Coordination Dynamic Therapy in Management of Hemiplegic Cerebral Palsy

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ABSTRACT

This study was conducted to determine the effect of coordination dynamic therapy on controlling spasticity and functional abilities of the affected upper and lower limbs in spastic hemiplegic cerebral palsied children. ***Subjects:*** *Thirty spastic hemiplegic children ranging in age from six to eight years represented the sample of the study. The degree of spasticity ranged from 1 to* 1^+ *grades according to the modified Ashworth scale. They were divided randomly into two groups of equal number (A and B). The two groups received a conventional physical therapy program, in addition group B received coordination dynamic therapy. A motion analysis system was used to determine the shoulder, elbow, hip, knee and ankle joints' angles during stance phase, before and after four months of treatment.* ***Results:*** *The collected data at the end of treatment revealed significant improvement in the measured variables of the two groups, which was higher in favor of group B.* ***Conclusion:*** *significant improvement observed in group B may be attributed to the effect of coordination dynamic therapy which caused control and improvement of neurogenesis and functional cell through improvement of motor organization and relearning of the central nervous system.*
Key words: *Coordination Dynamic Therapy, Hemiplegia, Cerebral Palsy.*

INTRODUCTION

Cerebral palsy (CP) is the most common physical disability in childhood. The motor impairment syndrome is obligatory for the diagnosis, but a broad range of neurological deficit can be present as well[1]. Spastic paresis which is the most common motor disorder (83%) is characterized by posture and movement dependent tone regulation disorder[2].

Hemiplegia is the common form of spastic cerebral palsy, which results from damage to the sensorimotor cortex that controls one side of the body, resulting in affection of one side of the body including the limbs, trunk and possibly the neck[3].

In spastic hemiplegia, loss of recruitment of agonist contraction, or reduced output due to paresis plays a major role in the impairment of muscle function[4].

Lack of reciprocal inhibition in spasticity reflects a deficient control of interneuron, which mediate this inhibitory spinal mechanism between antagonistic muscles[5].

Professionals in pediatric rehabilitation are faced with a diversity of problems in the child and family, so a multidisciplinary approach for treatment is needed. Treatment of children with cerebral palsy requires a long term process during growth, focusing on all developmental aspects of the child and planning interventions in relation to the most urgent needs of the child and family[6].

The central nervous system (CNS) is viewed as a neuronal network which organizes itself. This organization can be changed by re-learning[7]. The self organization is based on a relative (specifically changing) phase and frequency coordination of rhythmically firing sub neuronal networks and single neurons[7].

Various systems of treatment have focused on co ordination of motor output, facilitation of righting and equilibrium response control of sensory input and development of functional skills[8].

Coordination dynamic therapy is the new efficient method for treating patients with lesions or diseases affecting the central nervous system, unlike many other methods which affect only the periphery[9].

The aim of this study was to determine the effect of coordination dynamic therapy on controlling spasticity of the affected upper and lower limbs in spastic hemiplegic cerebral palsied children through re learning of the central nervous system.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty spastic hemiplegic cerebral palsied children (11 right sided and 19 left sided), from both sexes ranging in age from six to eight years represented the sample of the study. They were selected from the out-patient clinic of the Faculty of Physical Therapy, Cairo University. The degree of spasticity was determined according to the modified Ashworth scale[10] to be ranging from 1 to 1^+ grades. They were able to understand any command given to them with an IQ within normal average level. The affected upper and lower limbs were free from any structural deformities. However, few degrees of tightness were noticed namely shoulder adductors, elbow flexors, forearm pronators and wrist and fingers flexors, hip adductors and internal rotators, and ankle planter flexors. They were divided randomly into two groups of equal number (A and B).

Evaluation was conducted for each child before and after four months of treatment. Group A (control) received a conventional physical therapy program, while group B (study) received coordination dynamic therapy, in addition to the program given to group A.

Instrumentation

For evaluation

* Opto-electronic motor analysis system, Qualisys motor capture system to measure the joints' angles. This system is composed of camera system having six cameras which detect light reflected by reflective markers, placed on a specific anatomical reference points (lateral vensity of acromion, lateral articulation of the elbow joint, greater trochanter of the hip, lateral articulation of the knee and below the lateral malleolus). This camera system was connected with a PC computer with Q-trac and Q-gait software for analyzing the motion pattern of patient gait.
* Reflective skin markers.
* Mat, roll, wedge, ball.

For treatment

Giger MD medical device (Fig.1) which offer exact phase and frequency co-ordination for relearning.

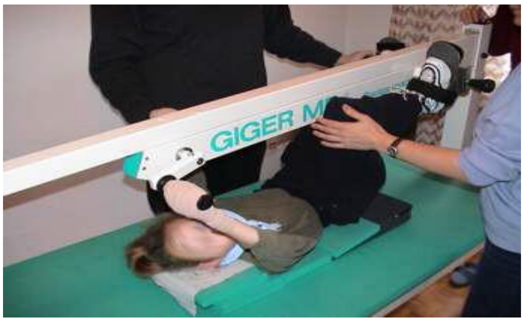

Fig. (1): Giger MD device.

Procedures

*** For evaluation**

All patients underwent gait analysis before and after four months of treatment by using the Qualisys motion analysis system to measure upper limb (shoulder, elbow) and lower limb (hip, knee, ankle) joints' angles during stance phase of gait.

*** For treatment**

The two groups A and B received conventional physical therapy program including neurodevelopment technique, faradic stimulation on the anti- spastic muscles, vestibular stimulation, facilitation of righting, equilibrium and protective reactions, and closed and opened environment gait training.

In addition, group B received coordination dynamic therapy in the form of alternative flexion and extension of the affected upper and lower limbs. Each child performed the alternative movement without resistance for three minutes as warming up and then with an intensity of 20 ramps per minute for five minutes repeated for three times with five minutes rest in between. It was conducted three times per week for successive four months. The total time for the treatment session for each child in the two groups lasted for one hour.

RESULTS

The raw data of the joints' angles of the affected upper and lower limbs were statistically treated to determine the mean and standard deviation of each measuring variable, for the two groups before and after three months of treatment. Student t-test was then applied to examine the significance of treatment procedures conducted in each group.

The obtained results in this study revealed no significant differences when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in all the measuring variables of the two groups (A and B), when comparing their pre and post-treatment mean values. However, high significant difference was observed in group (B), when comparing its post-treatment mean values with the post-treatment mean values of group (A).

Shoulder joints' angle

As shown in table (1) and figure (2), the mean values of the shoulder joint's angle for group A pre and post-treatment were 77.21° ± 4.46° and 80.79° ±4.58° respectively, ($P<0.01$). While the mean values for group B pre and post- treatment were 78.05° ± 4.89° and 91.80° ± 5.28° respectively, ($P<0.0001$).

Elbow joints' angle

Also, table (1) and figure (2) show the mean values of the elbow joints' angle for group A and B pre and post-treatment. The elbow joints' angle for group A pre and post-treatment were 110.46° ± 5.18° and 114.63° ± 5.40° respectively, (P<0.05). While the mean values for group B pre and post-treatment were 110.98° ± 5.74° and 126.04° ± 6.53° respectively, (P< 0.0001).

Table (1): Pre and post-treatment mean values of shoulder and elbow joints angles (degree) for groups A and B.

Joint	Groups	Pre $\bar{X}$±SD	Post $\bar{X}$±SD	t-test	P-value	Sig.
Shoulder	A	77.21±4.46	80.79±4.50	3.01	<0.01	Sig.
	B	78.05±4.89	91.80±5.28	7.39	<0.0001	H. sig.
Elbow	A	110.46±5.18	114.63±5.40	2.16	<0.05	Sig.
	B	110.98±5.74	126.04±6.53	8.96	<0.0001	H. sig.

$\bar{X}$: mean SD: standard deviation. T-test: student t-test
P: value: level of significance. Sig.: significance H. sig.: Highly significant

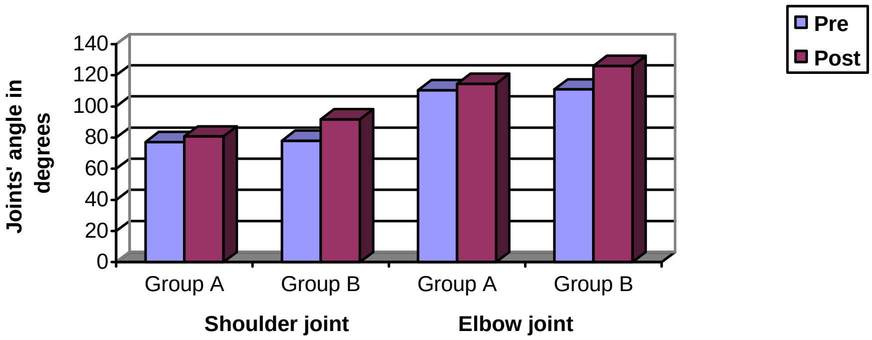

Fig. (2): Illustrating the pre and post-treatment mean values of shoulder and elbow joints' angles for groups A and B.

High significant increase in the mean values of the upper limb joints' angles (shoulder and elbow) were observed in group B when comparing the post-treatment mean values of the two groups A and B (P< 0.0001), fig.(3).

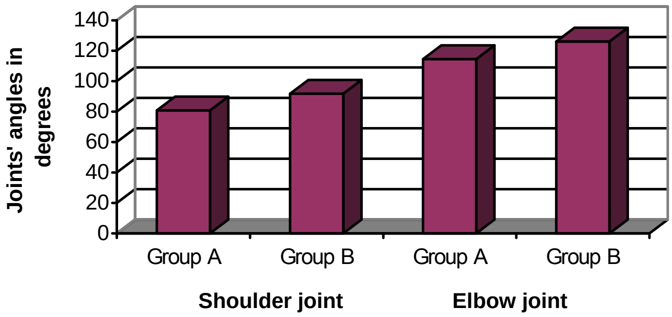

Figure (3): Shows the post-treatment mean values of the upper limb joints angles (shoulder, elbow) in degrees for groups A and B.

Hip joints' angle

As shown in table (2) and figure (4), the mean values of the hip joints' angle for group A pre and post-treatment were 6.78º ± 3.88º ± and 13.66º ± 3.54º respectively, (P<0.001). While the mean values for group B pre and post-treatment were 7.8º±2.41º and 19.21º ± 2.33º respectively, (P< 0.0001).

knee joints' angle

Table (2) and figure (4) show the mean values of the knee joints' angle for groups A and B pre and post-treatment. The knee joints' angle for group A pre and post-treatment were 2.15º ± 1.88º and 4.98º ± 2.15º respectively, (P<0.01). While the mean values for group B pre and post-treatment were 3.15º ± 1.98º and 8.57º ± 1.79º respectively, (P< 0.001).

Ankle joints' angle

As shown in table (2) and figure (4) the mean values of the ankle joints' angle for group A pre and post-treatment were 38.41º ± 3.19º and 34.87º ± 3.05º respectively, (P<0.05). While the mean values for group B pre and post-treatment were 37.11º ± 2.93º and 26.50º ± 2.65º respectively, (P<0.0001).

Table (2): Pre and post-treatment mean values of lower limb joints' angles (hip, knee and ankle) in degree for groups A and B.

Joint	Groups	Pre X̀ ±SD	Post X̀ ±SD	t-test	P-value	Sig.
Hip	A	6.78±3.88	13.66±3.54	5.07	<0.001	Sig.
	B	7.8±2.41	19.21±2.33	13.53	<0.0001	H. sig.
Knee	A	2.15±1.88	4.98±2.15	3.84	<0.001	Sig.
	B	3.15±1.98	8.57±1.79	7.86	<0.0001	H. sig.
Ankle	A	38.41±3.19	34.87±3.05	3.11	<0.05	Sig.
	B	37.11±2.93	26.50±2.65	9.80	<0.0001	H. sig.

X̀ : mean SD: standard deviation. T-test: student t-test
P- value: level of significance. Sig.: significance H. sig.: Highly significant

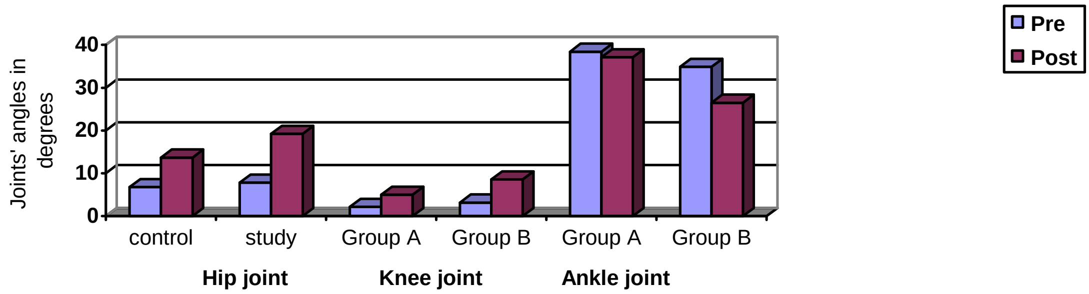

Fig. (4): Demonstrating the pre and post- treatment mean values of lower limb joints' angles (hip, knee and ankle) in degree for groups A and B.

High significant increase in the mean values of the lower limb joints' angles (hip, knee and ankle) were observed in group B when comparing the post treatment mean values of the two groups A and B ($P<0.05$), Fig.(5).

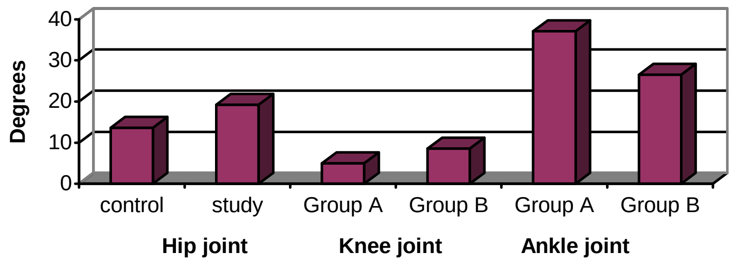

Fig.(5): Representing the post- treatment mean values of the lower limb joints' angles (hip, knee and ankle) in degree for groups A and B.

DISCUSSION

The results obtained from the present study demonstrated the evidence of using coordination dynamic therapy for improving the quality of movement of the affected upper and lower limbs in spastic hemiplegic cerebral palsied children. The mean values of the upper limb (shoulder and elbow) and lower limb (hip, knee and ankle) joints' angles revealed significant improvement in the two groups A and B, when comparing the pre and post-treatment mean values of the measuring variables of each group. Highly significant improvement was observed in favor of group B, receiving the coordination dynamic therapy, when comparing the post treatment means values of the two groups A and B.

Over the years, many systems of treatment have been developed(e.g. neurodevelopmental, Vojta method, conductive education, sensory integrative therapy) that differ in their specific treatment strategies, but aim at leading children with cerebral palsy toward the greatest degree of independence possible[11].

When distinguishing the therapeutic approaches on their emphasis, two basic principles can be recognized

1- Emphasis on normalization of the quality of movement.
2- Emphasis on functional activities.

In the present study the coordination dynamic therapy was used as an advanced technique based on both neurophysiological and functional basis.

Neurophysiological approaches focus on eliciting and establishing normal patterns of movement through controlled sensorimotor experiences. These sensory motor experiences are intended to inhibit abnormal movements and to facilitate postural adjustments to promote functional movement[12].

More recent theories on motor development and motor control, such as ecological approach introduced by dynamical systems approach described by Helen and Smith[13] and Kelso[14] emphasize that `motor behavior or developing behaviors should not be viewed as the unfolding of predetermined or prescribed patterns represented in the central nervous system.

The functional approach is based on an active rather than a passive view of motor learning. People learn by actively attempting to repetitively practice normal patterns of movement[15].

The post-treatment results agree with Wagenaar and Emmerik[16] who reported that it seems from the success in re-learning movements, vegetative and higher mental functions in patients with central nervous system lesion that the human central nervous system has a second integrative strategy to learn, re-learn, store and recall network states.

The results of the study also agree with Roelofsenet et al.,[17]who stated that the lesioned human central nervous system can be repaired by re-learning of partially lost phase and frequency co-ordination through coordinated rhythmic movements.

Significant improvement observed in group B may be attributed to the effect of coordination dynamic therapy which caused introduction and control of neurogenesis and functional cell proliferation by learning. Methods of re-learning basic central nervous system functions use especially rhythmic, dynamic, coordinated movements[18].

Improvement observed after the suggested period of treatment may be due to:

1-The exactness of the coordination of the performed movements during the therapy, to functionally reconnect disconnected network parts to recouple arms or legs that can not be moved.

2-The increase of the integration of the coordinated dynamic therapy which makes it possible to re-learn integrative functions.

3-The enhancement of the movement induced re-afferent input to strengthen the physiologic self-organization of the lesioned central nervous system and its communication with the environment.

4-The increase of the intensity of the therapy to force the "adaptive machine" central nervous system to adapt.

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الملخص العربي

العلاج بالتنسيق الديناميكى فى حالات الأطفال المصابين بالفالج الشقى

هذه الدراسةِ أجريتْ لتَقْرير تأثيرِ علاجِ التنسيقِ الديناميكي على السَيْطَرَة على زيادة نغمة العضلات والقدرات الوظيفية في الأطراف العليا والسفلي المتأثّرة في الأطفالِ المصابين بالفالج الشقي. **الموضوع:** ثلاثون طفلا من المصابين بالفالج الشقي تَرَاوُحت أعُمارهم مِنْ سَنَوات٦- ٨ تَمثّلَ عيّنةَ الدراسةِ وتَراوحتْ درجة زيادة النغمة العضلية مِن ١ إلى١+ درجات طبقاً لمِقياسِ أشورث المُعَدَّل. وتم تقسيمهم بشكل عشوائي إلى اثنان مِنْ مجموعاتِ العددِ المساوي (أ و ب). المجموعتان (أ) تلقت برنامج علاج طبيعي تقليدي مجموعة (ب) تلقتْ علاجَ تنسيقِ الديناميكي بالإضافة إلي برنامج العلاج الذي تلقته المجموعة الأولي . وتم قياس نظام تحلَيلِ الحركةِ لتَقْرير المدى الحركي لمفاصل الكتفِ، المِرْفَق، الورك، وكذلك مفاصلَ الكاحلَ والركبةَ أثناء مرحلةِ الموقفِ، قَبلَ وَبَعد أربعة شهورِ مِنْ المعالجةِ. **النَتائِج:** كَشفتْ البياناتُ المجمّعةُ لنهايةِ المعالجةِ تحسينَ هامَّ في المتغيّراتِ المدروسةِ مِنْ المجموعتين والتي كَانتْ أعلى لمصلحة خاتمةِ المجموعة (ب) والتحسين الهامّ الملحوظَ في المجموعة (ب) قَدْ تُنْسَبُ إلى تأثيرِ علاجِ التنسيقِ الديناميكي التي سبّبتْ السيطرةَ وتحسينَ وظيفية الخلية خلال تحسينِ المنظومة المحرّكة وكذلك إعادة التَعْلمُ للجهاز العصبي المركزَي .