from this work clearly demonstrated the evidence of the effect of the cross education training on improving supaination skill in hemiplegic cerebral palsied children.

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الملخص العربي

تأثير برنامج التعليم المتبادل على تعلم مهارة حركية لدى الأطفال المصابين بالشلل النصفي

يهدف البحث إلى دراسة تأثير برنامج التعليم المتبادل على تعلم مهارة حركية لدى الأطفال المصابين بالشلل النصفي . تم إجراء هذا البحث على 24 طفلا من المصابين بالشلل النصفي ، تتراوح أعمارهم بين 7 إلى 9 سنوات . وقد تم تقسيم هؤلاء الأطفال إلى مجموعتين مجموعة (أ) ، ومجموعة (ب) ، وقد تم قياس المدى الحركي لانبساط الساعد (بالدرجات) والزمن اللازم لإتمام هذا المدى الحركي بالثواني وذلك بواسطة مقياس زوايا تجاذبي معدل ذو دورات محوري لقياس المدى الحركي وساعة رقمية لقياس زمن الأداء مع استخدام كاميرا فيديو أثناء إجراء عملية القياس والتقييم . وقد تم قياس النتائج لكلا المجموعتين أ ، ب ، قبل بداية التجربة وبعد 3 شهور من العلاج . يعتمد البرنامج العلاج لمجموعة (أ) على تمرين أداء مهارة انبساط الساعد للطرف العلوي المصاب أما مجموعة (ب) فقد تم تدريبها على استخدام الطرفين العلويين في نفس الوقت (الطرف المصاب – السليم) وقد أظهرت نتائج البحث عن وجود فروق ذات دلالة إحصائية مرتفعة بالنسبة للمجموعة (ب) بالمقارنة بنتائج مجموعة (أ) . بناءا على نتائج هذا البحث تم التوصية بضرورة استخدام برنامج التعليم المتبادل في تأهيل الأطفال المصابين بالشلل النصفي .